

Appendix A: National Action Plan for Energy Efficiency Leadership Group



Co-Chairs

Marsha Smith
Commissioner, Idaho Public
Utilities Commission
President, National Asso-
ciation of Regulatory Utility
Commissioners

James E. Rogers
Chairman, President, and
C.E.O.
Duke Energy

Leadership Group

Barry Abramson
Senior Vice President
Servidyne Systems, LLC

Tracy Babbidge
Director, Air Planning
Connecticut Department of
Environmental Protection

Angela S. Beehler
Director of Energy
Regulation
Wal-Mart Stores, Inc.

Jeff Bladen
General Manager, Market
Strategy
PJM Interconnection

Sheila Boeckman
Manager of Business Op-
erations and Development
Waverly Light and Power

Bruce Braine
Vice President, Strategic
Policy Analysis
American Electric Power

Cheryl Buley
Commissioner
New York State Public
Service Commission

Jeff Burks
Director of Environmental
Sustainability
PNM Resources

Kateri Callahan
President
Alliance to Save Energy

Jorge Carrasco
Superintendent
Seattle City Light

Lonnie Carter
President and C.E.O.
Santee Cooper

Gary Connett
Manager of Resource Plan-
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Great River Energy

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Chairman and C.E.O.
New Jersey Natural Gas
(New Jersey Resources
Corporation)

Roger Duncan
Deputy General Manager,
Distributed Energy Services
Austin Energy

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New York Power Authority

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New Jersey Board of Public
Utilities

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Connecticut Department
of Public Utility Control

Dian Grueneich
Commissioner
California Public Utilities
Commission

Blair Hamilton
Policy Director
Vermont Energy Invest-
ment Corporation

Leonard Haynes
Executive Vice President,
Supply Technologies,
Renewables, and Demand
Side Planning
Southern Company

Mary Healey
Consumer Counsel for the
State of Connecticut
Connecticut Consumer
Counsel

Joe Hoagland
Vice President, Energy
Efficiency and Demand
Response
Tennessee Valley Authority

Sandy Hochstetter
Vice President, Strategic
Affairs
Arkansas Electric
Cooperative Corporation

Helen Howes
Vice President, Environ-
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Exelon

Bruce Johnson
Director, Energy
Management
Keyspan

Mary Kenkel
Consultant, Alliance One
Duke Energy

Ruth Kiselewich
Director, Conservation
Programs
Baltimore Gas and Electric

Rick Leuthauser
Manager of Energy
Efficiency
MidAmerican Energy
Company

Harris McDowell
Senator
Delaware General Assembly

Mark McGahey
Manager
Tristate Generation
and Transmission
Association, Inc.

Ed Melendreras
Vice President, Sales and
Marketing
Entergy Corporation

Janine Migden-Ostrander
Consumers' Counsel
Office of the Ohio
Consumers' Counsel

Michael Moehn
Vice President, Corporate
Planning
Ameren Services

Fred Moore Director Manufacturing & Technology, Energy The Dow Chemical Company	Jan Schori General Manager Sacramento Municipal Utility District	Mike Weedall Vice President, Energy Efficiency Bonneville Power Administration	Jeff Genzer General Counsel National Association of State Energy Officials
Richard Morgan Commissioner District of Columbia Public Service Commission	Ted Schultz Vice President, Energy Efficiency Duke Energy	Zac Yanez Program Manager Puget Sound	Donald Gilligan President National Association of Energy Service Companies
Brock Nicholson Deputy Director Division of Air Quality North Carolina Air Office	Larry Shirley Division Director North Carolina Energy Office	Henry Yoshimura Manager, Demand Response ISO New England Inc.	Chuck Gray Executive Director National Association of Regulatory Utility Commis- sioners
Pat Oshie Commissioner Washington Utilities and Transportation Commission	Tim Stout Vice President, Energy Efficiency National Grid	Dan Zaweski Assistant Vice President of Energy Efficiency and Distributed Generation Long Island Power Authority	Steve Hauser President GridWise Alliance
Douglas Petitt Vice President, Government Affairs Vectren Corporation	Deb Sundin Director, Business Product Marketing Xcel Energy	Observers	William Hederman Member, IEEE-USA Energy Policy Committee Institute of Electrical and Electronics Engineers
Bill Prindle Deputy Director American Council for an Energy-Efficient Economy	Paul Suskie Chairman Arkansas Public Service Commission	Keith Bissell Attorney Gas Technology Institute	Marc Hoffman Executive Director Consortium for Energy Efficiency
Phyllis Reha Commissioner Minnesota Public Utilities Commission	Dub Taylor Director Texas State Energy Conser- vation Office	Rex Boynton President North American Technician Excellence	John Holt Senior Manager of Generation and Fuel National Rural Electric Cooperative Association
Roland Risser Director, Customer Energy Efficiency Pacific Gas and Electric	Paul von Paumgarten Director, Energy and Envi- ronmental Affairs Johnson Controls	James W. (Jay) Brew Counsel Steel Manufacturers Association	Eric Hsieh Manager of Government Relations National Electrical Manu- facturers Association
Gene Rodrigues Director, Energy Efficiency Southern California Edison	Brenna Walraven Executive Director, Nation- al Property Management USAA Realty Company	Roger Cooper Executive Vice President, Policy and Planning American Gas Association	Lisa Jacobson Executive Director Business Council for Sustainable Energy
Art Rosenfeld Commissioner California Energy Commission	Devra Wang Director, California Energy Program Natural Resources Defense Council	Dan Delurey Executive Director Demand Response Coordi- nating Committee	Kate Marks Energy Program Manager National Conference of State Legislatures
Gina Rye Energy Manager Food Lion	J. Mack Wathen Vice President, Regulatory Affairs Pepco Holdings, Inc.	Reid Detchon Executive Director Energy Future Coalition	
		Roger Fragua Deputy Director Council of Energy Resource Tribes	

Joseph Mattingly
Vice President, Secretary
and General Counsel
Gas Appliance Manufac-
turers Association

Kenneth Mentzer
President and C.E.O.
North American Insulation
Manufacturers Association

Diane Munns
Executive Director, Retail
Energy
Edison Electric Institute

Michelle New
Director, Grants and
Research
National Association of
State Energy Officials

Ellen Petrill
Director, Public/Private
Partnerships
Electric Power Research
Institute

Alan Richardson
President and C.E.O.
American Public Power
Association

Andrew Spahn
Executive Director
National Council on
Electricity Policy

Rick Tempchin
Director, Retail Distribution
Policy
Edison Electric Institute

Mark Wolfe
Executive Director
Energy Programs
Consortium

Facilitators

U.S. Department of Energy

U.S. Environmental
Protection Agency

Appendix B: Glossary



Achievable potential: The amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential.

Applicability factor: The number of units per customer eligible for a certain measure.

Cost-effectiveness: A measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits outweigh the cost, the measure is said to be cost-effective.

Economic potential: Refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources.

End-use: A category of equipment or service that consumes energy (e.g., lighting, refrigeration, heating, process heat).

Energy efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way.

Feasibility factor: The fraction of the units that can technically be replaced with an efficient alternative from an engineering point of view.

Lost-opportunity: Refers to an efficiency measure or efficiency program that seeks to encourage the selection of higher-efficiency equipment or building practices than would typically be chosen at the time of a purchase or design decision.

Measure: Installation of equipment, subsystems, or systems, or modification of equipment, subsystems, systems, or operations on the customer side of the meter, in order to improve energy efficiency.

Net penetration rate: The difference between the anticipated adoption rate of the efficiency measures after intervention and the “business as usual” adoption rate absent efficiency intervention.

Participant cost test: A cost-effectiveness test that focuses on either “typical” or aggregate participating customer(s), comparing quantifiable benefits and costs.

Portfolio: Either (a) a collection of similar programs addressing the same market, technology, or mechanisms or (b) the set of all programs conducted by one organization.

Potential study: A quantitative analysis of the amount of energy savings that either exists, is cost-effective, or could potentially be realized through the implementation of energy efficient programs and policies.

Program: A group of projects with similar characteristics and installed in similar applications.

Program administrator cost test: A cost-effectiveness test that evaluates the impacts of the efficiency initiatives on the administrator or energy system (sometimes referred to as the utility cost test or energy systems test).

Program potential: Refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as “achievable” in contrast to “maximum achievable.”

Project: An activity or course of action involving one or more energy efficiency measures, at a single facility or site.

Ratepayer impact measure (RIM) test: A cost-effectiveness test that evaluates the impacts on customer rates.

Retrofit: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher efficiency units (also called “early-retirement”) or the installation of additional controls, equipment, or

materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, lighting occupancy controls, economizer ventilation systems).

Spillover: Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program, beyond the program-related gross savings of the participants. There can be participant and/or non-participant spillover.

Societal cost test (SCT): A cost-effectiveness test that is a variation of the total resource cost test that includes monetized effects of externalities (e.g., emissions impacts) benefits.

Technical potential: The theoretical maximum amount of energy use that could be displaced by efficiency,

disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures.

Total resource cost (TRC) test: A cost-effectiveness test that assesses the impacts of a portfolio of energy efficiency initiatives on the economy at large. The test compares the present value of costs of efficiency for all members of society (including costs to participants and program administrators) compared to the present value of benefits, including avoided energy supply and demand costs.

Turnover factor: The portion of existing units that will be naturally replaced each year due to failure, remodeling, or renovation.

Appendix Detailed Methodology C: Discussion



This appendix provides a summary of a typical analytical framework for conducting a potential study as well as additional discussion of the individual components. This is not intended to provide sufficient detail to direct readers to conduct their own studies, but rather to inform them of the types of issues that arise during a study so that they may participate meaningfully in discussions of methodology, data sources, etc. It should also be noted that this is an example of a typical analytical approach. Numerous variations on this method can and do exist, and will generally be developed in consideration of data, budget, and time available.

C.1 Forecasts and Disaggregation

Broadly speaking, the objective of a potential study is to estimate future energy savings opportunities resulting from the presence of some program or policy to promote efficiency. That is, the potential estimate is relative to some scenario that represents business as usual. Therefore, the first step in any potential study is to predict the future in the absence of intervention to promote additional efficiency investments. This baseline scenario forecast provides the context for the comparison of the efficient scenario. The baseline can be characterized in terms of annual kWh consumed, peak demand of the system (whatever its boundaries) in MW, tons of pollutants emitted, or other metric. In practice, the first two metrics are most typically used.

It is critical to understand what the baseline forecast represents. For example, many jurisdictions have some efficiency programming already. Do the forecasts include expansion of the existing program, ignore it altogether, or somewhere in between? Furthermore, does the forecast include assumptions about “natural efficiency” (the proportion of all equipment purchases that will flow to efficient products in the absence of any programmatic incentives) or changes in building codes or other energy use standards (e.g., national ENERGY STAR requirements)?

The effect of economic growth and new construction on the forecast should also be understood. Electricity

demand and consumption typically grow over time because there are both new consumers (represented by new households, commercial buildings, and industrial facilities) and growth in existing consumers’ consumption. Understanding the relative contribution of these two factors to the baseline forecast provides important input to assumptions made later in the analysis, particularly in determining the number of opportunities for different types of efficiency investment.

Care should also be taken to ensure that, if forecasts for different sectors are derived from different sources, they are harmonized to the extent possible. For example, the underlying economic or demographic assumptions behind a forecast of residential energy growth should match those used to determine industrial energy consumption. Another potential pitfall concerns different treatment of some industries or building types by different data sources.¹ A detailed discussion of this issue is beyond the scope of this paper; suffice it to say that the user should try to understand the underlying assumptions and limitations in their input data, as with any analytical effort.

Disaggregating the baseline forecast typically presents challenges. Good state- or utility-level energy use data are typically not readily available. Utilities may have data sets that provide some information on their customer population such as building size or industry classification, but many do not. Refer to Section 3.3.2 for a more detailed discussion of some of the primary data sources on energy consumption in the United States.

In some cases, utilities or states have undertaken end-use surveys, particularly in the residential sector. Such information is highly valuable for potential studies. Even if the survey is several years old, there may be sufficient information to adjust for changes in technology, economy, and demographics since the data were collected. For studies that require a robust, detailed understanding of energy use by building type or end-use, field visits and/or site surveys—which can add substantial cost to the overall effort—may be needed to acquire the necessary information.

C.2 Measure Characterization

Measure characterization is the determination of parameters for individual or bundles of technologies, services, or design practices that define the costs, savings, and lifetimes for different measures. Measure characterization will typically rely on research about existing technologies available in the market and their performance, as well as engineering calculations and cost estimation. Typical steps include:

- Determination of an efficiency measure, including defining the baseline efficiency or practice as well as that of the efficient scenario.
- Calculation of the annual energy savings and peak demand impact coincident with the utility system. This generally will be specific to individual customer types, reflecting differences in operating hours, load shapes, existing efficiency levels, etc.
- Determination of the pattern of savings over time. This is dependent on the energy-use load shape of the measure. Because energy reductions are more valuable at some times than others (e.g., during business hours on a hot summer day versus during the night in the winter for electric systems), modeling the hourly occurrence of savings is important to estimating the benefits from efficiency. Ideally, hourly data by building type and measure will be used. If potential study results are integrated with power production models, hourly data will typically be necessary. If not, aggregated data for seasonal on- and off-peak periods may suffice, along with “coincidence factors,” which estimate the portion of customer peak demand savings that will be coincident with the time of the utility system peak. Often development of this data requires building simulation modeling or reliance on secondary research.
- Determination of differences in operation and maintenance costs of efficient versus baseline measures. For example, if efficient equipment lasts longer than baseline equipment, savings in avoided replacement parts may occur.
- Determination of non-energy costs and benefits, such as savings in water, waste reduction, improvements in productivity, etc., related to adoption of efficient systems.
- Determination of the measure cost. For “lost opportunity” measures such as in new construction and planned replacement of failing equipment, this will typically be the incremental cost of efficient equipment as compared to baseline equipment. For discretionary early retirement measures that replace functioning equipment or other retrofit measures such as building shell improvements, costs will typically represent the total labor and equipment costs of new systems.
- Determination of the average service life of the efficient alternative.
- Determination of shifts in savings and capital investments over time. For example, initial savings from equipment retrofit measures represent the difference in efficiency between the efficient equipment and the old, inefficient existing equipment at a facility. However, this old equipment would naturally be replaced at some point in the absence of an efficiency initiative with new equipment at the standard efficiency available at that time. As a result, the long-term savings from early retirement measures are often much less than the initial savings. Similarly, the retrofit defers the need for new capital investment to replace the old equipment at the normal replacement time. The

present value of this permanent shift in capital expenditures must be taken into account to properly assess the cost-effectiveness of these measures.

C.3 Applying Data Parameters

While the disaggregated forecast and measure-level data provide many of the inputs to a potential estimate (along with specific penetration rates, described above), an analytical approach to combine all these data and take account of the many moving parts is necessary. In general, there are two main approaches to calculating the potential of an efficiency measure: top-down and bottom-up.

A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its efficient counterpart, and then multiplies these numbers by the number of measures expected to be installed throughout the life of the program. Often, a bottom-up approach is preferred for residential analysis because of the greater amount of data available and homogeneity of the buildings. While this approach does not rely as directly on a disaggregation of the energy use forecast, when using a bottom-up approach it is important to calibrate results to the disaggregated data to ensure that credible results are obtained. For example, if one has an overly high estimate of the number of households with electric heat, relying only on a bottom-up approach could result in estimated potential that exceeds the total existing heating consumption of all customers. A bottom-up approach requires the same basic factors as a top-down approach, with a couple of key differences:

- The applicability factor is not expressed as the percentage of eligible kWh sales, but rather as the number of customers eligible for a certain measure. Depending on the measure, it may range from less than one (say, the fraction of customers with a dishwasher) to greater than one (say, the number of incandescent light bulbs per customer).
- The savings factor is not needed, since a bottom-up approach already starts with the energy and demand saved by a given measure.

The resulting formula is:

$$\begin{aligned} \text{Measure Savings} &= \text{Per Unit Savings} \\ &\times \# \text{ of Households or Customers} \\ &\times \text{Applicability Factor} \\ &\times \text{Feasibility Factor} \\ &\times \text{Turnover Factor} \\ &\times \text{Net Penetration Rate} \end{aligned}$$

C.4 Industrial Efficiency Potential

Developing a potential analysis for industrial energy consumers can be more complicated than for the residential and commercial sectors due to the relative heterogeneity of energy consumption patterns and end-uses across different industries. Industrial efficiency potential estimates can be developed using either a top-down or a bottom-up approach, depending on data availability, the variability in facility type included in the study, and other factors.

Whereas industry-level data on energy consumption may be difficult to come by, it is often relatively easy to gather economic data at the industry level within an area of interest. Therefore, a useful approach starts with these data and develops industry-specific energy use estimates using average energy intensities for each industry. Expressed in kWh per dollar value of output, sales volume, or other economic measure, these factors are available from the Energy Information Administration's Manufacturing Energy Consumption Survey (see Section 3.3.2). Depending on the level of rigor required, these factors may be verified and/or adjusted by surveying a sample of local industries to determine if local conditions result in substantially different energy intensities from the published averages. Given that most regions have a small number of industries responsible for a large fraction of industrial energy use, this type of survey need not be exhaustive to provide a valuable increase in accuracy.

Once industry-level energy use forecasts are in hand, a top-down approach using published factors for the potential energy savings available in different industries—applied to industry-sector-specific economic forecasts—is a relatively straightforward way to assess the potential

available in the area of interest. An example of this approach is found in a study of energy efficiency potential in New York State (NYSERDA, 2003). The potential savings in each industry from this study may be transferred to other states or regions and applied to the distribution of industrial energy use there. This was recently done in a high-level potential study for Texas (Optimal Energy, 2007).

A bottom-up approach requires more detailed data regarding the average saturation of key energy-using equipment in industrial facilities, such as motors, mechanical equipment, refrigeration, etc. Assuming sufficient data are available or are captured through onsite visits, this approach would proceed in the same fashion as described above. For a targeted study, resources can be focused on accurately characterizing one or a small number of industries in the area of interest through site visits or surveys. When applying this approach to industrial facilities, it is important to note the heterogeneity in the energy savings of various efficiency measures across industries. For example, whereas the average energy savings in residential applications are relatively consistent (say, for a more efficient refrigerator), industrial equipment operates under widely variable conditions in different facilities. A motor may be in use 250 hours per year or 7,500. Any industrial potential estimate must acknowledge this variability, include mechanisms to address it, and clearly state the assumptions that result.

C.5 Understanding Interactions Between Efficiency Opportunities

While Section 3.4 provides a general overview of typical analytical methods for quantifying overall efficiency potential, care must be taken to recognize the dynamic nature of real-world efficiency adoption and interactions among different efficiency resources. Three major factors must be explicitly addressed in any analysis:

- Acknowledging and accounting for the changing building and equipment stock over time and its effect on future efficiency opportunities.

- Identifying and adjusting for mutually exclusive efficiency opportunities.
- Estimating the interactions among different efficiency measures.

Without explicitly adjusting for the above three items, significant errors can occur in analysis that result in double counting or other large overestimation of potential. The first issue recognizes that as one assumes adoption of aggressive efficiency, the baseline stock of equipment becomes different so that future years' efficiency opportunities are diminished. For example, in the extreme case of a technical or economic potential study, all retrofit opportunities are assumed to be captured immediately. Under this scenario, in the short term no remaining opportunities to improve efficiency at the time of natural replacement exist because they have all been captured through retrofit. In the case of achievable potential, keeping track of the changes to existing equipment over time becomes more critical, as some percentage of opportunities may be captured through retrofit programs while others will be targeted at the time of natural replacement.

The second issue is important because many technologies analyzed may be mutually exclusive. For example, an office can replace an existing tank-type water heater with either: 1) a high efficiency tank-type water heater; 2) a separate storage tank with water heated through a heat exchanger off a central boiler; and 3) a point-of-use heater. However, all three would not simultaneously be installed. Therefore, while each technology's individual efficiency potential is initially calculated, the aggregate efficiency potential must parse out how much adoption will occur from each technology in consideration of the others to avoid double counting.

Finally, the cumulative efficiency potential will necessarily be less than the sum of the individual potential for each measure. This is the result of interactions between systems. For example, adoption of efficient windows or insulation will lower the cooling and heating loads in building. As a result, once these are installed the efficiency potential from an efficient air conditioner or

boiler will be lower, as will its cost-effectiveness. Therefore, once individual measure potential is estimated, an iterative process must be undergone to properly reflect interactions to determine ultimate total potential for a given market segment, customer class, or total sector.

C.6 Program Budgets

Though energy efficiency almost always provides positive net benefits to both society and program administrators, it costs money to make it happen. The budgets associated with energy efficiency are important components of all of the economic tests. The degree of detail that goes into determining budgets for an achievable or program potential study is driven by the level of detail desired and the study's uses.

For a high-level study, program budget estimates are often determined by applying cost adders to the modeled measure or financial incentive costs, based on typical ratios of program non-measure costs (for things such as administration, marketing, data tracking, monitoring and evaluation, etc.) to measure costs or incentives. Ideally, when using adders, distinct adders should be applied to different programs, and adders should vary over time. For example, a market transformation program that focuses on upstream efforts at manufacturers and distributors may have proportionally much higher non-measure costs than an industrial retrofit program that focuses on distinct, site-specific opportunities. Similarly, some programs may have very high adders in early years for training and marketing, with significant drops over time as participation increases and start-up costs go away. As with any economic analysis, all dollars should be consistent between budgets, avoided costs, measure costs, and other inputs in terms of whether they are real or nominal, and the years dollars they are expressed in.

For a more detailed study, especially where the potential study may or will be used as a starting point for initiative planning, more detailed budgets should be derived. While incentive costs will be driven by estimates of installed measure costs and the incentive design (e.g.,

50 percent of incremental costs for new construction), there are a range of budget categories to consider. Program budgets should be built up by line item, based on expected needs of things like staffing, outside engineering assistance, annual evaluation costs, etc. Some typical budget line items that should be considered include, but are not limited to:

- **Administrative management:** The portion of upper-level management costs that will be assigned to any individual or portfolio of initiatives.
- **Program management:** This labor cost is incurred by overseeing implementation of any initiative, whether using in-house or outsourced staff.
- **Project management:** Represents labor spent in working directly with customers or supporting contractors, architects, or engineers; managing efficiency projects; and providing coordination services and in-house documentation.
- **Business development:** Labor costs associated with face-to-face sales efforts in bringing participants and partners into the initiatives.
- **Planning:** Costs of establishing initiative strategies and ongoing program design and analysis.
- **Technical assistance:** Providing customers with analysis of individual efficiency opportunities, including opportunity identification and quantification of benefits, costs, and performance issues. May be provided by a combination of in-house and outsourced staff.
- **Administrative:** Costs for day-to-day administration plus allocated costs for office management, accounting, payroll, fulfillment (e.g., cutting incentive checks).
- **Subcontractors:** Could range from outsourced labor for any of the above, to subcontractors representing the entire workforce for a particular initiative.
- **Measurement and verification:** Costs to verify claimed energy efficiency savings. Typically includes in-house quality assurance/control activities as well as pre- and post-installation inspections of customer sites.

- **Tracking:** The development, maintenance, and use of a data tracking system for customer interaction, claimed energy savings (both by customer and in aggregate), associated costs, and management and regulatory reporting.
- **Marketing and advertising:** Ranges from radio and/or television advertisements, to developing articles to be published in local newspapers or trade journals, to the development and maintenance of a Web site and program materials. Often includes labor to directly market to various entities.
- **Technical assistance/design assistance/commissioning/retro-commissioning incentives:** Project-based incentives separate from direct measure incentives to support market-based design and technical service costs.
- **Evaluation:** The costs of performing third-party evaluations of programs. This may include process, market, and impact evaluations.
- **Performance incentives and lost revenue:** Some jurisdictions provide performance incentives to program administrators to encourage exemplary performance. Others provide compensation to utilities for revenue losses from efficiency programs. Where these costs are a required part of implementing programs, they should be included in budgets, depending on the economic tests being performed. In economic tests from a societal perspective, performance incentives and lost revenue are not resource costs in that they are simply transfer payments—typically from ratepayers to shareholders or some other entity.

C.7 Cost-Effectiveness Screening

Once all of the data are available to determine the energy savings and costs associated with a forecast set of efficiency investments, the analyst can determine the overall effects of efficiency investments or policies. As described in Section 3.4, economic effects are of particular interest to decision-makers. The process of assessing the economic effects of efficiency investments is typically

referred to as “cost-effectiveness screening.” This refers to the comparison of the benefits of the investment to its cost. Efficiency measures should pass the “cost-effectiveness screen” of having positive net benefits (i.e., benefits greater than costs), based on whatever economic tests are applied.

Screening is conducted using one or more of the tests described in Section 3.4.3. To calculate the economic benefits from individual measures, benefits in individual years are calculated, added together, and discounted to provide a present value. Accurate estimates ensure that energy savings are not counted beyond the predicted lifetime of a measure and adjust savings when the baseline changes or “shifts” (as discussed above). The major component of economic benefits generally result from the direct energy and demand savings, and are calculated by multiplying the savings in each year by that year’s avoided costs for energy and demand (if applicable). Additional benefits can include non-energy economic benefits such as reductions in maintenance or replacements costs as well as water and other resource savings. Efficiency measures provide savings across multiple years, while costs are typically assumed to be borne in the installation year, so all benefits and costs should be expressed in terms of their present-value in a common year. In the case of economic potential estimates, measures that do not pass the cost-effectiveness screen will be eliminated from the analysis results. These economic results are then used in the application of the range of economic tests.

Numerous models exist to perform these economic screens. Some analysts have their own proprietary databases or spreadsheets, while others rely on commercially available software. Each platform has strengths and weaknesses, typically as a result of its development to support a particular project or projects. A detailed review of these models is beyond the scope of this Guide. Nevertheless, just as with other aspects of the analysis, the policy-maker should understand the key limitations of any model used as part of a potential study and any potential biases introduced as a result (e.g., whether the model tends to overestimate or underestimate the potential, or the cost of achieving that potential).

C.8 Notes

1. For example, municipal wastewater treatment plants are sometimes categorized as an industrial load and sometimes as commercial.



This appendix lists some common data sources used for potential studies, and a short description of each.

Title	Description	URL Address
Database for Energy Efficient Resources (DEER)	Sponsored by the California Energy Commission and the California Public Utilities commission, this database provides a list of measures, with their associate costs, savings, and expected lifetime. Note that these data are based on California information, and may have to be adjusted for use in other regions.	< www.energy.ca.gov/deer/ >
Commercial Building Energy Consumption Survey (CBECS)	CBECS is a survey conducted by the Energy Information Administration (EIA) every 4 years. It collects and quantifies "information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures." This has data for the nine census divisions, and is mostly used to find the applicability of a given measure (e.g., the percent of buildings that have air conditioning).	< www.eia.doe.gov/emeu/cbecs/ >
Residential Energy Consumption Survey (RECS)	This is the residential counterpart to CBECS, though in addition to the nine census divisions, it also has data for the four most populous states—California, Florida, New York, and Texas. It also tends to have better consumption data by end-use than CBECS.	< www.eia.doe.gov/emeu/recs/ >
Manufacturing Energy Consumption Survey (MECS)	The manufacturing counterpart to CBECS and RECS. The basic unit of data for MECS is the manufacturing establishment, and MECS provides consumption information on 48 industry groups and 21 industry subsectors.	< www.eia.doe.gov/emeu/mecs/contents.html >
Annual Energy Outlook	Released annually by the EIA, this report gives electric load forecasts by end-use for the nine census divisions.	< www.eia.doe.gov/oiaf/aeo/index.html >
eShapes	eShapes data, owned by ITron, are based on audit data for more than 20,000 buildings across the country. They consist of hourly electricity consumption data for various sectors and end-uses. These data are used to find what time of the day and year energy savings occur, and the coincidence factor for demand savings.	< www.itron.com/pages/products_detail.asp?ID=itr_000491.xml&pgtype=&subID=fb >
Economy.com	Economy.com provides a wide range of economy data and forecasts that can be used to help develop an accurate prediction for future load growth.	< www.economy.com/default.asp >

Title	Description	URL Address
Utility Information	Often, the utilities in the region of interest can provide valuable information on the size of the electric load, load forecast, electric consumption by sector, and more. Also, some utilities fund separate organizations to perform market research. For example, California's Pacific Gas and Electric Company started the Food Service Technology Center to test the performance and efficiency of commercial kitchen equipment.	Food Service Technology Center: <www.fishnick.com/>
Lawrence Berkeley National Laboratory (LBNL)	LBNL is a federal laboratory that performs much research on new energy systems and environmental solutions. It releases many helpful reports on emerging technology, which can be used for measure characterizations.	<www.lbl.gov/>
Consortium for Energy Efficiency (CEE)	CEE is a nonprofit corporation dedicated to promoting the manufacture and purchase of energy efficient products and services. It performs market research and sets reasonable high-efficiency standards for a range of different products and appliances.	<www.cee1.org/>
Industry data	Often it is possible to get relevant measure data directly from the industry group or manufacturer. Examples include the National Electrical Manufacturers Association (NEMA) and the American Refrigeration Institute (ARI). Also, equipment catalogs and information sheets are often good sources for cost and consumption data.	NEMA: <www.nema.org/> ARI: <www.ari.org/>
Census	The Energy Consumption Surveys contain good data at the census division level, but if you need data at the state or county level, you can go to the U.S. Census. While the Census does not contain energy consumption data, it can tell you the number of households or businesses in a region.	<www.census.gov/>

Appendix Example E: Potential Studies



This appendix provides a list of past potential studies, with brief descriptions.

Title/Description	Purpose	URL Address
Midwest	Examining the Potential for Energy Efficiency to Address the Natural Gas Crisis in the Midwest. The results of this study suggest that a modestly aggressive, but pragmatically achievable, energy efficiency campaign (achieving about a 5% reduction in both electricity and natural gas customer use over 5 years) could produce tens of billions of dollars in net cost savings for residential, commercial, and industrial customers in the Midwest.	This study was conducted to examine efficiency to mitigate the effects of rising gas prices in the Midwest, which uses natural gas at a much higher rate than the rest of America. Thus this case builds a case for efficiency, but also examines how much gas usage can be offset by efficiency efforts. www.aceee.org/pubs/u051.htm
Northeast	Economically Achievable Energy Efficiency Potential in New England. This report provides an overview of areas where energy efficiency could potentially be increased in the six New England states.	This is a meta-study, designed to give policy-makers direction on how to implement and direct energy efficiency efforts. www.neep.org/files/Updated_Achievable_Potential_2005.pdf
	Electric Energy Efficiency and Renewable Energy in New England: An Assessment of Existing Policies and Prospects for the Future. This report applies analytical tools, such as economic and environmental modeling, to demonstrate the value of consumer-funded energy efficiency programs and renewable portfolio standards and addresses market and regulatory barriers.	This study was conducted to "contribute to a growing body of work applying analytical tools to show the value of consumer funded energy efficiency programs and renewable portfolio standards with new rigor." www.neep.org/html/NEEP_C&IReview.pdf

Title/Description		Purpose	URL Address
Northeast	NEEP Initiative Review: Commercial/Industrial Sectors Qualitative Assessment and Initiative Ranking for the Residential Sector. Shtick Consulting. Submitted to Northeast Energy Efficiency Partnerships, Inc., October 1, 2004.	This is a qualitative assessment of commercial and industrial initiatives based on a quantitative study done by Optimal Energy, Inc. and Vermont Energy Corporation. It was conducted to provide feedback for specific efficiency initiatives.	< www.neep.org/html/NEEP_C&IReview.pdf >
Southeast	Powering the South, A Clean & Affordable Energy Plan for the Southern United States. This report shows that a clean generation mix can meet the region's power demands and reduce pollution without raising the average regional cost of electricity and lists the policy initiatives that can make the changes.	This report was developed mainly for the purpose of building a case for clean energy. It estimates potential not only for efficiency, but also for renewables and combined heat and power, with the aim of offering a comprehensive energy plan for the Southeast.	< www.crest.org/articles/static/1/binaries/pts_repp_book.pdf >
Southwest	The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest. This report for the Southwest Energy Efficiency Project examines the potential for, and benefits from, increasing the efficiency of electricity use in the southwest states of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.	This report builds a case for efficiency, analyzing the achievable potential and macro-economic benefits, but also examines specific savings opportunities and proposes a range of policy recommendations.	< www.swenergy.org/nml/index.html >

Title/Description		Purpose	URL Address
Southwest (continued)	A Balanced Energy Plan for the Interior West. This report shows how energy efficiency, renewable energy, and combined heat and power resources can be integrated into the region's existing power system to meet growing electric demands in a way that is cost-effective, reliable, and reduces risk and improves environmental quality for the interior west region of Arizona, Colorado, Montana, New Mexico, Nevada, Utah, and Wyoming.	This report first makes a case for efficiency and renewables, analyzing the economic and environmental costs of the status quo, and then proposes a specific "balanced energy plan" for the interior west region that would essential eliminate load growth.	< http://westernresources.org/energy/bep.html >
California	California's Secret Energy Surplus: The Potential for Energy Efficiency. This study focuses on assessing electric energy potential in California through the assessment of technical, economic, and achievable potential savings over the next 10 years.	This study was commissioned to expand previous studies to cover all sectors and vintages in California for a 10-year horizon.	< http://docs.cpuc.ca.gov/published/report/30114.pdf >
	California Statewide Residential Sector Energy Efficiency Potential Study. Presents a sequence of analyses to estimate the technical, economic, and maximum achievable potentials, as well as a set of program potential estimates that provide a range of results based on variation in program funding and energy price forecasts.	Conducted for policymakers interested in knowing the amount of savings or resource reduction that could occur in response to a particular set of programs or policies.	< www.env-ne.org/Publications/CT_EE_MaxAchievablePotential%20Final%20ReportJune%202004.pdf >

Title/Description		Purpose	URL Address
Connecticut	Independent Assessment of Conservation and Energy Efficiency Potential for Connecticut and the Southwest Connecticut Region. This study estimates the maximum achievable cost-effective potential for electric energy and peak demand savings from energy efficiency measures in the geographic region of Connecticut served by United Illuminating Company and Connecticut Light and Power Company.	This study gives an estimate of the total potential in Connecticut, but it focuses on the 52 towns and, in particular, 16 critically constrained areas in southwest Connecticut. The study concludes that there is significant potential in the areas it examines.	www.env-ne.org/Publications/CT_EE_MaxAchievablePotential%20Final%20ReportJune%202004.pdf
Florida	Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands. Estimates the capacity for energy efficiency using building energy simulations.	Provides the state with an achievable efficiency estimate and a suite of policy options to consider towards realizing this potential.	www.aceee.org/pubs/e072.htm
Georgia	Assessment of Energy Efficiency Potential in Georgia. This report presents a profile of energy use in Georgia; the potential for, and public benefits of, energy efficiency; and a public policy review.	This report was written primarily to build the case for efficiency, as there were no existing programs in Georgia when the report was released.	www.gefa.org/Modules/ShowDocument.aspx?documentid=46
Iowa	The Potential for Energy Efficiency in Iowa. This report uses existing programs, surveys, savings calculators, and economics simulation to estimate the potential for energy savings in Iowa.	The purpose of this study was to provide an initial estimate of the potential, to build the case for efficiency.	www.ornl.gov/sci/btc/apps/Restructuring/IowaEEPotential.pdf

Title/Description	Purpose	URL Address
Massachusetts The Remaining Electric Energy Efficiency Opportunities in Massachusetts. This report addresses the remaining electric energy efficiency opportunities in the residential, commercial, and industrial sectors in Massachusetts.	This study focuses on program designs, examining how various funding levels will affect the savings of various building and end-use sectors.	www.mass.gov/Eoca/docs/doer/pub_info/e3o.pdf
Nevada Nevada Energy Efficiency Strategy. Nevada has taken a number of steps to increase energy efficiency. This report provides 14 policy options for further increasing the efficiency of electricity and natural gas and reducing peak power demand.	This study focuses on policy and program design.	www.swenergy.org/pubs/Nevada_Energy_Efficiency_Strategy.pdf
New Jersey New Jersey Energy Efficiency and Distributed Generation Market Assessment. This study estimates mid- and long-term potential for energy and peak-demand savings from energy efficiency measures and for distributed generation in New Jersey.	This study was conducted to analyze the achievable and business-as-usual cases to see whether New Jersey is meeting its efficiency targets, and to make recommendations for future policies.	www.policy.rutgers.edu/ceeep/images/Kema%20Report.pdf
New York Energy Efficiency and Renewable Energy Resource Development Potential In New York State. Final Report Volume One: Summary Report. This study examines the long-range potential for energy efficiency and renewable energy technologies to displace fossil-fueled electricity generation in New York by looking at the potential available from existing and emerging efficiency technologies and practices and by estimating renewable electricity generation potential.	This study was commissioned to estimate the technical and maximum achievable potentials in New York State, including the potential from renewables and combined heat and power.	www.nyserda.org/sep/EE&ERpotentialVolume1.pdf

Title/Description		Purpose	URL Address
Oregon	Energy Efficiency and Conservation for the Residential, Commercial, Industrial, and Agricultural Sectors. This report is designed to inform the project development and selection process for a list of potential energy efficiency and renewable energy measures that could provide electricity savings for Oregon consumers.	The stated goal of this project was "to provide the Energy Trust of Oregon, Inc. with a list of potential energy efficiency and renewable energy measures that could provide electricity savings for Oregon consumers."	< www.energytrust.org/library/reports/Resource_Assessment/ETOResourceAssessFinal.pdf >
	Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors. This is a resource assessment to evaluate potential natural gas conservation measures that can be applied to the residential and commercial building stock serviced by Northwest Natural Gas.	The purpose of this study was to evaluate potential natural gas efficiency measures, to find out if they are technically feasible and cost-effective.	< www.energytrust.org/library/reports/Resource_Assessment/GasRptFinal_SS103103.pdf >
Texas	Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs. Presents both economic and program potential estimates. The economic potential was determined using a detailed bottom-up analysis.	Prepared in response to announced plans to construct several large coal-fired power plants to meet future peak loads in Texas.	< http://aceee.org/pubs/e073.pdf >
	Power to Save: An Alternative Path to Meet Electric Needs in Texas. Estimates the potential for efficiency and other demand-side strategies by relying on the results of other studies in similar or nearby regions.	Commissioned by national nonprofit groups with an interest in energy efficiency and climate change.	< www.ceres.org/pub/docs/Ceres_texas_power.pdf >

Title/Description		Purpose	URL Address
Vermont	Assessment of Energy Efficiency and Customer-Sited Generation Investments in the Southern Loop. A detailed analysis of program potential given aggressive efficiency programming.	Prepared in relation to efforts to build a new transmission line serving a small geographic region in Southern Vermont.	<www.velco.com/Templates/default.asp?pagelId=48>

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**MISSOURI'S ENERGY EFFICIENCY POTENTIAL:
OPPORTUNITIES FOR ECONOMIC GROWTH
AND ENERGY SUSTAINABILITY**

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© American Council for an Energy-Efficient Economy
529 14th Street, N.W., Suite 600, Washington, D.C. 20045
(202) 507-4000 phone, (202) 429-2248 fax, aceee.org

Prepared by:

American Council for an Energy-Efficient Economy

Maggie Molina, mmolina@aceee.org
Suzanne Watson, swatson@aceee.org
Nate Kaufman (CHP analysis)
Skip Laitner (macroeconomic analysis)
Eric Mackres (local policy discussion)
Dan Trombley (industrial analysis)
Dan York (utility regulatory policy)

With analysis and written contributions from:

Navigant Consulting

(demand response analysis)

Marca Hagenstad
Stuart Schare
Dan Violette

EnSave

(rural and agriculture analysis)

Amelia Gulkis
Craig Metz
Gary Gawor

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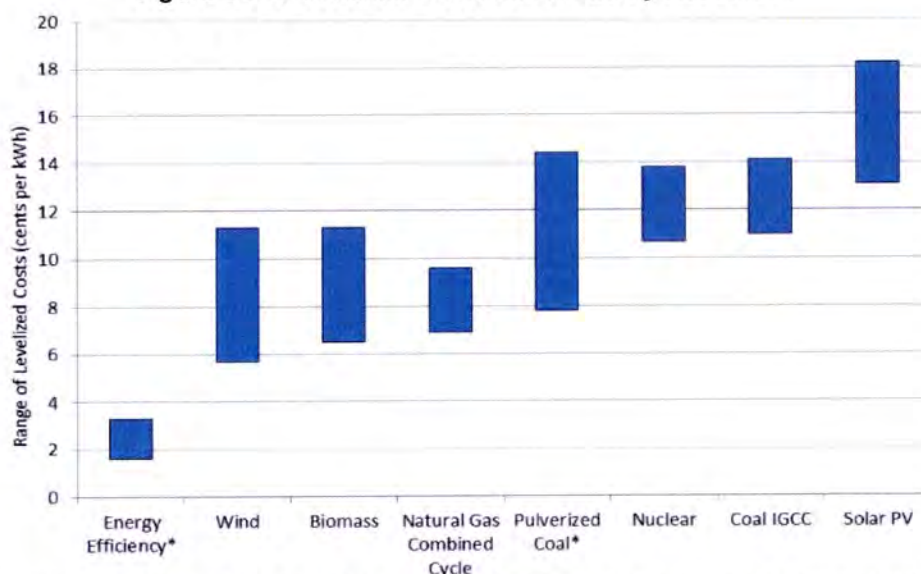
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EXECUTIVE SUMMARY

Each year, Missourians spend about \$12 billion on their energy bills to heat, cool, and power their homes and businesses (EIA 2010a).¹ By comparison, the state collected less in taxes from individuals and businesses—\$10.5 billion—in 2010 (MODR 2010). And while Missouri often touts having some of the lowest average electricity prices in the nation, its buildings actually consume energy at one of the highest rates per capita (45th nationally in 2008).² Meeting the energy needs for homes and businesses is clearly a substantial portion of annual costs to the state, and these energy needs are growing. Missouri's population is expected to grow 10% by 2025 and with that growth will come increased demand for energy resources and services. Energy efficiency—long-term improvements in technology performance and practices that reduce energy demand—is Missouri's lowest cost energy resource and offers significant potential to meet this growing demand for new energy sources.

National estimates show that energy efficiency improvements cost only a fraction of new electricity supply (see Figure ES-1) (Friedrich et al. 2009; Lazard 2009). Even with relatively low electricity prices in the state, energy efficiency can be a critical resource to foster a secure and sustainable energy future for Missouri. This report examines how energy efficiency policies and programs can reduce energy bills for Missouri homes, businesses, and governments while stimulating the economy and reducing reliance on more expensive energy resources. While the state has several efforts underway, significant potential for energy efficiency would remain untapped if the state continues on its current track. The multiple economic benefits of efficiency analyzed in this report demonstrate that efficiency is a financially responsible strategy for the state of Missouri that will set the state on a path toward economic growth and energy sustainability.

Figure ES-1. Levelized Costs for Electricity Resources



Notes: Energy efficiency data from Friedrich et al. 2009 (ACEEE), which represents 5 years of average utility efficiency program cost data from 12 states. The states included are geographically disperse and therefore a good indication of efficiency program costs throughout the country; all other data from Lazard 2009. High-end range of advanced pulverized coal includes 90% carbon capture and compression.

¹ This does not include spending on energy for transportation, which accounts for another \$14 billion in per year in Missouri. In aggregate, Missourians spend 2.5 times more on energy than on taxes.

² This includes residential and commercial building sectors, based on data from EIA's State Energy Data System (SEDS) for 2008. In 2008, residential and commercial buildings consumed 158 million Btu's per capita while the national average was 130 MBtu per capita.

Energy Efficiency in Missouri

Missouri is increasingly turning to energy efficiency as an economic policy to save consumers money and create jobs, as well as foster energy sustainability by investing in a clean, local resource that reduces emissions and boosts in-state energy expertise. Missouri state agencies, local governments, utilities, and non-governmental organizations are already investing in energy efficiency, and have made notable progress in recent years.

The state government has taken steps to improve efficiency in its own facilities and rolled out numerous customer programs, and local governments are also taking action through such measures as building energy codes and local community efficiency programs. For example, Kansas City's "Green Impact Zone" is emerging as an example of concentrated energy efficiency initiatives acting in concert with economic development goals (see text box).

Under long-standing requirements for integrated resource planning (IRP), most utilities in Missouri currently offer some energy efficiency programs to electric and natural gas customers and have expanded programs in recent years. In 2009, utilities in Missouri spent about \$27 million on electricity and natural gas efficiency programs and in 2010, program budgets increased to about \$40 million (CEE 2010a, 2010b).

Missouri took a significant step in 2009 toward regulatory changes necessary to align utility financial objectives with saving energy through customer energy efficiency programs. The Missouri Energy Efficiency Investment Act (SB 376 or MEEIA), enacted in 2009, declares that the policy of Missouri is to value "demand-side" investments such as energy efficiency equal to traditional investments in energy supply and delivery infrastructure. After passage of SB 376, the Missouri Public Service Commission (PSC) conducted a rulemaking proceeding that involved a broad spectrum of Missouri energy stakeholders. In April 2011, the PSC published a final rulemaking to implement the MEEIA. The rules allow utilities to submit cost recovery and incentive mechanisms along with their energy efficiency plans.

Case Study: Targeted Energy Efficiency Investments—The Green Impact Zone and SmartGrid Demonstration Project in Kansas City

Dozens of local and metropolitan region partner organizations and agencies are collaborating on this geographically-focused community redevelopment project aimed at vastly improving a neighborhood of Kansas City's urban core through coordinated "green" investments. Energy efficiency in buildings is one of the core strategies—along with jobs, safety & services, infrastructure, housing, youth, and agriculture—being applied to transform the neighborhood. Four separate but coordinated programs are working in the Green Impact Zone to improve energy efficiency: a neighborhood-based low-income weatherization program, two building energy assessment and improvement financial incentive programs, and a "Smart Grid" demonstration project. The Green Impact Zone Low-Income Weatherization Program is managed by the zone in partnership with the regional planning agency, Mid-America Regional Council (MARC), and funded by the Missouri Department of Natural Resources.

By March 2012, the program aims to have weatherized more than 419 homes in the Zone and at the end of May 2011 the program had completed work on 63 homes, work was underway at another 60 homes, and 44 additional prerequisite energy assessments had been completed. Participants will receive up to 35 percent reduction in energy usage and save on average \$435 per house in heating and cooling costs annually at current prices. The program has made a concerted effort to work with contractors to provide jobs and training, as well as outreach about the benefits of the program through door-to-door canvasses and in-person meetings with landlords.

Despite the clear intent of SB 376 to boost utility energy efficiency efforts by addressing fundamental financial barriers to utility investments in energy efficiency, initial plans filed by the utilities call for reduced spending on customer energy efficiency programs. This contrary result stems in part from the utilities viewing the new rules as not effectively addressing fundamental barriers. To achieve the amount of energy savings through utility programs outlined in this report requires a regulatory framework that effectively aligns utility financial interests with saving energy through successful customer energy efficiency programs. The initial impacts stemming from recent rate cases and related proceedings before the PSC suggest that such a framework has yet to be established.

Policy Implementation Opportunities

While the state has taken important steps, significant potential for energy efficiency will remain untapped if the state does not take additional policy actions nor address regulatory challenges such as those leading to recently announced plans by utilities to roll back their efficiency programs. And while some localities have shown leadership—for example, by adopting the latest model building energy codes, many more regions stand to benefit from updated policies and programs. Passage of MEEIA clearly shows that Missouri policymakers recognize the very real and significant value of energy efficiency to Missouri's energy customers and the economy as a whole.

This report presents a vision of what is possible in Missouri if a suite of ten comprehensive policies and programs were to be enacted to encourage the adoption of greater energy efficiency. We then estimate the resulting energy savings compared to a business-as-usual scenario, the associated policy costs and investments, net consumer savings on energy bills, emissions reductions, and macroeconomic impacts such as net job creation. We recognize that there are numerous existing energy efficiency initiatives underway in the state. Our suite of ten policies represents expansions and additions to such existing efforts.

The suite of ten energy efficiency-related policies examined in this report includes:

1. Energy efficiency targets and regulatory policies for utilities
2. Advanced new buildings initiative
3. Manufactured homes programs
4. Behavioral initiative
5. Efficient manufacturing initiative
6. Rural and agricultural initiative
7. Building energy codes and enforcement
8. State and local public buildings upgrades
9. Combined heat and power (CHP)
10. Demand response

The first policy in this list—energy efficiency targets for utilities and regulatory policies for utilities—is a significant component to a robust, long-term strategy that would improve energy efficiency in Missouri. To tap into this potential in the coming years, the state must fine-tune its regulatory framework to align investor-owned utilities' financial interest with efficiency programs, and utilities must continue to build up their programmatic experience. Missouri could, as a next step, develop binding, five-year energy efficiency targets for investor-owned utilities (IOUs), which could be tailored to individual utilities and would work in conjunction with utility IRP processes. Municipal utilities and cooperatives, which are not regulated by the Missouri PSC, could follow the same vision by adopting similar voluntary standards. Utilities would achieve the savings through a variety of program strategies for its customers, and our analysis presents one possible scenario for how the savings could be achieved (see Table ES-1). Five-year goals for IOUs could start at modest levels and ramp up to 1% savings by 2016: 0.3% in 2012, 0.5% in 2013, 0.7% in 2014 and 2015, and 1% in 2016. There is general agreement among stakeholders that these types of savings are achievable in the short term. Therefore, these initial results can be used to help set longer-term savings targets—an approach that is consistent with Missouri being the "Show Me" state. After the programs are

implemented and evaluated, the Commission and stakeholders could then reexamine the targets for the following five-year program cycle.

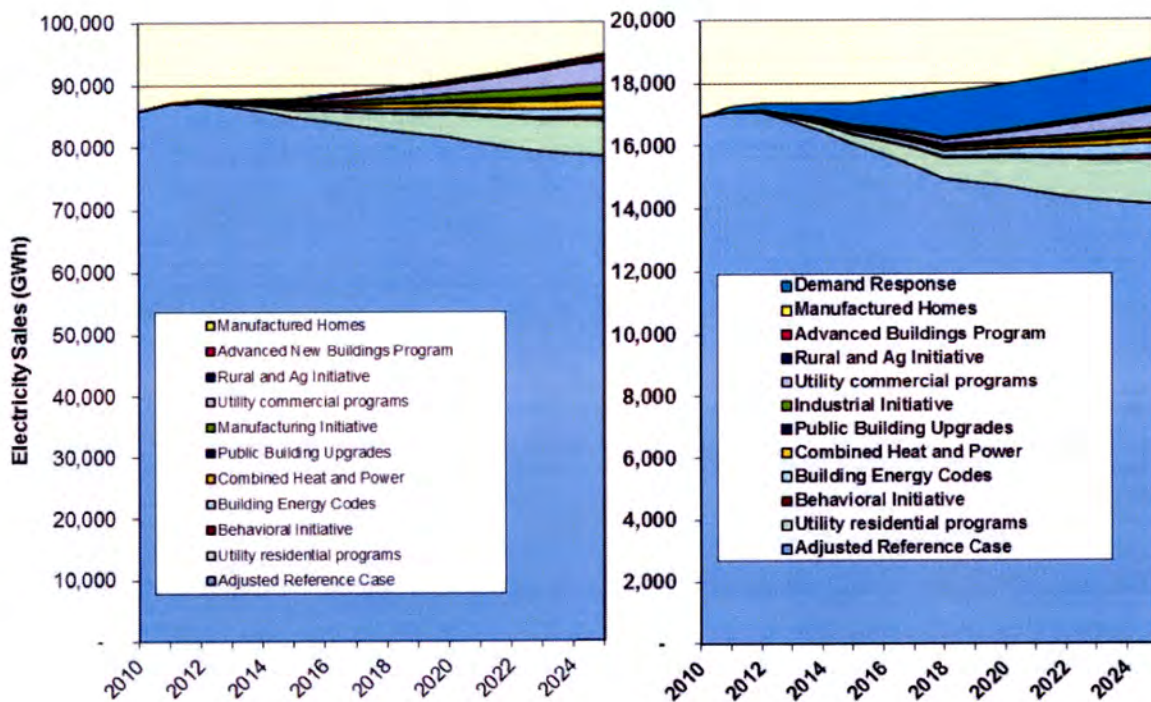
Several other state and local initiatives included in our analysis are complementary to the utility energy efficiency programs and policies. Leading local governments in the state, for example, have set stringent building energy codes and enforcement activities, which ensure more efficient buildings that save energy and money for residents. Other local governments throughout the state should follow suit. Existing state and locally-owned public buildings also have significant potential for energy savings. Improving the efficiency of these facilities provides an immediate return in lower energy bills—a fiscally responsible strategy for the state and its residents.

Combined, we estimate that deployment and implementation of these policies and programs through 2020 can achieve total savings of about 10% of electricity usage and 7% of natural gas usage (see Figures ES-2 and Table ES-1). Through 2025, we estimate these savings to increase to 17% of electricity usage and 13% of natural gas usage. Efficiency targets for utilities are achieved through a portfolio of proven programs for residential and commercial customers, as displayed in Table ES-2. Efficiency measures can also achieve significant savings in “peak” electricity when demand reaches its highest and it becomes most expensive for utilities to provide power. Demand response programs, which aim to shave electricity usage during the peak hours or shift usage to off-peak hours, can add further reductions. Combined, we estimate that efficiency and demand response can reduce peak demand 18% by 2020 and 25% by 2025 relative to projected demand.

Table ES-1. Summary of Total Annual Energy Savings in 2020 by Policy or Program

Policies and Programs	Electricity		Peak Demand		Natural Gas	
	GWh	%	MW	%	Million Therms	%
Utility Residential Buildings and Equipment Programs*	3,645	4.0%	911	5.1%	65	2.5%
Utility Commercial Buildings and Equipment Programs*	1,559	1.7%	231	1.3%	28	1.1%
Advanced Buildings Initiative*	334	0.4%	56	0.3%	9	0.3%
Manufactured Homes*	69	0.1%	17	0.1%	2	0.1%
Behavioral Initiative*	246	0.3%	62	0.3%	7	0.3%
<i>Utility Programs</i>	<i>5,854</i>	<i>6.4%</i>	<i>1,276</i>	<i>7.1%</i>	<i>111</i>	<i>4.2%</i>
Manufacturing Initiative	935	1.0%	95	0.5%	29	1.1%
Rural and Agriculture Initiative	202	0.2%	20	0.1%	n/a	n/a
Building Energy Codes and Enforcement	909	1.0%	227	1.3%	36	1.4%
State and Local Public Building Retrofits	416	0.5%	62	0.3%	10	0.4%
Combined Heat and Power	848	0.9%	110	0.6%	n/a	n/a
Demand Response Programs	n/a	n/a	1,458	8.1%	n/a	n/a
<i>Total Savings</i>	<i>9,164</i>	<i>10.1%</i>	<i>3,249</i>	<i>18.1%</i>	<i>187</i>	<i>7.1%</i>
Reference Case Energy Usage	90,819		17,958		2,642	

Notes: Savings are shown for the year 2020. Percentage savings are measured against reference case energy usage in 2020. *We assume these program savings go toward meeting the utility efficiency program targets, which start as five-year targets that ramp up to 1% by 2016. Additional programs and policies could be eligible toward achieving targets, and the target levels should depend on how inclusive they are of multiple program strategies.

Figure ES-2. Missouri Electricity and Peak Demand Savings from Energy Efficiency Scenario, 2010–2025

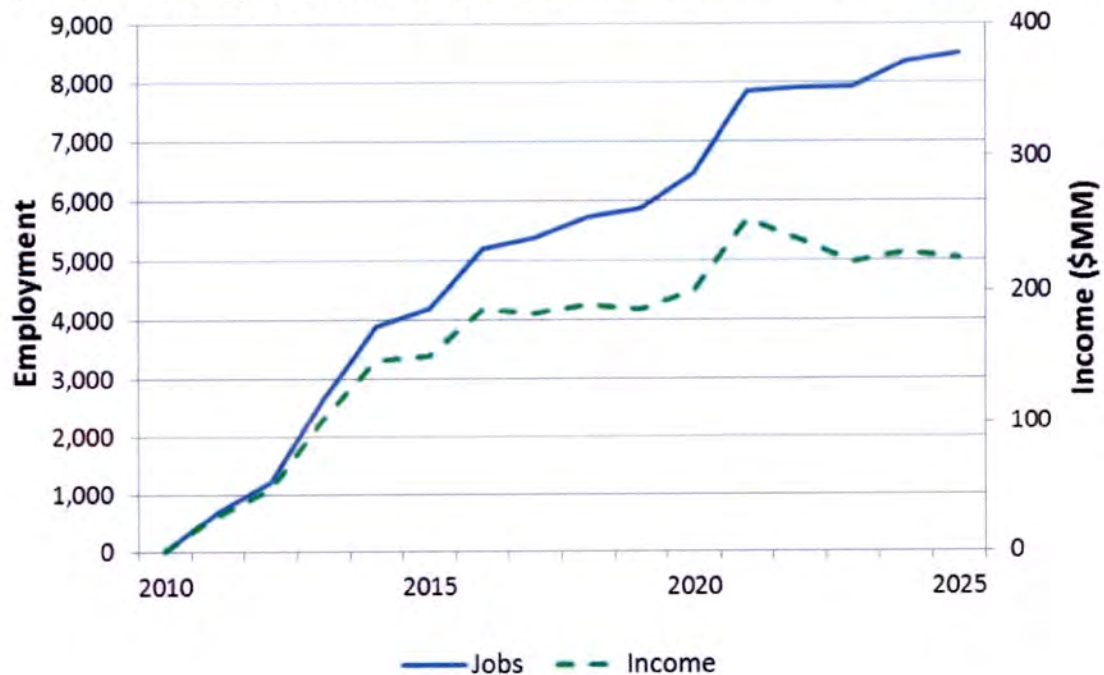
While the energy efficiency policies and programs included in this analysis will require public and private investments, they can yield a high return to Missouri consumers and the overall economy. We estimate that by 2025, consumers in Missouri can save a net cumulative \$6.1 billion dollars in lower energy bills (see Table ES-2). And because efficiency measures have relatively long lifetimes of about 10–12 years, net savings will continue to accrue to consumers on the order of \$1 billion annually after 2025.

Investments in efficiency policies and programs can also help create new, high-quality jobs in Missouri while also increasing wages. Compared to a reference case scenario, our analysis finds that energy efficiency investments can create 8,500 new local jobs in Missouri by 2025 (see Table ES-2 and Figure ES-3). These include well-paying trade and professional jobs needed to design, install, and operate energy efficiency measures (direct jobs) and also a broader impact on job creation through re-spending of energy bill savings in other areas of the economy (induced jobs). The creation of 8,500 net jobs in our energy efficiency policy scenario is equivalent to about 50 small manufacturing plants opening in the state.

Table ES-2. Economic Impacts from the Energy Efficiency Case Policy Scenario

Macroeconomic Impacts	2015	2020	2025
Net Jobs (Actual)	4,199	6,455	8,512
Wages (Million 2009\$)	\$151	\$200	\$224
Cumulative Net Energy-Bill Savings (Million 2009\$)	\$273	\$2,034	\$6,145

Figure ES-3. Net Employment and Wage Impacts for Missouri in Policy Scenario (2011–2025)



Conclusion

Over the last several years, Missouri has demonstrated a growing commitment to energy efficiency as a means to attain energy, economic, environmental, and sustainability goals. Recent developments, however, have suggested that the state is struggling to make the major strides needed to significantly advance energy efficiency. Missouri stands to gain much more from broadening its policies and programs that encourage efficiency. Several recent studies have demonstrated that there is a large amount of cost-effective, untapped efficiency that the state could take advantage of over the next 15 years to save energy and save money. This report complements those recent studies by analyzing a series of concrete, long-term state policy and program strategies that have the potential to meet 17% of the state's electricity needs and create up to 8,500 new jobs. A comprehensive set of state and local policy strategies, along with a collective commitment by policymakers, businesses, and individuals, can enable Missouri to reap this potential efficiency resource while returning numerous benefits to Missouri's economy and environment.

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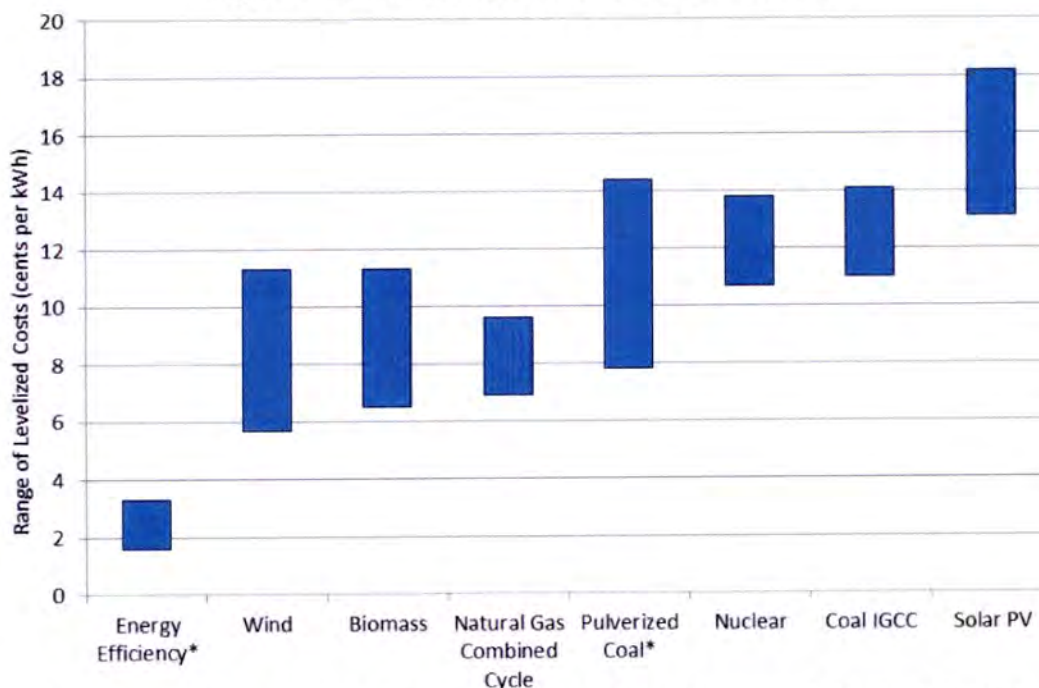
We engaged several individuals and organizations in the state, too numerous to list here, who helped to inform our policy analysis for Missouri, and we thank everyone for those invaluable contributions. We describe our stakeholder outreach in the report methodology and mention the organizations or individuals with whom we met. We also thank many of these organizations and individuals who also provided feedback on the draft report. Thank you also to ACEEE's Executive Director Steven Nadel for providing comments on draft versions of this report and Renee Nida for final editing and production.



INTRODUCTION

Each year, Missourians spend about \$12 billion on energy bills to heat, cool, and power their homes and businesses (EIA 2010a).³ By comparison, the state collected less—\$10.5 billion—in taxes from individuals and businesses in Missouri in 2010 (MODR 2010). And while Missouri often touts having some of the lowest average electricity prices in the Nation, its buildings actually consume energy at one of the highest rates per capita (45th nationally in 2008).⁴ Meeting the energy needs for homes and buildings is clearly a substantial portion of annual costs to Missouri residents and businesses and these energy needs are growing. Missouri's population is expected to grow 10% by 2025 and with that growth will come increased need for energy services.⁵ Energy efficiency—long-term improvements in technology performance and practices that reduce energy demand—is Missouri's lowest cost energy resource and offers significant potential to reduce energy bills for Missouri homes, businesses, and government while stimulating the economy and reducing reliance on more expensive energy resources. National estimates show that energy efficiency improvements cost only a fraction (one-third to one-fifth) of new electricity supply (see Figure 1) (Friedrich et al. 2009; Lazard 2009). Based on the economics alone, energy efficiency should be a critical resource to foster a secure and sustainable energy future for Missouri.

Figure 1. Levelized Costs for Electricity Resources



Notes: Energy efficiency data from Friedrich et al. 2009 (ACEEE), which represents 5 years of average utility efficiency program cost data from 12 states. The states included are geographically disperse and therefore a good indication of efficiency program costs throughout the country; All other data from Lazard 2009. High-end range of advanced pulverized coal includes 90% carbon capture and compression.

³ This does not include spending on energy for transportation, which accounts for another \$14 billion in per year in Missouri. In aggregate, Missourians spend 2.5 times more on energy than on taxes.

⁴ This includes residential and commercial building sectors, based on data from EIA's State Energy Data System (SEDS) for 2008. In 2008, residential and commercial buildings consumed 158 million Btu's per capita while the national average was 130 MBtu per capita.

⁵ Population projection is according to the MO Office of Administration (2011).

Efficiency also produces macroeconomic benefits in the form of job creation. By lowering consumer energy bills and shifting economic activity toward labor-intensive jobs for energy efficiency services, energy efficiency can create a small, but net positive effect on job creation. The environmental benefits are also substantial. By reducing the electricity generation needs from traditional, carbon-based electricity supplies such as coal and natural gas that pollute the environment, energy efficiency can substantially reduce carbon dioxide, nitrogen oxides, and sulfur dioxide emissions.

But despite the benefits of energy efficiency and high returns on investment, most homes and businesses are still highly inefficient. The reason is that consumers face tremendous barriers to improved efficiency, including lack of information, split incentives (when the tenant pays the energy bills but the landlord makes decisions about equipment), upfront costs, access to capital, and aversion to risks. National estimates suggest that more than 20% of energy usage could still be reduced through energy efficiency by 2020 (McKinsey & Company 2009).

State-level policies and programs have been successful in breaking down many of these barriers to help consumers reap the benefits of energy efficiency. Each year, leading states are already meeting 1.2%-2% of their overall electricity needs from new energy efficiency alone⁶ and saving consumers billions of dollars each year on energy bills. And over the long-term, these efficiency savings accrue and can avoid the need to build costly new energy supply infrastructure. Most states in fact have long-term resource goals in place to ramp-up their energy efficiency efforts. Local governments are also showing innovative policy solutions to encourage greater energy efficiency.

While Missouri has taken some significant steps toward energy efficiency, much more potential remains to create lasting economic benefits to the state. Energy consumption patterns in fact signify an increasing level of energy reliance in the state. For example, per-capita energy consumption has risen from about 300 million Btu's per capita to 325 million Btu's per capita in 2008 (EIA 2010a).⁷ Also, with a strong focus on the historically low electricity rates in Missouri, consumers in the state may not be aware of the significant economic benefits they can still gain by improving efficiency. This report, one in a series of state-level energy efficiency studies by ACEEE, will assess the potential for cost-effective efficiency in Missouri, the policy and program opportunities to encourage greater efficiency, and the benefits that could accrue to the Missouri economy from a long-term energy efficiency strategy.⁸

METHODOLOGY

In this section we describe our overall project approach and methodology.

Overall Project Context

Over the past several years, ACEEE has worked increasingly at the state level as a growing number of state legislatures, governors, and other public entities are showing interest and leadership in energy efficiency. As states engage in this sometimes new area of interest, they identify a need for analysis and technical assistance. ACEEE's State Clean Energy Resource Project (SCERP) aims to create a series of state assessments of efficiency resources and other clean energy strategies, and aims to serve as a center of information and expertise to support relevant policy strategies at the state level. This assessment for Missouri is the latest—and tenth—study in this series of reports.

⁶ See Sciortino et al. 2011; refers to net savings from utility-sector energy efficiency programs.

⁷ Readers should note that energy efficiency is one among many factors that underlie changes in per-capita energy consumption metrics, including changes in electricity supply mix, shifts in the share of customers by class (i.e., industrial, commercial, and residential), and changes in sources of end-use energy consumption.

⁸ For more information on the other studies in the series, see ACEEE's State Clean Energy Resource Project Web page at <http://aceee.org/sector/state-policy/scerp>.

Stakeholder Engagement

Part of our project methodology is to engage with Missouri stakeholders and understand which energy policy options might work best for the state. We talked to a broad range of stakeholders over several months to tailor our proposed recommendations to fit the unique needs of the state. Engaging the many interest groups in Missouri was a significant undertaking. We endeavored to meet in person with as many different sectors as possible in order to get the feedback required to better understand Missouri's unique energy structure and needs. We met with many of the business and environmental groups; the Governor's staff; Commissioners and their staff with the Public Service Commission; the Director and staff of the Department of Natural Resources (DNR); agricultural community representatives including the Missouri Farm Bureau Federation; REGFORM; Regional Commerce & Growth Association; the Mid-America Regional Council; local chambers of commerce; the Missouri Energy Development Authority; utility (gas and electric) companies including: Ameren Missouri, Kansas City Power & Light, the Missouri Association of Municipal Utilities, and Missouri Gas Energy; the Associated Industries of Missouri; the Office of Public Counsel; and various other interested organizations in the state. We also spoke with individuals with Columbia Water & Light and the Missouri Association of Accredited Energy Professionals. We also called or visited with various state legislators' offices, local government representatives such as the Kansas City Department of City Planning and Development/Development Services, and Washington University in St. Louis.

We were asked to give presentations on comprehensive energy efficiency policy options and methodology of our study to:

- A forum (150 plus in attendance) organized by the MO Public Service Commission titled, "State of Electricity Industry Presentation, Part 2" in Jefferson City on August 24, 2009.
- Missouri Energy Initiative's Conference, "Missouri's Energy Future", held in Columbia, MO, on November 2, 2010.
- "Advancing Renewables in the Midwest," 6th Annual Regional Conference held in Columbia, MO, on March 29, 2011.

We shared a draft version of this study with all of these stakeholders for their review in advance of its final publication, and their comments have been incorporated in this report as appropriate. Free copies of the final report are made available at follow-up outreach events as well as on the ACEEE Web site.

Reference Case Forecasts

The first step in conducting the analysis was to collect data to characterize the state's current and expected patterns of electricity and natural gas consumption over the study time period (2011–2025), as well as population and buildings data. As described in more detail in the next section of the report, we relied on several data sources to develop reference case projections for electricity and natural gas consumption, avoided electricity costs, and retail electricity and natural gas prices.

Energy Efficiency Resource Assessment

There are numerous "levels" of efficiency potential that analysts assess, and these typically include technical, economic, and achievable potential (for a meta-review of efficiency potential studies in the U.S. see Eldridge et al. 2008). The next task in estimating energy efficiency potential is to assess the cost-effective resource that is available given the state's mix of residential, commercial, and industrial energy consumers. Several comprehensive assessments of the energy efficiency potential for Missouri or the surrounding area have been recently completed. In 2009, a meta-review of energy efficiency potential studies was completed for the Midwest (ECW 2009). Next, in 2010 Global Energy

Partners⁹ completed an energy efficiency potential study for Ameren Missouri's (formerly AmerenUE) service territory (GEP 2010). And finally, KEMA¹⁰ prepared a statewide energy efficiency potential study for Missouri in 2011 (KEMA 2011). Together, these studies provided a basis for our energy efficiency resource assessment.

Energy Efficiency Policy Analysis

While efficiency resource assessments provide an important basis for understanding the general magnitude and types of energy efficiency potential in a given state, their limitation is that they provide theoretical estimates but do not provide solutions for capturing the efficiency resource. For example they do not typically address how a state could tap into its cost-effective efficiency potential through specific policies and programs. Toward this end, our study builds on the recent findings of the various efficiency potential studies and analyzes a specific suite of energy efficiency policies and programs. The suite of policies, including measures like building standards and utility programs for example, would enable homeowners and businesses in the state to take advantage of the energy efficiency resource.

Demand Response Analysis

The Demand Response (DR) analysis, which was prepared by Navigant Consulting, assess current demand response activities in Missouri, uses benchmark information to assess the potential for expanded activities in the state, and offers policy options that could foster demand response as a resource to help the state meet its peak electricity needs. Potential electricity load reductions are estimated for a set of DR programs that represent the technologies and customer types that span a range of DR efforts. These reductions are in addition to demand reductions from expanded energy efficiency. Readers should note that multiple "scenarios" of demand response potential are assessed, however the medium scenario is recommended as a reasonably conservative scenario of demand response potential and therefore is the one scenario incorporated into the overall estimates of energy efficiency and demand response potential in the policy analysis.

Macroeconomic and Emissions Impacts

Next, using the energy efficiency policy analysis results on energy savings, program costs, and investments, we run ACEEE's macroeconomic model, DEEPER, to estimate the policy impacts on jobs, wages, and Gross State Product (GSP) in Missouri. DEEPER is the Dynamic Energy Efficiency Policy Evaluation Routine, ACEEE's input-output model that evaluates macroeconomic impacts of energy efficiency investments. This is discussed in greater detail in this section of the report. Finally, we assess the impacts of energy efficiency policies to reduce air emissions, including carbon dioxide, sulfur dioxide, and nitrogen oxides.

BACKGROUND

This section presents information on current statewide energy consumption trends in Missouri and also on existing efforts to improve energy efficiency. The potential for greater energy efficiency and expanded policy opportunities, as examined in this report, should build on existing experience, lessons learned, and infrastructure related to energy efficiency. Therefore it is important to provide a comprehensive review of what the state has already achieved.

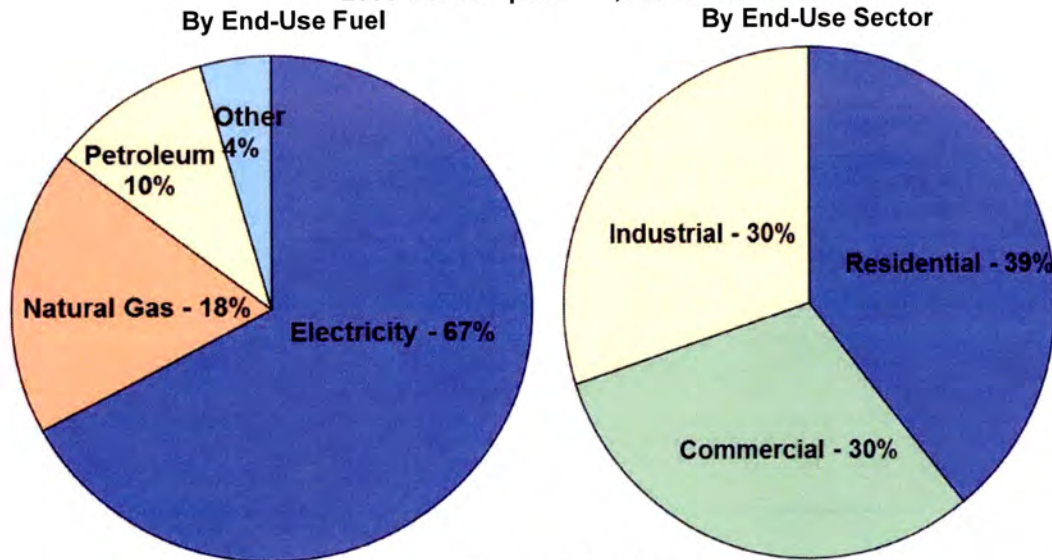
⁹ Global Energy Partners, LLC is a provider of energy and environmental engineering and technical services to utilities, energy companies, research organizations, government/ regulatory agencies and private industry. <http://www.gepllc.com/home.asp>

¹⁰ KEMA is an energy consulting firm that provides performance, risk, and quality management in the field of electricity, gas and heat—from production to use. <http://www.kema.com/Default.aspx>. As of this writing the study has not been officially accepted by the Missouri Public Service Commission, however the study still provides a reasonable and meaningful analysis for our meta-review.

Energy Consumption Trends in Missouri

In this report we examine energy efficiency opportunities in Missouri's residential and commercial buildings, as well as industrial facilities. We do not include efficiency opportunities for the Missouri's transportation sector; however, there are numerous policy and technology opportunities the state could explore for this sector (see Molina et al. 2010). Electricity and natural gas account for the vast majority of energy consumption in Missouri's buildings and industries (see Figure 2), and are therefore the focus of this report and analysis. Petroleum use in the state is attributed mainly to the industrial sector, and other fuels include wood and biomass.

Figure 2. Total Energy Consumption in Missouri Buildings and Industry
2008 Consumption = 1,353 Trillion Btu



Source: EIA 2010a

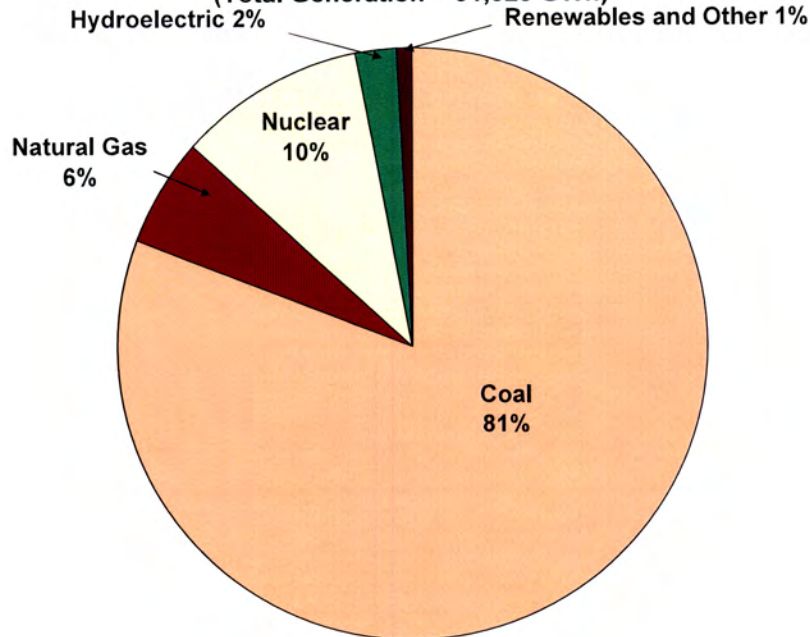
Note: Electricity consumption includes primary energy and the associated generation losses.
Totals may not sum to 100% due to rounding.

Electricity

Electricity utilities in Missouri rely heavily on coal-fired power plants for electricity generation (81%), followed by nuclear power (10%) and natural gas (6%) (see Figure 3).

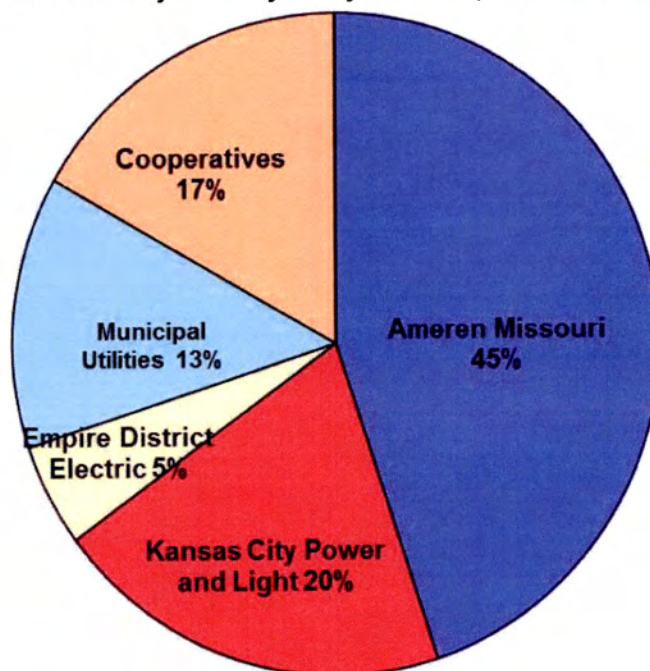
Figure 3. Missouri Electricity Generation by Fuel Type for 2008

(Total Generation = 91,029 GWh)



Source: EIA 2010b

Figure 4. Missouri Electricity Sales by Utility for 2008 (Total Retail Sales = 84,382 GWh)



Source: EIA 2010b

Note: Kansas City Power and Light includes both KCP&L and its Greater Missouri Operations (GMO).

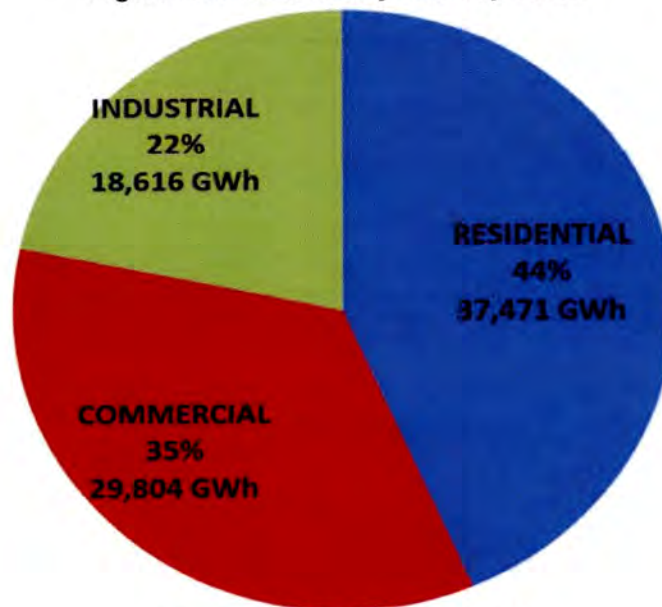
As shown in Figure 4, the three regulated investor-owned electric utilities in Missouri include: Ameren Missouri (formerly AmerenUE); Empire District Electric Company; and Kansas City Power & Light (KP&L), which also includes KCP&L Greater Missouri Operations (GMO).¹¹ Ameren Missouri is the largest electric utility in the state, selling the largest share of Missouri's electricity (45%) and serving about 1.2 million electricity customers. The utility also provides natural gas services to about 126,000 customers. Kansas City Power and Light and GMO serve about 20% of electricity sales and Empire District Electric Company serves a small Southwestern portion of the state (5% of sales) (EIA 2010b). The electric cooperatives (17%) and municipal utilities (13%) serve the remaining electricity generation needs.

Missouri's residential sector accounts for the greatest share of electricity consumption, followed by the commercial and industrial sectors (see Figure 5). We base these data on the U.S. Energy Information Administration and make some adjustments to the commercial and industrial shares based on the allocations made in the KEMA analysis using data provided by the Missouri utilities.

Natural Gas

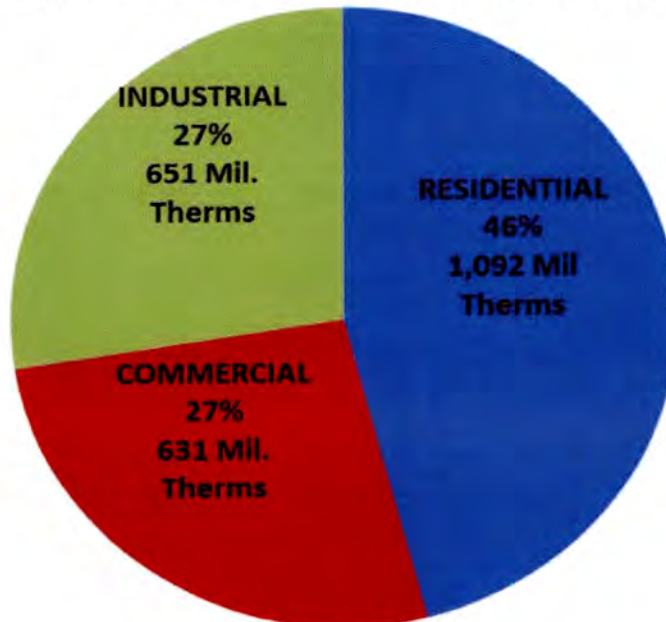
As shown in Figure 2, natural gas is a significant direct source of energy to consumers in Missouri in addition to its use for electricity generation. Most homes (58%) in the state use natural gas for heating, and the residential sector accounts for the largest share of natural gas consumption in the state at 46% (see Figure 6). Natural gas energy efficiency efforts will therefore be important for improvements in home heating equipment and systems. Commercial buildings also rely on natural gas for heating and the industrial sector relies on natural gas for some needs. The commercial and industrial sectors both account for about 27% of natural gas consumption in the state. The main natural gas utilities in the state are Missouri Gas Energy and Laclede Gas Company. Ameren Missouri is the third largest natural gas provider in the state.

Figure 5. 2010 Electricity Sales by Sector



Source: EIA 2010b; KEMA 2011

¹¹ Both KCP&L and GMO are subsidiaries of Great Plains Energy; however, they file separate plans with the Public Service Commission.

Figure 6. 2009 Natural Gas Use by Sector in Missouri

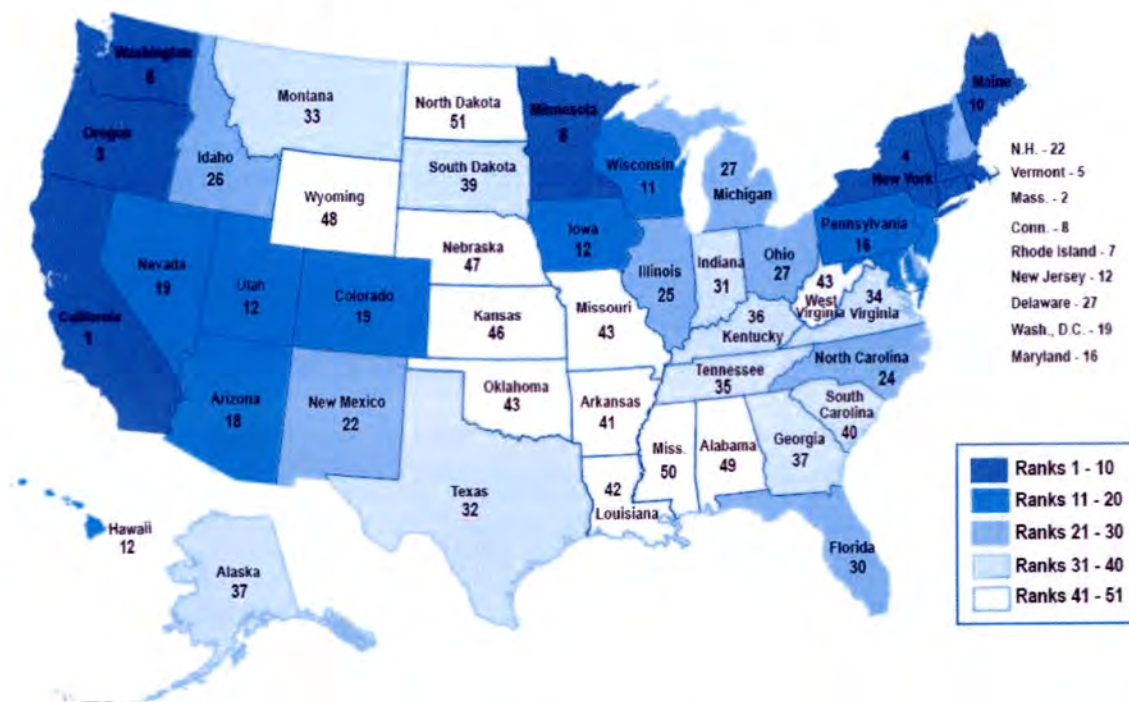
Source: EIA 2010c

Energy Efficiency in Missouri

Historically, Missouri has not typically made significant statewide investments in energy efficiency compared to other leading states. Missouri has ranked in the lower tier of ACEEE annual State Energy Efficiency Scorecards which benchmarks state-level efficiency programs and policies (see, for example, York and Kushler 2002; and Molina et al. 2010 as shown in Figure 7). However, there has been a recent upswing in energy efficiency program offerings by Missouri utilities as well as legislative and regulatory activity to encourage greater energy efficiency. There have also been recent efforts by local governments, such as building energy code development and implementation of energy efficiency and clean energy projects through federal stimulus funding. State government efficiency programs have also seen an uptick with the support federal stimulus funding. Next we discuss some of these recent efforts in Missouri that signal the state's growing and broadening interest in energy efficiency.

Missouri Energy Efficiency Investment Act: SB 376 and PSC Rulemakings

The Missouri Energy Efficiency Investment Act (SB 376 or MEEIA), enacted in 2009, declares that the policy of Missouri is to value "demand-side" investments such as energy efficiency equal to traditional investments in energy supply and delivery infrastructure. To achieve these ends, the law allows the Missouri Public Service Commission (PSC) to provide timely cost recovery for energy efficiency programs, to ensure that utilities' financial incentives are aligned, and delegates authority to the PSC to establish rules to implement MEEIA. After passage of SB 376, the Missouri Public Service Commission conducted a rulemaking proceeding that involved a broad spectrum of Missouri energy stakeholders. In April 2011, the PSC published a final rulemaking to implement the MEEIA. The rule, effective May 30, 2011, allows utilities to submit cost recovery and incentive mechanisms along with their energy efficiency plans. Despite the clear intent of SB 376 to boost utility energy efficiency efforts by addressing fundamental financial barriers to utility investments in energy efficiency, initial plans filed by the utilities call for reduced spending on customer energy efficiency programs. This contrary result stems from the utilities viewing the new rules as not effectively addressing these fundamental barriers.

Figure 7. Results of ACEEE's 2010 State Energy Efficiency Scorecard

Source: Molina et al. 2010

In April 2011, the PSC issued several final rules to implement the MEEIA, allowing utilities to submit demand-side programs investment mechanisms (DSIM) such as cost recovery and performance incentives along with their energy efficiency plans.¹² The rules establish guidelines by which the PSC can determine whether utility plans would achieve all cost-effective efficiency, and require that the Commission approve a utility plan only if it is consistent with a goal of achieving all cost-effective savings. The rules also have provisions for utility program cost recovery, lost revenue recovery, and incentives, as discussed in more detail later in the report.

The rule requires that the Commission use either an electric utility's efficiency market potential study or a pre-established set of annual goals (whichever is higher) as a guideline for determining whether programs are meeting all cost-effective efficiency. The pre-established incremental annual energy savings goals are: 0.3% in 2012; 0.5% in 2013; 0.7% in 2014; 0.9% in 2015; 1.1% in 2016; 1.3% in 2017; 1.5% in 2018; 1.7% in 2019; and 1.9% in 2020. The goals are not mandatory and no penalty is assessed for not meeting them. Rather, the goals provide useful guidance for comparison to utility proposals.

Utility Energy Efficiency Programs

Most utilities in Missouri currently offer some energy efficiency programs to Missouri electric and natural gas customers and have plans to continue offering programs at some level. In 2009, utilities in Missouri spent about \$27 million on electricity and natural gas efficiency programs and in 2010, program budgets totaled about \$40 million (CEE 2010a, 2010b). Such programs have largely been enacted and required by long-standing regulations that require integrated resource planning. Under that regulatory framework, however, utilities still faced significant financial barriers for investments in demand-side resources such as energy efficiency.

¹² For the final rules published in the Code of State Regulations in April 2011 and effective May 30, 2011, see <http://www.sos.mo.gov/adrules/csr/current/4csr/4c240-20.pdf>

Ameren Missouri significantly increased its commitment to energy efficiency in recent years.¹³ The utility reported efficiency program expenditures of about \$3 million in 2008 and a sevenfold increase to a 2009 annual program budget of \$21.5 million (CEE 2010b). Ameren Missouri had a comprehensive energy efficiency market potential study completed in early 2010 by Global Energy Partners to assess electrical energy efficiency and demand response potential in the residential, commercial, and industrial sectors for the Ameren Missouri service territory from 2009 to 2030 (GEP 2010). The utility plans to continue offering some level of energy efficiency programs; however they have recently indicated that they will scale back programs from about \$25 million in 2010 to about \$20 million in 2011 (St. Louis Dispatch 2011). In their most recent Integrated Resource Plan, Ameren Missouri reported plans to spend \$60 million over 3 years on energy efficiency programs (Ameren Missouri 2011).

Kansas City Power and Light (KCP&L),¹⁴ the second largest investor-owned utility (IOU) in the state, also offers several energy efficiency programs for customers, and the utility identified an increasing amount of energy efficiency in its most recent resource plan for the Greater Missouri Operations (KCP&L 2009). KCP&L recently reported its projected expenditures for 2010 at about \$26 million including GMO (KCP&L 2010).

Several municipal utilities and electricity cooperatives also currently offer programs. For example, the City Utilities of Springfield, the largest municipal utility in the state, invested about \$500,000–\$600,000 per year to energy efficiency from 2008–2010 (CEE 2010a, 2010b). Columbia Water and Light, another large municipal utility, identified energy efficiency as the least cost power supply option in its 2008 Integrated Resource Plan (IRP), which identified that programs could reduce demand from the existing forecast by about 5 to 10% over the next 10 years (CW&L 2011). The Columbia City Council approved the expansion of residential and commercial energy efficiency programs offered by the utility (CW&L 2011).

Gas utilities also administer energy efficiency programs. For example, Missouri Gas Energy spent \$1.5 million in 2009 on energy efficiency programs for residential customers and ramped up to a budget of \$2.25 million in 2010 (CEE 2010b). For more information on energy efficiency programs provided by Missouri gas companies (Laclede Gas Company, Ameren Missouri, Atmos Energy, and Missouri Gas Energy), see the DSIRE Web site (www.dsireusa.org).

But while numerous utilities in the state are offering energy efficiency services, the level of collective commitment still falls well below that of leading states. In 2009, Missouri utilities budgeted about 0.4% of its revenues for energy efficiency services, while leading states budgeted on the order of 2–4% of revenues and the national average was about 1% (Molina et al. 2010).

State-Led Energy Efficiency Programs

The state government has also developed programs, separate from those offered by utilities, to encourage energy efficiency. With federal stimulus recovery funds (ARRA), the state Department of Natural Resources (DNR) has rolled out several programs and continues to offer resources for Missouri citizens and businesses to improve energy efficiency. Combined, these programs are estimated to achieve significant annual electricity savings of about 240 GWh (Popp 2011).¹⁵ These estimated savings are equivalent to about 0.3% of electricity needs of the entire state.

For example, the *Energize Missouri* Communities program distributes \$43 million to cities and counties (19% of ARRA funding), for public building energy efficiency retrofits, street lighting and traffic signals, and water and wastewater treatment. Over half (54%) of the ARRA funding, or \$128

¹³ For a list of current program offerings, see: <http://www.ameren.com/sites/aeu/MyHome/ResEfficiency/Pages/ResEngyEffElecProgs.aspx> and <http://www.ameren.com/sites/aeu/UEfficiency/businessenergyefficiency/Pages/BusinessEfficiency.aspx>.

¹⁴ Data for Kansas City Power and Light (KCP&L) also includes KCP&L-Greater Missouri Operations (GMO)

¹⁵ These are estimates of projected savings based on calculations of measures implemented. DNR will report savings to the U.S. DOE as projects are completed, but does not plan to evaluate its programs in the future.

million, goes to the state's Low-Income Weatherization Assistance Program through the *Energize Missouri* Housing Initiative, which focuses on improving energy efficiency in homes of Missouri low-income families. In April 2010, the state rolled out its ENERGY STAR appliance rebate program—\$5.6 million (2%)—which provided rebates for gas furnaces, gas water heaters, clothes washers, and dishwashers

The State Energy Program (SEP) received \$57 million, or 24% of ARRA funding, for a variety of initiatives. These include programs for Missouri homeowners, industries, and farmers. The *Energize Missouri* Homes program includes a homeowner upgrades program and a neighborhood challenge program. The *Energize Missouri* Industries initiative has developed a competitive grant program and a reverse auction program. The first provides funding through a competitive grant process to assist Missouri industries in reducing energy costs and increasing competitiveness. Most of the grant recipients have been manufacturing companies, including Noranda, New World Pasta, Boulevard Brewing Co. and Purina. Projects have included mostly lighting, motors, heating and air conditioner upgrades. The "Best Price EE Program" is a reverse auction that allowed industries to bid on what savings at what cost they could achieve. There were 16 successful bidders that are implementing \$100,000–\$500,000 projects for a total of \$3 million. The state is also currently putting together a \$5.8 million revolving loan fund for energy efficiency and waste water treatment projects. And finally, the *Energize Missouri* Agriculture program consists of a cost-share grant program, energy training, and a loan program. This initiative is discussed in greater detail in the policy analysis section on agricultural efficiency.

Energy Efficiency Initiatives in Local Communities and Metropolitan Areas

The metropolitan areas of Kansas City and St. Louis hold around 56 percent of the state's population¹⁶ and the state's major utilities that serve these regions represent about 70% of electricity sales in the state. The other, smaller major population centers in the state, designated by the U.S. Census Bureau as Metropolitan Statistical Areas (MSAs)—the Missouri counties surrounding Jefferson City, Columbia, Springfield, St. Joseph, and Cape Girardeau-Jackson, Joplin, and Fayetteville-Springdale-Rogers—account for nearly an additional 16 percent of the state's population. In total these MSAs make up 18 percent of the state's land area, while accounting for nearly 75 percent of its population.

Regional and local governments, in partnership with utilities and non-profits, have put in place energy efficiency policies and programs that focus on improving energy efficiency in their communities. Local efforts to improve energy efficiency, especially in high population areas, can have a significant energy saving impact for the state as a whole. Additionally, these local efforts can produce significant non-energy benefits such as household and business cost savings and subsequent reinvestment of those savings into the local community. In this section we feature a few of the numerous local energy efficiency initiatives around the state.

¹⁶ Census 2000. http://factfinder.census.gov/servlet/GCTTable?_bm=y&-context=gct&-ds_name=DEC_2000_SF1_U-CONTEXT=gct&-mt_name=DEC_2000_SF1_U_GCTPH1_US10&-tree_id=4001&-redoLog=true&-caller=geoselect&-geo_id=04000US29&-format=ST-1&-lang=en

LOCAL LEADERSHIP ON RESIDENTIAL BUILDING ENERGY CODES—ST. LOUIS COUNTY

Although Missouri is one of only eight states which does not have a statewide building energy code for either residential or commercial buildings, many local governments within the state have adopted building codes for their jurisdictions, some of which include energy requirements. St. Louis County has been a leader among local governments by including energy considerations a part of its building code since 1980. Most recently the county adopted a variation on the 2009 International Energy Conservation Code (IECC) for new residential buildings effective November 1, 2010. The previous code in place was the 2003 IECC. Additionally the county has updated its commercial building code to incorporate the most recent energy code, ASHRAE 90.1-2007. The County's code adoption process happens through a series of public hearings of the Building Commission which then sends it recommendation to the County Council and Executive for approval.

In addition to applying within unincorporated areas of the county, the County's residential building codes also apply in the 32 (out of a total of 91) municipalities within the county that contract with the county to implement their code. Additionally, the county is seen by municipalities and other counties in the region as a standard to watch for building codes and perhaps follow suit with a similar code update. The department tasked with code implementation emphasizes the importance of regional code consistency on its website, "Public Works is interested in promoting uniformity of construction regulations throughout the entire area because we are convinced that uniformity and consistency in building code enforcement will result in better construction quality and attract more industry and businesses to the region."

St. Louis County is home to more than 995,000 people, approximately 17 percent of the state's population and 47 percent of the Missouri population in the St. Louis metropolitan area. Between 2009 and 2010, new home construction has been in the 400-500 annual range for single-family homes and 40-80 range for multi-family. If the County's development rate stays flat at its modest level, as it is expected to do, the improvement of the building energy code from 2003 to 2009 IECC will result in an energy and cost savings for heating, cooling, water heating, and lighting of approximately 17 percent in these new homes.

St. Louis County is now viewed by many homebuilders as "built-out." Much of the new construction has shifted to more historically rural counties, such as St. Charles, which is seeing annual new single-family home construction of 1,200 to 1,400 and 130 to 170 for multi-family. Upgrading to the most recent building energy code in these high-growth counties in the metropolitan region and elsewhere in the state will produce energy saving for an even larger number of households.

A recent analysis concluded that implementing the 2009 IECC across the entire state of Missouri would on average add a one-time upfront cost of \$875 in the construction of new homes but would result in \$459 in annual energy cost savings, or a payback of 1.9 years (Paquette et al. 2010). The Building Codes Assistance Project estimates that if Missouri began statewide implementation of the 2009 IECC code for residential buildings and the ASHRAE 90.1-2007 for commercial buildings starting in 2011, it would result in annual savings for households and businesses of \$99 million annually in 2020 and \$200 million annually in 2030 (BCAP 2011). Later in the report we present an analysis of the statewide energy savings opportunities through improved building energy codes and enforcement similar to the actions already taken by St. Louis County.¹

CITY OF COLUMBIA, MO—MUNICIPAL UTILITY INITIATIVES TO ADVANCE ENERGY EFFICIENCY

The City of Columbia is home to one of 108 municipal electric utilities in Missouri. Because the city grants the charter to its utility, Columbia Water and Light (CW&L), which is also a department of the city, they have regulatory control over the utility. This organizational structure has enabled collaboration between the city and utility. Columbia is a small city with a population of just over 100,000. Despite the community's small size, Columbia Water and Light has many well-developed commercial and residential energy efficiency programs. Many of these resulted from CW&L's Integrated Resource Planning in 1992 and 2008 as well as the City of Columbia's Visioning Goals approved by the city council in 2008.

Like the Kansas City region, Columbia has a Home Performance with ENERGY STAR program. In the October 2009-September 2010 fiscal year the program had 607 participants who received energy assessments, including 167 rental units (for the 2010 calendar year there were 855 participants). Participants who implemented the recommended home energy upgrades saw an average 33% reduction in summer cooling energy use. CL&W estimates that the program has created 45 local jobs and resulted in \$6.5 million spent locally, while reducing energy use by 570,000 kWh and capacity need by 173 kW from FY2010 investments. Complementing this program are rebates for high-efficiency air conditioners and heat pumps (resulting in energy savings of 289,000 kWh and load reduction of 112 kW from the 192 participants in FY2010), free home energy audits, and a low-interest (1-5% depending on term length, up to \$15,000) residential loan program, called Super Save, for home energy improvements. In FY2010, the loan program had nearly 300 participants with an average loan amount of \$10,000.

Two additional programs are focused on new homes: rebates for homes built to ENERGY STAR New Homes specifications and a "Tree Power" program that provides a free landscape audit to encourage energy-efficient landscaping and educates consumers how well-placed shade trees can reduce cooling costs by 30%. Low-income programs include partnership on a weatherization program and a window air conditioner exchange program. Commercial programs include incentives for lighting improvements, energy assessments, infrared scans, commercial loans up to \$30,000, and building operators certification. The lighting incentive program in FY2010 alone led to energy savings of 648,000 kWh and load reduction of 185 kW.

Columbia Water and Light has also developed several educational programs. Energy Choices is a curriculum supplement focused on how energy-wise choices can save money and protect the environment. It is taught to over 2,000 junior high school students each year. Another program is Saturday Science in which staff members spend their Saturdays teaching students various energy-related science courses through hands-on demonstrations. The utility also produces a video program called Energy Tips which are disseminated on YouTube. The programs received over 60,000 views during summer 2010.

Beyond its existing utility customer energy efficiency programs and education efforts, the City of Columbia has recently pursued and received several grants for innovative energy planning and projects:

- A \$285,000 Climate Showcase Communities grant from the U.S. Environmental Protection Agency (EPA) to target the downtown Special Business District with a "City Green" program focusing on building improvements for energy savings. Around 70 buildings are expected to be included. Each building will receive an energy audit, begin using Portfolio Manager Software to track their energy use over time, and track the impact of energy improvements made on their buildings. Additionally, the project will be used as an opportunity for education about energy use for the broader population of Columbia.
- A Missouri Water Wastewater Utility Partnership pilot program grant from the U.S. EPA Region 7 for a partnership between the city's Public Works Department and CW&L to improve energy efficiency in Columbia's water and wastewater treatment facilities. Assessments identified improvements that could lead to energy savings of 3,097 MWh per year. The program also provided energy management training to operators of the facilities.
- A \$200,000 Local Energy Assurance Plan grant from the U.S. DOE to develop a plan to improve resilience of the community's electric system in the event of a natural disaster or other catastrophic event.

TARGETED ENERGY EFFICIENCY INVESTMENTS—THE GREEN IMPACT ZONE AND SMARTGRID DEMONSTRATION PROJECT IN KANSAS CITY

Dozens of local and metropolitan region partner organizations and agencies are collaborating on this geographically-focused community redevelopment project aimed at vastly improving a neighborhood of Kansas City's urban core through coordinated "green" investments. Energy efficiency in buildings is one of the core strategies—along with jobs, safety & services, infrastructure, housing, youth, and agriculture—being applied to transform the neighborhood. Four separate but coordinated programs are working in the Green Impact Zone to improve energy efficiency: a neighborhood-based low-income weatherization program, two building energy assessment and improvement financial incentive programs, and a "Smart Grid" demonstration project. The Green Impact Zone Low-Income Weatherization Program is managed by the zone in partnership with the regional planning agency, Mid-America Regional Council (MARC), and funded by the Missouri Department of Natural Resources. The program aims to weatherize more than 650 homes in the Zone in the twenty-month period ending March 2012. At the end of March 2011 the program had completed work on 30 homes, work was underway at another 51 homes, and 109 additional prerequisite energy assessments had been completed. The program estimates that participants will receive up to 35 percent reduction in energy usage and save on average \$435 per house in heating and cooling costs annually at current prices. The program has made a concerted effort to work with contractors to provide jobs and training for residents of the zone and outreach to residents about the benefits of the program through door-to-door canvasses and in person meetings with landlords.

Households that do not qualify for the low-income weatherization program can participate in the regional Home Performance with ENERGY STAR program that is administered by Metropolitan Energy Center in partnership with Missouri Gas Energy and Kansas City Power & Light (KCP&L). The program provides comprehensive energy assessments and rebates of up to \$1,200 for the installation of energy saving measures. Between July 2009 and April 2011 homeowners participating in the program spent \$3.3 million on home energy improvements and utilities had provided bill credits of \$1.8 million to participating customers. During that time, 1,862 projects were completed with predicted annual savings of about 1800 MWh of electricity and 1 million therms of natural gas for a combined annual savings to homeowners of \$1.2 million.

A new energy performance program, EnergyWorks KC, is under development to provide energy improvements for homes and businesses in seven neighborhoods, including the Green Impact Zone. The program has been seeded by \$20 million in funds from the American Recovery and Reinvestment Act (ARRA) 2009. The Metropolitan Energy Center coordinates a single point-of-contact program for participating property owners, both residential and commercial, to obtain a building analysis, receive information about energy-efficient upgrades, and maximize available incentives and financing that can be used to employ local improvement contractors. MARC is focusing on the workforce development and policy needs that will facilitate a regional expansion of the service. The City is administering the grant and coordinating funds that will be leveraged as a loan loss reserve for participating financial organizations, rebates that help cross-market existing envelope and mechanical incentives from the area utilities, and neighborhood targeted measures, such as free audits, hazard abatement, and deconstruction to solve pre-weatherization bottlenecks.

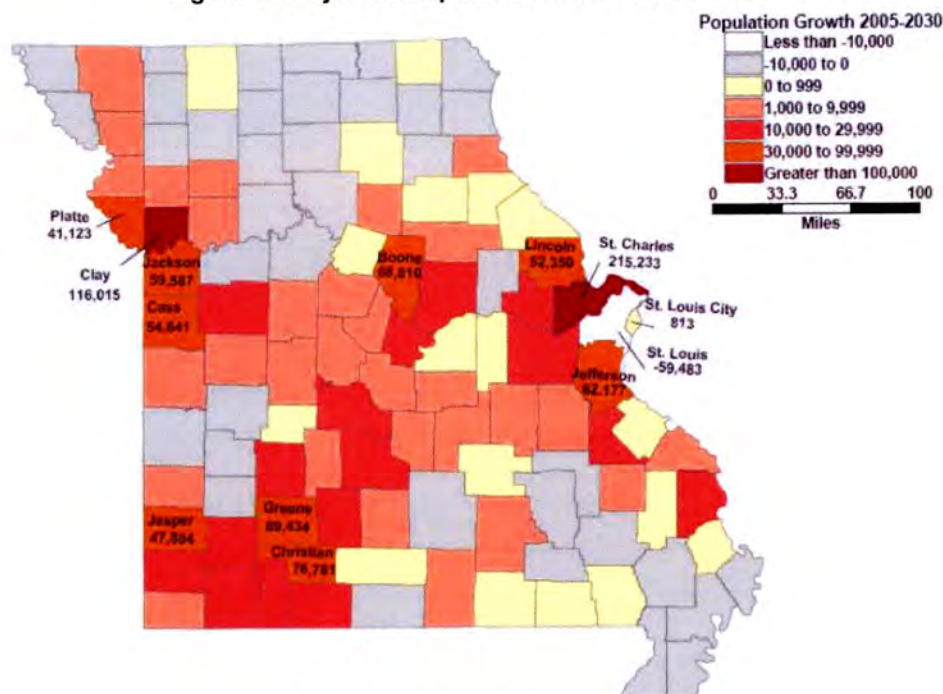
The SmartGrid Demonstration Project will invest \$48 million in the installation of electrical distribution infrastructure that will impact 14,000 customers in and around the Green Impact Zone. It is funded by the U.S. Department of Energy (DOE) and led by KCP&L in partnership with the Green Impact Zone and other organizations. The infrastructure improvements will provide customers with real time information on their energy use and costs, more efficient delivery of electricity, and improve reliability and response time to outages. The program also aims to increase awareness of KCP&L's energy efficiency programs, provide jobs opportunities in the demonstration area and install an electric vehicle charging stations in the project area. The project is being implemented in five phases scheduled to run from 2009 through 2014. In March 2011 the installation of new electric meters was nearly completed and substation upgrades were underway. In-home displays providing real-time energy use data had been provided to around 700 homes. KCP&L is estimating household energy savings of 6.5% from the in-home displays. They report that other pilots of similar technologies have resulted in energy savings of 2.5 to 15 percent.

More information is available at: www.greenimpactzone.org, www.hpwes.net, and www.kcplsmartgrid.com; Image: <http://www.kcplsmartgrid.com/about/smartgridmap.pdf>

REFERENCE CASE

Population in Missouri is expected to grow a moderate 10% by 2025 (MO Office of Administration 2011), but with a disparity in growth around the state. The high-concentration of growth will be in the Kansas City and St. Louis metro regions as well as central and southwestern parts of the state, as shown in Figure 8. The top ten growth counties account for 72% of total expected growth in the state's 115 counties.

Figure 8. Projected Population Growth 2005–2030



Source: MO Office of Administration 2011

Next, we develop a reference case for electricity consumption based on various resources, including current retail sales data through 2010 (EIA 2010), Missouri energy efficiency potential studies including the statewide study prepared by KEMA and Ameren Missouri's study (KEMA 2011; GEP 2010), and utility Integrated Resource Plans (KCP&L 2009; Empire 2011; Ameren Missouri 2011). We also make an adjustment to EIA sales data by sector as KEMA's study applied for commercial and industrial sales for 2008–2011 (as shown previously in Figure 5). We then adjust the baseline forecast to account for forthcoming federal appliance and equipment standards (Neubauer et al. 2009). We find that our adjusted forecast is consistent with KEMA's basecase projections for statewide electricity sales in 2020. Based on Missouri utility IRP projections, we estimate that electricity sales will increase at a compound annual growth rate of 0.7% per year between 2010 and 2025, and sales in the commercial buildings sector (0.8%) will slightly outpace residential (0.7%) and industrial (0.4%) (see Figure 9).

For natural gas, we similarly draw upon data from the EIA and from Missouri data sources including the recent KEMA energy efficiency potential study. We develop a reference case forecast using current year natural gas sales (EIA 2010c) and regional projections from the Annual Energy Outlook (AEO) (EIA 2011). We then adjust the baseline to account for forthcoming federal appliance and equipment standards. As is the case for our electricity forecast, our adjusted natural gas forecast based on regional AEO data is similar to the base case projections in the KEMA study. The reference case projects that natural gas sales will increase by about 0.2% per year overall, with most growth coming from the industrial sector (see Figure 10).

Figure 9. Projected Electricity Sales 2010–2025

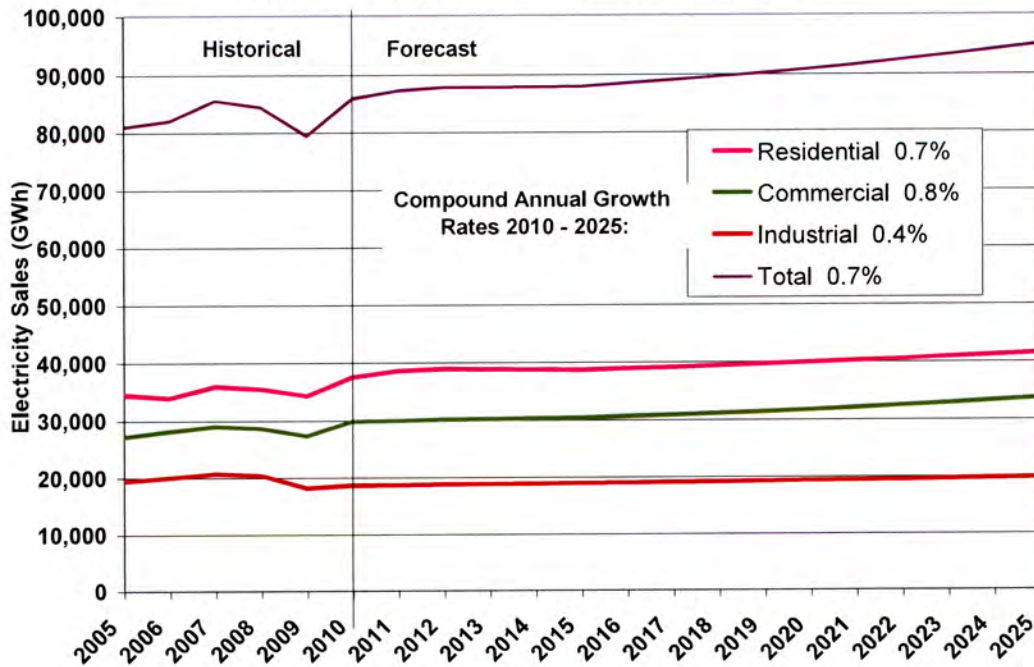
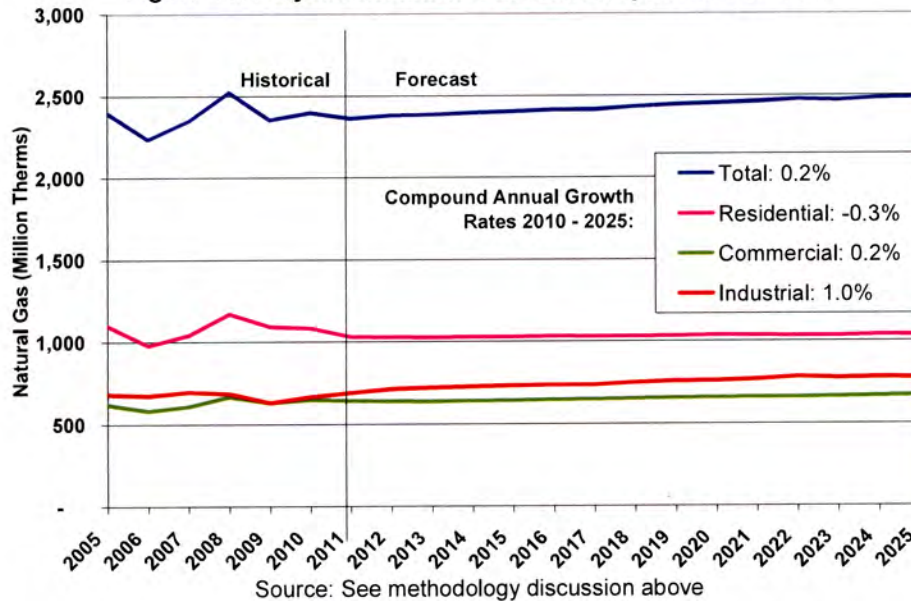


Figure 10. Projected Natural Gas Consumption 2010–2025

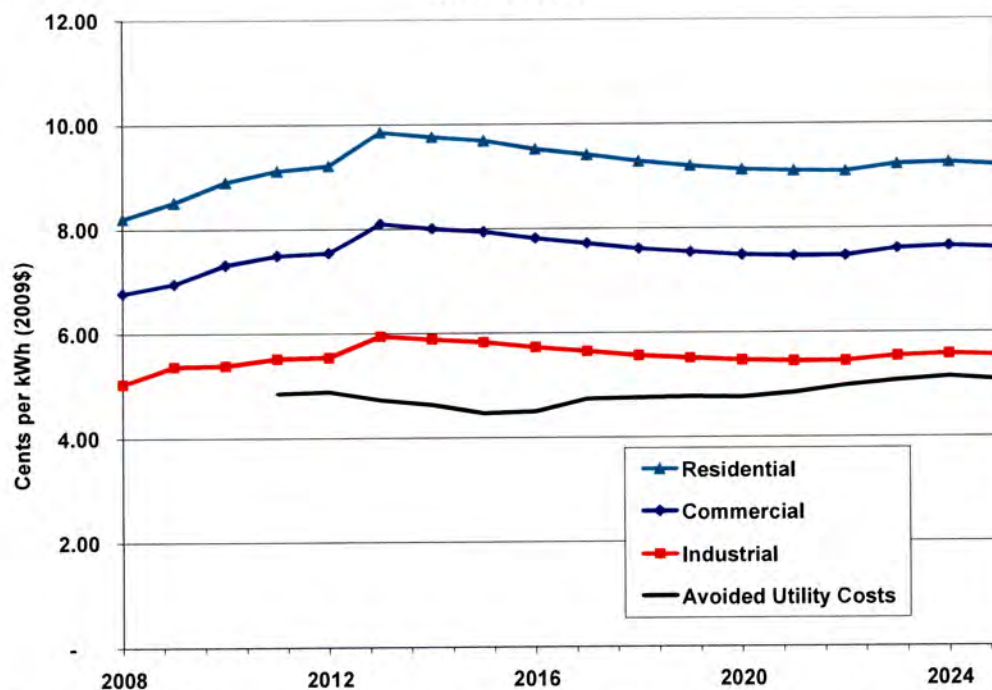


We also make projections for retail electricity prices in the state in order to estimate benefits to participants from improved energy efficiency services, and avoided costs to utilities in order to estimate system wide benefits for the Total Resource Cost (TRC) test. We rely on the following references and assumptions for the projections in Figure 11:

- Current electricity rates through 2010 are based on state-level data collected by the U.S. EIA (EIA 2010b);

- Short-term retail rate projections are based on recently-approved rate increases for KCP&L and pending rate cases for Ameren and Empire District Electric (MO PSC 2011); and
- Long-term projections are based on the U.S. EIA's AEO 2011 forecasts for the regional electricity markets (EIA 2011).
- Avoided costs are based on estimates from the Missouri PSC, as presented in the KEMA report, and remain relatively flat at about 5 cents/kWh in real dollars. Recent utility IRPs in Missouri do not suggest significant expansion plans for new electricity generation supply over the next 10 years, which explains why the avoided costs do not change (MO PSC 2011). These rates are conservative for our analysis, which extends beyond 10 years to 2025. It is possible that avoided costs will increase as utilities incorporate expansion plans for generation supply. Also, these avoided costs do not incorporate any price for carbon, which may be likely by 2025.

Figure 11. Projections of Retail Electricity Sales and Avoided Electricity Costs in Missouri (Real, 2009\$)



Note: Retail rates are based on data from EIA 2010b and regional projections in the Annual Energy Outlook (EIA 2011). Avoided utility costs are based on data from the Missouri Public Service Commission, as reported in the KEMA 2011 analysis.

ENERGY EFFICIENCY RESOURCE POTENTIAL

An assessment of a state's cost-effective energy efficiency resource is an important tool for policymakers and program designers when evaluating and developing energy efficiency policies and programs. There are numerous "levels" of efficiency potential that analysts examine, which typically include technical, economic, and achievable potential, and varying methodologies and assumptions (for a meta-review of state-level efficiency potential analysis in the U.S., see Eldridge et al. 2008):

- *Technical potential*: The technically feasible conservation levels that could be realized over time under specific engineering assumptions about performance and applicability of various efficiency measures. Costs do not serve as a basis; however analysts might have a tendency to include known measures that are generally cost-effective and fewer, less-known emerging technologies with higher costs.
- *Economic potential*: The subset of technical potential expected to be cost-effective, according to various jurisdiction-specific criteria, often the total resource cost (TRC) test.
- *Achievable potential (or program potential)*: The subset of economic potential that can be achieved through programs. Analysts recognize this level as the most uncertain, as it takes into account various levels of investments in incentives and marketing efforts by conservation program administrators.

Numerous energy efficiency resource potential studies have been completed in recent years for a wide geographic range of states and utilities, and increasingly analysts recognize the importance of efficiency potential studies in utility resource planning (see Haeri 2011 for a recent review of efficiency potential assessments in the U.S.). This review also points out that the determination for policy and program planning has to begin with a robust understanding of what is technically and economically feasible, followed by an understanding of the achievable potential under different funding scenarios. These estimates provide critical points of reference to help guide resource planning. Ultimately what is reasonably achievable for setting performance standards is a policy and program decision rather than a modeling exercise.

In this section we present a summary of some of the recent studies prepared for Missouri or the Midwest region, including a meta-review of about a dozen studies done for Midwest states (ECW 2009), a potential study for Ameren Missouri in their utility service territory (GEP 2010), and a statewide energy efficiency potential study for Missouri in 2011 (KEMA 2011).¹⁷ Together, these studies provided the basis for our energy efficiency resource assessment.

Technical and Economic Potential Results

Technical and economic potential are “bottom-up” assessments that screen all efficiency measures first for technology availability (technical potential) and then for cost-effectiveness (economic potential). The latter are typically evaluated using the Total Resource Cost (TRC) test. This bottom-up approach includes numerous technology measures, and takes into account energy savings, costs, and current saturations of energy efficiency measures, but does not examine program participation. Because technical and economic potential do not model program penetration over a certain number of years, they are less time-dependent and can therefore be examined as a total snap-shot of what is cost-effective given current technology and cost assumptions both as well as on an average annual basis.¹⁸ For this reason, we can draw some comparisons among studies of economic potential even if the analysis examined slightly different time periods. As shown in Figure 12, numerous studies recently completed for Missouri and the Midwest as a whole have shown that electricity savings on the order of 15-35% (22% median) are currently cost-effective. And taking into account the various time periods, we also examine average economic annual savings potential as shown in Figure 13, which present a range of about 1.4–2.5% per year (1.8% median). We do not attempt to evaluate each study individually, but rather use the broad trends to underscore the finding that a significant, cost-effective energy efficiency resource is available to Missouri should the state choose to deploy policies and should consumers adopt behaviors to capture the resource.

¹⁷ The KEMA study has not been accepted by the Missouri Public Service Commission as of this writing.

¹⁸ There will be some variations over time, however, because some measures with long lifetimes may only become cost-effective when consumers are ready to replace them at the end of their lifetime.

Figure 12. Economic Potential Results for Electricity Efficiency in Missouri and the Midwest: Aggregate Savings Potential (%)

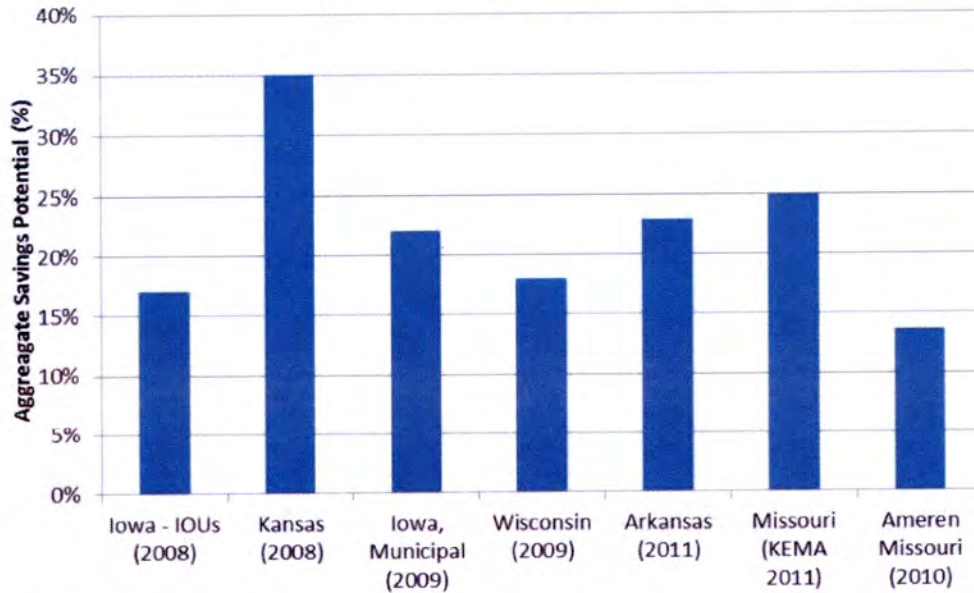
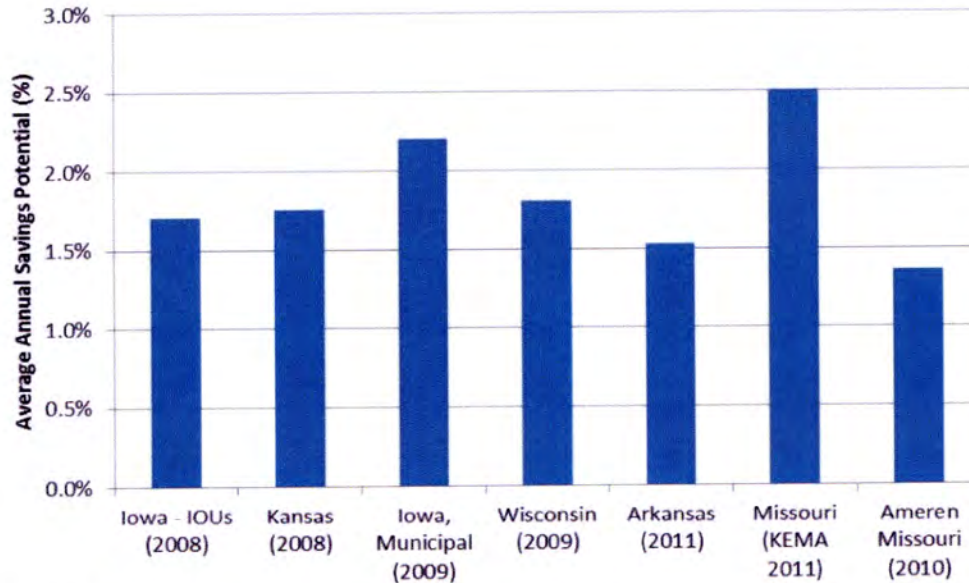


Figure 13. Economic Potential Results for Electricity Efficiency in Missouri and the Midwest: Average Annual Savings Potential (%)

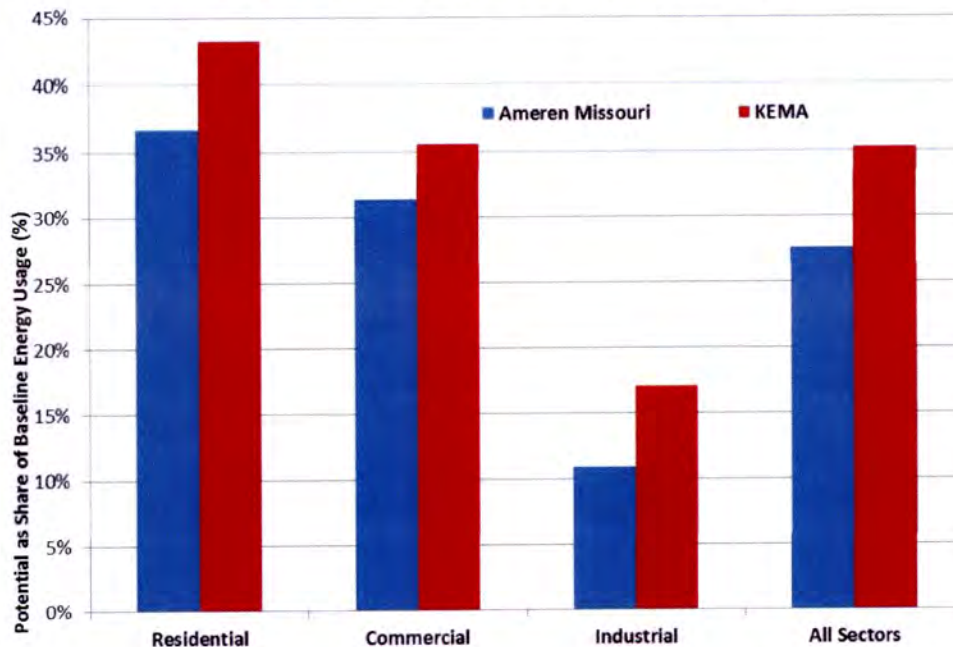


Note: Average annual savings are also shown because the studies have various end-years (Iowa IOUs and Municipal—2018; Kansas—2028; Wisconsin—2018; Arkansas—2025; Missouri KEMA—2020; and Ameren Missouri—2025).

The technical and cost-effective efficiency resource varies by customer class, which is one reason it is important for a particular state or utility service territory to examine economic potential in their own region. Next we provide more detailed sector-specific findings from the two Missouri-specific studies. In Figure 14, we examine the relative technical potential identified in each study by sector (both for the analysis year 2020). Both studies identify the same general trend of the largest technical

potential (as a percentage of baseline sales) coming from the residential sector, followed by the commercial sector, and finally the industrial sector.

Figure 14. Technical Potential for Electricity Efficiency in Missouri by Sector in 2020: Results of Ameren Missouri study and KEMA statewide study

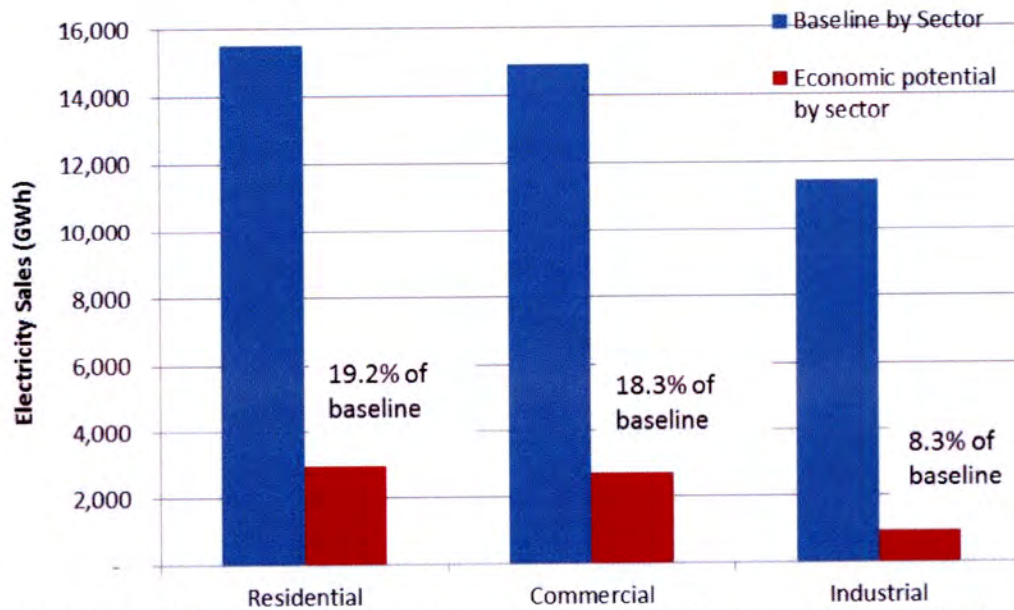


Next we show results for the economic potential analysis, which screens for cost-effectiveness. As shown in Figure 15, the Ameren Missouri study identifies various levels of electricity economic potential by sector in 2025: 2,985 GWh of residential potential; 2,727 GWh of commercial potential; and 946 GWh of industrial potential. In aggregate, the study estimates 6,657 GWh of economic potential in 2025, which is equivalent to 15.9% of baseline sales in the same year. The KEMA study finds a similar trend in how the potential varies significantly by sector, with the residential sector having the largest potential, followed by the commercial and industrial sectors. In aggregate, the KEMA study estimates an economic potential of 25% in 2020.

The KEMA study finds an overall higher technical and economic potential for each sector compared to the Ameren Missouri study results, as a percentage relative to baseline sector sales. It appears that the treatment of pending energy efficiency standards could account for much of the difference in results, because the Ameren Missouri study accounts for upcoming efficiency standards in its baseline assumptions for each measure whereas the KEMA study makes these adjustments in its achievable analysis. This means that a portion of the economic potential presented in the KEMA study would not be deemed achievable because pending standards would produce these savings anyway without program intervention. Also, any variations in the number and type of measures in each also likely explain some of the difference in technical and economic potential.

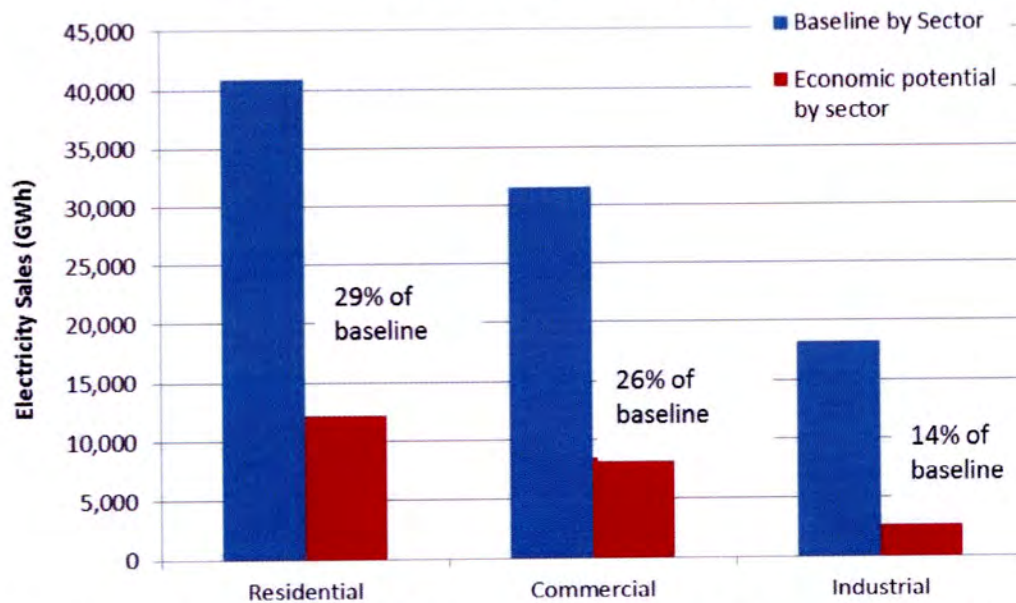
Also of note is the difference in customer class mixes between the Ameren service territory and the statewide mix, most notably that the residential sector makes up a significantly larger share of baseline statewide sales than of Ameren's sales. This means that a statewide analysis has a slightly higher *aggregate* relative savings potential because the residential sector contributes slightly greater savings opportunities than the other sectors, as was found in both studies.

**Figure 15. Ameren Missouri Electricity Efficiency Assessment:
Economic Potential by Sector in 2025 (GWh)**



Note: Baseline electricity sales represent that of Ameren Missouri's service territory in the state only. Therefore the y-axis differs between these two figures. We show 2025 results, which is the same end-year used in this report.

**Figure 16. KEMA's Missouri Electricity Efficiency Assessment:
Economic Potential by Sector in 2020 (GWh)**

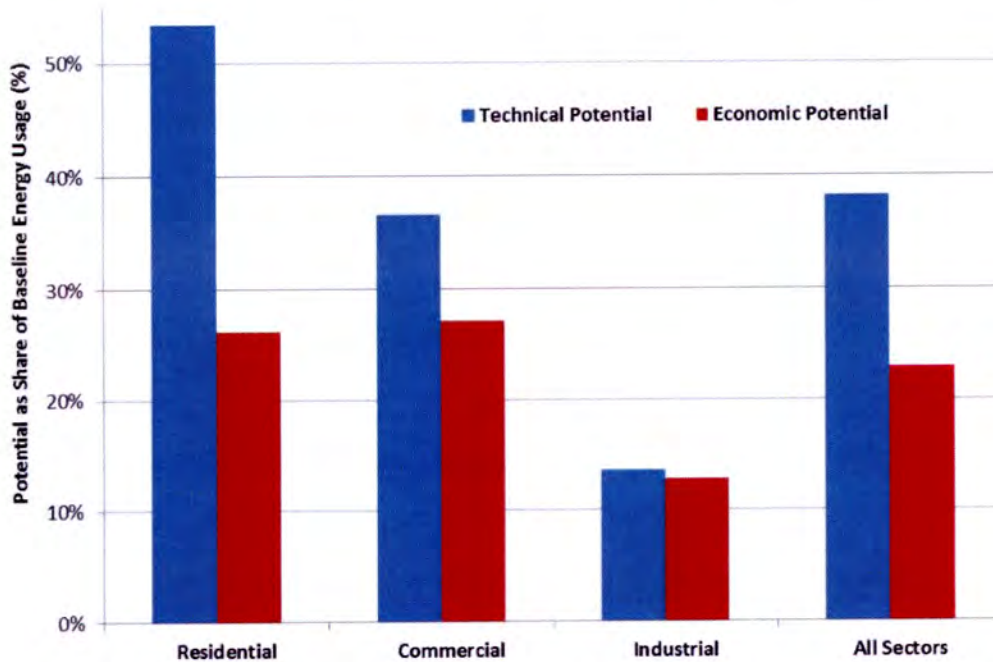


Note: Baseline data represents electricity sales for the entire state. We show results for 2020, which is the benchmark year for results presented in that report.

The KEMA study was the only of these two studies that examined natural gas potential. According to the KEMA study results, efficiency potential in the natural gas sector is slightly lower than electricity,

at about 38% and 23% for technical and economic potential, respectively. The residential and commercial sectors both provide about 25% economic potential, but because the residential sector accounts for a larger share of sales, it has the greatest opportunity for energy efficiency savings.

**Figure 17. Natural Gas Efficiency Assessment (KEMA Study Results):
Economic and Technical Potential**



Achievable Energy Efficiency Potential Results

Unlike the technical and economic potential results, achievable potential attempts to account for program participation levels, measure awareness, and other barriers to measure uptake. Efficiency analysts note that the uncertainty in the achievable potential estimates is greater than the uncertainty of the technical and economic potential results. In Figure 18, we show results for achievable potential from several studies for Missouri and the Midwest, which shows average annual savings over the study time periods. These results show a range of savings of 0.3% to 1.6% per year, and an average and median savings of 0.8% per year. The results of these analyses provide useful guidance to Missouri policymakers and energy efficiency program developers. Next, we provide a discussion to shed light on some of the uncertainty around achievable results.