Missouri Comprehensive State Energy Plan

DEPARTMENT OF ECONOMIC DEVELOPMENT
DIVISION OF ENERGY

OCTOBER 2015

Acknowledgements

The Missouri Comprehensive State Energy Plan is the product of the dedication and hard work of more than 300 stakeholders. We would like to recognize and thank those who participated in the development of this Plan including members of the Steering Committee, members of Working Groups who contributed throughout the process, and members of the public who shared their opinions and ideas with us. Participants should be credited for their tireless dedication in providing essential information, data, analysis, and experience to the betterment of this undertaking.

A list of the members of the Steering Committee and Working Groups is included as an Appendix to this Plan.

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Notes to the Reader

- Chapters 1 through 6 of this document provide background information on the energy industry in Missouri. This information and the analysis that accompanies it were used to develop policy recommendations for our state that are presented in Chapter 7.
- Data used in preparing this Plan was collected from a variety of sources such as the U.S. Energy Information Administration, the U.S. Department of Energy, the U.S. Bureau of Economic Analysis, and the U.S. Census Bureau. State-specific sources used include the Department of Economic Development, the Department of Transportation, the Department of Agriculture, the Public Service Commission, and the Office of Administration.
- For purposes of this Plan, the following states have been used to benchmark energy metrics: Kansas, Illinois, and Iowa. These states were selected as a comparison group because of their geographic proximity to Missouri, similar climates, consumer characteristics, and industrial usage profiles.

This document was prepared by Missouri Department of Economic Development – Division of Energy with assistance from Inova Energy Group and Elevate Energy.

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Introduction

I. Plan Objectives and Executive Order

In 2014 Governor Jeremiah W. (Jay) Nixon announced during the State of the State Address that "we need to develop a comprehensive energy plan for our state: one that balances the need for low-cost, reliable energy with our duty to be responsible stewards of the environment." How Missouri produces and consumes energy has a profound and lasting impact on our economy, our security, and our quality of life.

The Governor's statement followed the 2013 transfer of the Division of Energy (the Division) from the Department of Natural Resources to the Department of Economic Development pursuant to Executive Order 13-02. This Executive Order was made in recognition of the fact that Missouri residents and businesses depend on affordable and reliable energy, and that opportunities exist to attract high-paying energy jobs to our state that advance economic development.[1] After consulting with his advisors and interested parties, Governor Nixon signed Executive Order 14-06 directing the Division to lead the development of a Comprehensive State Energy Plan (the Plan) for Missouri that would put our state on the path to meet Missouri's short- and long-term needs for clean, reliable, affordable, and abundant energy.

The Executive Order 14-06 guided the creation of the Plan by requiring an inventory and assessment of the way we consume energy in our state, an analysis of Missouri's resources, an examination of existing energy policies, and the identification of emerging challenges and opportunities associated with further development of energy resources and infrastructure for a sustainable and prosperous energy future. This Plan identifies the policies needed to encourage the efficient use of energy in all sectors; allow household budgets to be more effectively managed; help businesses to run more profitably; and prompt capital investment to be made more efficiently to spur job creation and economic growth. Promoting the development, security, and affordability of diverse energy sources will not only increase Missouri's domestic production of energy resources and energy generation to sustain and grow the economy, but it will also decrease risks in energy supply, delivery, and security while, most importantly, promoting affordable prices.

II. Background

Increasing Missouri's domestic production of energy resources, energy generation, and energy efficiency decreases risk associated with energy supply disruption, delivery, security, and price volatility. Efforts around energy planning have been made over the past twenty-five years, including determining Missouri's contribution to global climate change and ozone depletion, conducting a statewide energy study, determining the causes for the 2000-2001 winter energy crisis, evaluating energy security post-9/11, convening a task force focused on renewable fuels and affordable heating bills, and contemplating Missouri's energy future. However, the last comprehensive energy outlook occurred in the 1990s and resulted in the Missouri Energy Futures Coalition, which has since disbanded. All other efforts initiated by the executive or legislative branches of government were limited to narrow topics within the energy realm.

Until now, it had been decades since the state and its energy stakeholders participated in a comprehensive examination of our energy challenges and opportunities.[i] The most recent effort, which the Joint Committee was charged with examining Missouri's "increasing and future energy demand ...while being cost effective and environmentally feasible"[2] with the goal of determining "the best strategy to ensure a plentiful, affordable, and clean supply of electricity... for the next 25 years."[3] This Joint Committee on Missouri's Energy Future issued a nine-page report that concluded that Missouri should diversify its portfolio of energy sources and take advantage of energy efficiency, renewable energy sources such as wind, solar, biomass, and geothermal, as well as nuclear and natural gas. The Joint Committee also recommended exploring the research and development of "clean coal" technologies in order to mitigate carbon dioxide emissions. Finally, the report acknowledged the aging coal-fired baseload fleet, the need to update infrastructure particularly for distribution of renewable energy, volatility of natural gas supplies and prices, availability of capital for investments, and a forecasted shortage of skilled labor in the utility industry. The Committee's recommendations were closely reviewed and served as a starting point for the development of this comprehensive Plan.

III. Plan Development Process

1. Steering Committee

To assist in guiding the development of the Plan, Governor Nixon invited more than 50 leaders in business, labor, education, and energy to join a Steering Committee. The members of the Steering Committee were selected because each had expertise in a certain aspect of Missouri's energy outlook and represented a constituency that has a substantial interest in Missouri's energy future. Stakeholders were convened in a collaborative and inclusive manner with the intention of avoiding the entrenched positions normally taken in the adversarial regulatory and legislative arenas. The Steering Committee membership possessed the knowledge, interest, and capability to contemplate the short- and long-term energy needs of Missourians. They sought to evaluate ideas and information brought forward by the public, experts, and fellow committee members with a critical eye toward addressing the challenges and needs to accomplish the Governor's vision.

During the public meetings held in October 2014, Steering Committee members learned about the particular aspects of energy to be addressed in the Plan through presentations by subject matter experts and had discussions with other Steering Committee members who have expertise in these areas. In addition, Steering Committee members were encouraged to participate in Working Groups that were formed around specific topic areas, were asked to provide insight into policy recommendations, and were asked to assist in shaping the Plan. The Steering Committee's expertise and dedication were invaluable assets to the development of the Plan.

2. Public Meetings and Testimony

To provide opportunities for interested stakeholders and members of the public to offer input on the development of the Plan, the Division hosted seven public meetings across the state during the month of October 2014. Members of the General Assembly and the general public were invited to attend

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[i] Past efforts included: "Missouri Commission on Global Climate Change and Ozone Depletion Recommendations Report. " 1991. HCR12 and extended by HCR3; Environmental Improvement and Energy Resources Authority. "Missouri Statewide Energy Study." May 1992; "Interim Report of the Missouri Energy Futures Coalition." October 25, 1995; "Missouri Energy Futures Coalition Final Report" and 1997; "Initial Report to the Governor, Causes of the 2000-2001 Winter Energy Crisis." 2001; "Interim Report to Governor Bob Holden by the Missouri Energy Policy Task Force." August 2001; "Joint Committee on Telecommunications and Energy Interim Report." 2002; "Missouri's Energy Task Force Report: A Comprehensive Look at Fossil Fuels & A Plan for Missouri's Future." 2006; and "Report of the Joint Interim Committee on Missouri's Energy Future." 2009.

these meetings to learn about the Plan development process. Those in attendance were encouraged to share their views during a public comment period.

A total of 359 members of the public, including state and local policy makers and regulators, attended the meetings, and some individuals participated in more than one session. Each public meeting focused on a different energy topic and included presentations from local and national experts. A synopsis of all seven meetings is available on the Division's website.[4]

The Division also created an online forum through its website, energy.mo.gov, to provide Missourians an additional opportunity to offer comments on the Plan. A total of 194 comments were received through the online forum between October 2014 and January 2015. Comments received were varied and focused on natural resources, fuels, generation technologies, and end uses. Some common themes included the need to diversify supply by identifying opportunities for more efficient use of resources and increasing the use of in-state renewable energy sources. In addition, a number of comments mentioned the need for a secure supply of affordable energy.

Due to the public meetings being held in October 2014, a time-demanding month at the height of the election cycle, only three members of the General Assembly were able to attend a public meeting. Legislators were also invited to participate in a webinar to receive a briefing on the Plan process and summary of the public meetings. The Division provided individual briefings to members upon request and accepted invitations from chairpersons to provide updates to their committees once session started. In July 2015 Representative Rocky Miller, Chairman of the House Energy and Environment Committee, announced plans to hold three interim committee hearings across the state to discuss the Plan: July 27 in St. Charles, August 13 in Independence, and September 17 at Lake of the Ozarks. The focus of the meetings was to discuss the energy policy components identified in the executive order and provide legislative engagement. Delivering the Plan on October 15 of 2015 means that Missouri's policy makers including the Governor, the General Assembly, and regulators will have sufficient time to analyze the material and recommendations made in the Plan in order to determine which recommendations to pursue in 2016 and beyond.

3. Working Groups

In an effort to continue receiving input on the Plan from interested Missourians, the Division established six technical Working Groups that focused on specific energy topics identified in the Executive Order. The Working Groups served as discussion forums and were comprised of leaders in the energy field who shared their experience and knowledge throughout the development of the Plan.

In total, 514 individuals, including Steering Committee members, business leaders, energy innovators, and members of the public, served on a Working Group by contributing ideas, acting as liaisons between the Working Groups and their respective stakeholder groups or constituencies, and reviewing and providing feedback on the Plan.

Working Group members contributed to the Plan through their participation in meetings and via an online platform. In addition, sections that form the research and background portions of the Plan were circulated to Working Group participants for comments and feedback, particularly related to the policy and strategy recommendations that are contained in this Plan.

IV. Plan Recommendations

Consistent with the General Assembly comments to the U.S. Environmental Protection Agency,[5] "balancing a multitude of factors, primarily affordability and the ability to produce enough energy to keep our electrical grid stable and reliable" is critical for Missouri's energy future and is also a goal of this Plan. In order to ensure both reliability and affordability, which were conveyed as being very important in many of the public comments received, Missouri's energy supply must be diverse and secure, and its usage must be efficient.

Currently, Missouri is deeply dependent on coal for electricity generation and heavily reliant on petroleum for transportation. Expectations that Missouri will become energy independent or completely eliminate the need for fossil fuels to supply our energy needs are unrealistic. While the transition to a more diverse energy portfolio will take time and will not be without transition costs, economic drivers and sound policy provide ample room to increase diversity in the state's energy supply. Missouri should also encourage the use of new energy technologies and pursue the economic development opportunities associated with these efforts.

Although Missouri has taken steps to encourage efficiency in its energy usage, the state can greatly improve in this area simply by implementing proven cost-effective strategies. The efficient use of energy helps maximize our natural and financial resources. By using less energy, our businesses can produce products with lower overhead, improve our gross state product, and free up capital to create more jobs and economic growth. Using electricity more efficiently makes meeting our energy needs more affordable, helps family budgets, and means that utilities can delay having to build expensive new generating plants, which results in long-term savings.

Chapter 7 of this Plan offers a series of recommendations designed to achieve the goal of the Executive Order: to meet Missouri's short- and long-term needs for clean, reliable, affordable, and abundant energy. By understanding, adopting, and implementing these recommendations we can improve the reliability and resilience of our energy systems, ensure our utility bills remain affordable, and seize opportunities to grow our economy by creating more 21st century jobs.

Chapter 1:
Missourians and the Energy Outlook

This first chapter focuses on energy consumption and expenditures by Missouri's various end-use sectors. A snapshot that includes consumption and pricing is provided for background on some of the more significant fuels and natural resources used by Missourians. More in-depth information on energy generation and usage is available in Chapter 2: Energy Supply and Chapter 3: Energy Use.

I. State Energy Profile

Missouri is the 21st largest and the 18th most populous state and has access to the two largest rivers in the country. Comprising 114 counties and the city of St. Louis, Missouri has an estimated population of 6.06 million (2014)[6], which is projected to increase to 6.8 million by 2030.[7]

Despite seasonal temperature variation, Missouri has a moderate climate with few extended periods of very cold or very hot weather. In 2012 Missouri consumed 1,813 trillion British Thermal Units (BTU) of energy and was ranked by the U.S. Energy Information Administration (EIA) as the 25th state in terms of energy consumption per capita. That same year the state produced 206 trillion BTU in energy resources.[8]

Missouri is a net importer of energy and the state has few fossil fuel supplies that are economically and commercially recoverable with current available technologies. Although Missouri was the first state west of the Mississippi River to produce coal commercially, it currently ranks third from the bottom both among those states that produce coal[9] and among those that produce crude oil,[10] and has marginal natural gas reserves and production.

While renewable energy resources do not constitute a significant percentage of our current generation portfolio, Missouri does have several utility-scale solar and wind farms, as well as various hydropower facilities. The state has significant potential for renewable energy growth, given that it is located in the U.S. wind corridor and has good solar resources. In addition, forests and farmland throughout the state provide ample resources for biomass and alternative fuels. Finally, although not a renewable energy resource, the state contains one of the world's largest and most important deposits of lead, which can be used for production of lead-based batteries and development of stationary energy storage technologies. Energy storage is currently a key challenge in leveraging intermittent resources.

Table 1. Missouri State Profile

Demography	Missouri	Share of U.S.	Reporting Period
Population[1]	6.06 million	1.90%	2014
Civilian Labor Force	3.1 million	2.00%	Jan-2015
Economy	**Missouri**	**U.S. Rank**	**Reporting Period**
Gross State Product	$ 284.5 billion	21	2014
Per Capita Personal Income[2]	$41,613.00	34	2014
Land in Farms	28.3 million acres	12	2012
Production	**Missouri**	**Share of U.S.**	**Reporting Period**
Total Energy	206 trillion BTU	0.30%	2012
Crude Oil[3]	214 thousand barrels	*	2014
Natural Gas[4]	8.8 billion cu ft	*	2014
Coal	414 thousand short tons	*	2013
Electric Power	**Missouri**	**Share of U.S.**	**Reporting Period**
Net Summer Capacity	21,763 MW	2.00%	Dec-14
Net Generation[5]	88.1 GWh	2.20%	2014
End-Use Consumption & Expenditures	**Missouri**	**U.S. Rank**	**Reporting Period**
Total Consumption	1,813 trillion BTU	20	2012
Total Consumption per Capita	301 million BTU	25	2012
Total Expenditures	$ 26,146 million	18	2012
Total Expenditures per Capita	$4,340.00	27	2012

*Note: * indicates a minimal share of U.S. production.*

Sources: U.S. Energy Information Administration (EIA), "State Energy Profiles," Updated March 19, 2015, http://www.eia.gov/state/?sid=MO

[1] U.S. Census Bureau, "Population," Accessed April 2015, http://www.census.gov/popest/data/national/totals/2014/NST-EST2014-popchg2010-2014.html

[2] U.S. Department of Commerce Bureau of Economic Analysis, "Per Capita Income," Accessed April 2015, http://bea.gov/iTable/iTableHtml.cfm?reqid=70&step=30&isuri=1&7022=21&7023=0&7024=non-industry&7033=-1&7025=0&7026=xx&7027=2014&7001=421&7028=-1&7031=0&7040=-1&7083=levels&7029=21&7090=70

[3] U.S. EIA, "Missouri Field Production of Crude Oil," Accessed April 2015. http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPMO1&f=A

[4] Missouri Department of Natural Resources, "Oil and Gas Production". Updated March, 12 2015. http://dnr.mo.gov/geology/geosrv/oilandgas.htm

[5] U.S. EIA, "Net Generation for all Sectors". Accessed April 2015. http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=vvg&geo=g000gq&sec=g&linechart=ELEC.GEN.ALL

II. Overview of How Missourians Use Energy

Energy plays a significant role in our lives. We need fuels to generate the electricity that powers our homes and places of business; transportation fuels to move goods across the state and to provide people with affordable and convenient access to work, school, and essential services; and natural resources such as natural gas and oil products to cook our food, heat buildings, and manufacture products. Energy should be analyzed as a system with intricate parts. It is composed of many different fuel sources that feed into different activities and are consumed by the transportation, industrial, residential, commercial, and electric power sectors.

As shown in Figure 1, transportation is Missouri's largest end-use sector and is responsible for 30 percent of total energy consumption. The residential, commercial, and industrial sectors follow at 27, 22, and 21 percent of the state's end-use energy consumption, respectively.

Missouri Energy Consumption by End-Use Sector, 2012 (1,813 Trillion BTU)

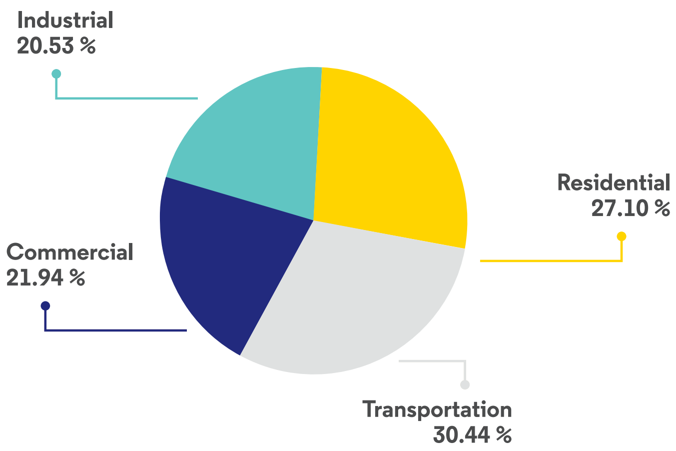


Figure 1. Total Energy Consumption by Sector and Source in Missouri in 2012.

Sources: U.S. EIA. "State Energy Data System (SEDS): 2012," Accessed April 2015. Tables CT2 and CT4 through CT8.

In Missouri, 42 percent of the energy consumed is derived from coal, the primary fuel used to generate electricity – see Figure 2. Motor gasoline is the second leading source at 20 percent. Natural gas, the third leading energy source and the primary fuel used for home heating, comprises 14 percent of consumption. Nuclear energy resources account for approximately six percent of energy consumption. Propane, at 1.5 percent of consumption, is used to heat approximately nine percent of Missouri homes, primarily in rural areas.[11]

Even though renewable energy resources currently account for only 4.4 percent of the energy consumed in our state, they continue experiencing strong growth driven primarily by utility-level additions of solar and wind generation capacity, increased integration of biofuels, and policies and incentives that promote distributed generation.

Missouri Energy Consumption by Source, 2012 (1,848 Trillion BTU)

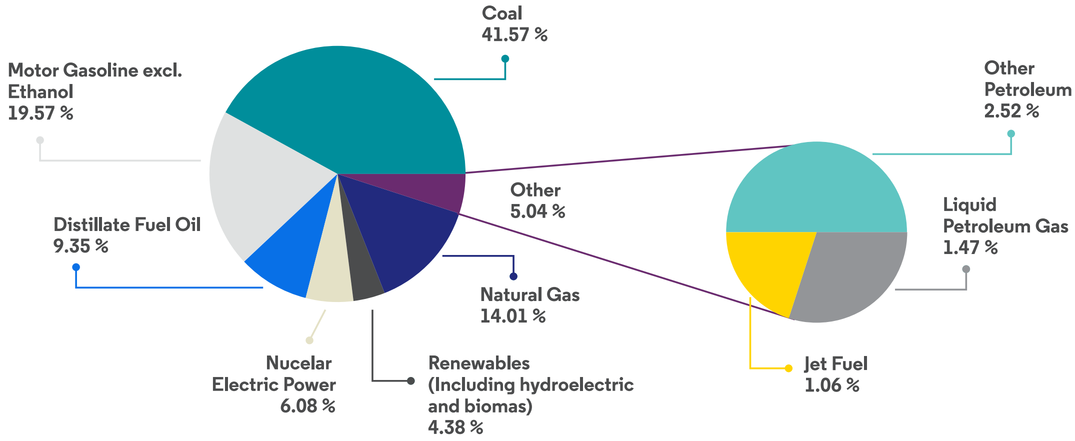


Figure 2. Total Energy Consumption by Sector and Source in Missouri, 2012.

Source: U.S. EIA "SEDS: 2012," Accessed April 2015. Tables CT2 and CT4 through CT8. Note: Total energy consumption by source excludes reduction from net interstate flow of electricity.

In 2012, Missourians collectively spent $26.2 billion on energy sources that include natural gas, transportation fuels, coal and other source fuels. On a per capita basis, this translates to roughly $4,340 in total energy expenditures, which is less than residents spend in the neighboring states of Kansas and Iowa, but more than what a resident spends in Illinois – see Table 2. In that same year, approximately 10.1 percent of Missouri's Gross State Product (GSP) was spent on energy.[12]

Table 2. Comparison of Energy Expenditures, 2012.

	Total Energy Expenditures	Total Energy Expenditure Per Capita	U.S. Rank (By expenditures per capita)	Energy Intensity of GSP (Index)	Rank (Intensity of GSP)
Missouri	$26.15 billion	$4,340.00	27	10.1	25
Illinois	$48.09 billion	$3,737.00	42	6.9	45
Iowa	$16.42 billion	$5,339.00	10	10.8	20
Kansas	$14.27 billion	$4,944.00	17	10.3	23

Note: Energy Intensity of Gross State Product is defined as total energy expenditures divided by Gross State Product in current dollars.

The sections that follow provide an overview of key energy resources in the state that are significant to our economy and showcase how energy is consumed in Missouri. Additional information on the generation, transmission, and distribution of these resources is available in Chapter 2: Energy Supply.

1. Electricity Snapshot

In 2013, Missourians consumed approximately 83.4 gigawatt hours (GWh)[13] of electricity for which they paid a total of $7.4 billion or $1,222 per person.[14] Missouri's 2013 electricity intensity relative to its Gross State Product equates to approximately 0.30 kWh/$GSP.

As shown in Figure 3, in 2013 Missouri's residential sector was the largest consumer of electricity, accounting for approximately 42 percent of total statewide consumption and about half of the state's electricity expenditures. That same year the commercial sector, which includes commercial and institutional buildings as well as electricity needed to light public streets and highways, consumed 38 percent of the state's electricity and was responsible for 37 percent of expenditures. Finally, the industrial sector, which includes manufacturing, agriculture, mining, and construction, accounted for roughly 20 percent of electricity usage and 14 percent of expenditures. Electricity consumption and expenditures from the transportation sector are negligible given that this sector relies primarily on petroleum-based fuels and not electricity.

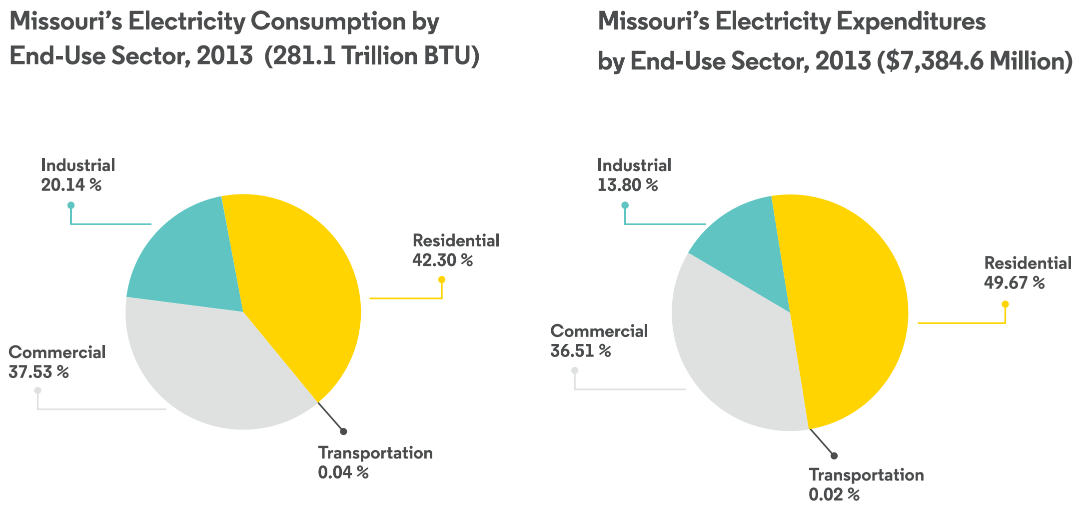


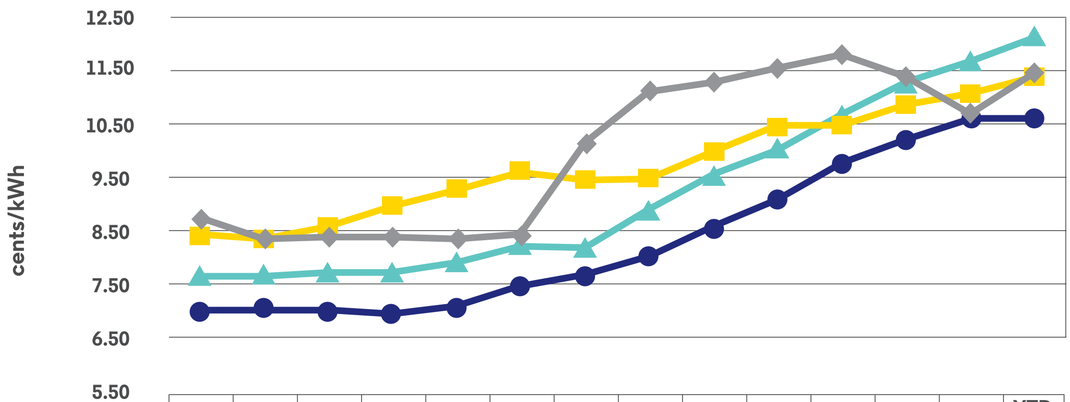
Figure 3. Missouri's Electricity Consumption and Expenditures by End-Use Sector, 2013.

Source: U.S. EIA, "Electricity Data Browser," Accessed March 2015, http://www.eia.gov/electricity/data/browser/

Note: Data comes from preliminary electricity sales information posted by the EIA on 12/5/2014 as part of the State Energy Data System. Final verified numbers for the year 2013 were unavailable at the time this document was created.

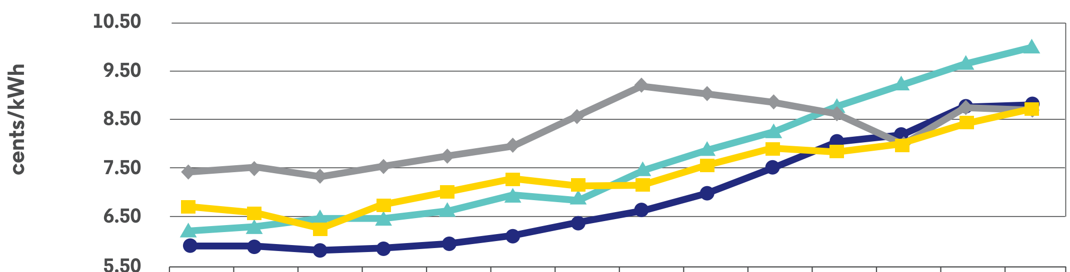
Missouri's residential retail electricity prices have historically been lower than average national retail prices and also lower than prices in the neighboring states of Illinois, Iowa, and Kansas. Missouri's affordable electricity prices are due, in large part, to the fact that approximately 83 percent of its electricity is generated from coal. In Missouri, as is common in the rest of the country, the residential sector pays the highest average price and the industrial sector pays the lowest average price – see Figure 4.

Residential Average Electricity Price 2001-2014



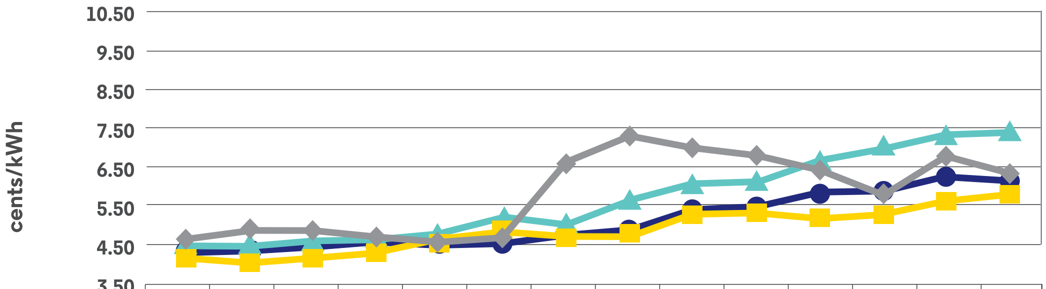
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	YTD 2014
Missouri	7.00	7.06	6.96	6.97	7.08	7.44	7.69	8.00	8.54	9.08	9.75	10.17	10.60	10.59
Illinois	8.71	8.39	8.38	8.37	8.34	8.42	10.12	11.07	11.27	11.52	11.78	11.37	10.67	11.41
Iowa	8.41	8.35	8.57	8.96	9.27	9.63	9.45	9.49	9.99	10.42	10.46	10.82	11.05	11.35
Kansas	7.66	7.67	7.71	7.74	7.90	8.25	8.19	8.89	9.53	10.03	10.65	11.24	11.64	12.13

Commercial Average Electricity Price 2001-2014



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	YTD 2014
Missouri	5.89	5.88	5.78	5.80	5.92	6.08	6.34	6.61	6.96	7.50	8.04	8.20	8.80	8.82
Illinois	7.40	7.52	7.30	7.54	7.75	7.95	8.57	9.25	9.04	8.88	8.64	7.99	8.76	8.73
Iowa	6.69	6.56	6.24	6.75	6.95	7.29	7.11	7.18	7.55	7.91	7.85	8.01	8.44	8.74
Kansas	6.20	6.28	6.42	6.45	6.60	6.96	6.83	7.44	7.87	8.25	8.78	9.24	9.68	10.03

Industrial Average Electricity Price 2001-2014



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	YTD 2014
Missouri	4.39	4.42	4.49	4.62	4.54	4.58	4.76	4.92	5.42	5.50	5.85	5.89	6.30	6.19
Illinois	4.65	4.89	4.86	4.65	4.61	4.69	6.61	7.34	7.01	6.82	6.42	5.80	6.77	6.35
Iowa	4.18	4.06	4.16	4.33	4.56	4.92	4.74	4.81	5.27	5.36	5.21	5.30	5.62	5.77
Kansas	4.55	4.53	4.61	4.69	4.85	5.20	5.13	5.69	6.10	6.23	6.71	7.09	7.39	7.47

Figure 4. Average Retail Price of Electricity by End-Use Sector for Missouri and Comparison Group, 2001-2014.

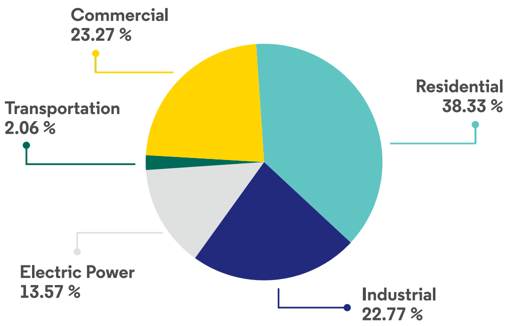
Source: (2001-2013 data): U.S. EIA, "Electricity Data Browser," accessed March 2015, http://www.eia.gov/electricity/data/browser/Source (Dec. 2014 data): Table 5.6.B. for Dec. 2014 (Electric Power Monthly) Forms EIA-861 and EIA-826

2. Natural Gas Snapshot

In Missouri, natural gas is used primarily to heat residential and commercial buildings. As mentioned previously, the electric power sector consumes large quantities of natural gas to generate electricity and the transportation sector uses relatively low volumes of natural gas in the operation of pipelines, primarily in compressors, and as vehicle fuel. In 2013, Missourians consumed 277 billion cubic feet (BCF)[15] of natural gas for which they paid a total of $2.4 billion[16] or the equivalent of $401 per capita. Missouri ranks 20th in the nation in terms of natural gas expenditures and its annual natural gas consumption relative to its GSP equates to approximately 1.00 cubic feet (CF)/$GSP.[17]

Over half of Missouri households use natural gas to heat their homes, which makes the state's residential sector the largest consumer of natural gas, accounting for 38.3 percent of total statewide consumption – See Figure 5. The commercial and industrial sectors, which require natural gas to heat buildings but also to manufacture products, account for 23.3 and 22.8 percent of statewide natural gas consumption, respectively.

Missouri's Natural Gas Consumption by Sector, 2013 (281.5 Trillion BTU)



Missouri's Natural Gas Expenditures by Sector, 2013 ($2,426 Million)

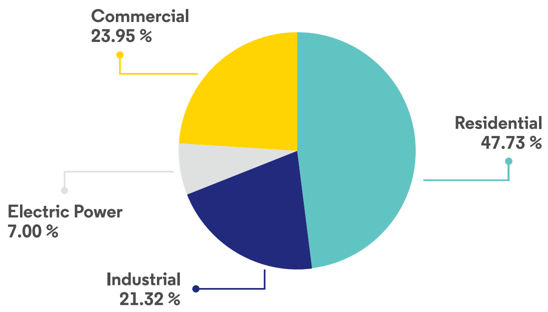


Figure 5. Missouri's Natural Gas Consumption and Expenditures by End-Use Sector, 2013.

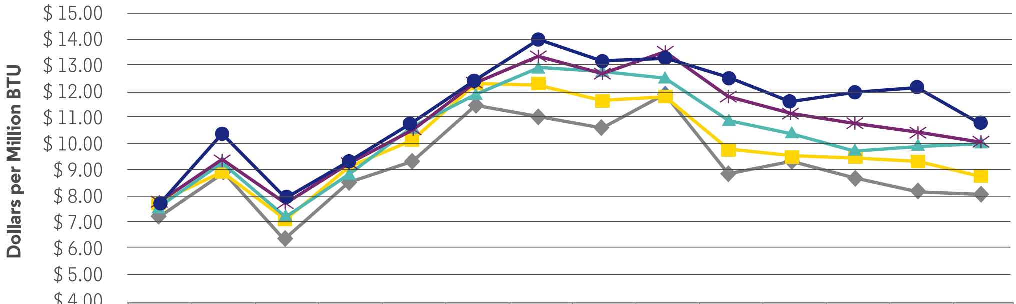
Source: EIA, "State Profiles and Energy Estimates," Released March 20, 2015, http://www.eia.gov/state/?sid=MO#tabs-2Table F19: Natural Gas Consumption Estimates; Table E17: Petroleum and Natural Gas Prices and Expenditures.

Note 1: data includes supplemental gaseous fuels that accompany natural gas.
Note 2: data for expenditures from the transportation sector was unavailable.

Relative to other states, Missouri ranks low both in total and per capita natural gas consumption. In fact, in recent years Missouri's consumption ranking has fallen because other states are increasing their consumption faster than Missouri, driven primarily by replacements of coal-fired power plants with natural gas-fired plants to generate electricity.

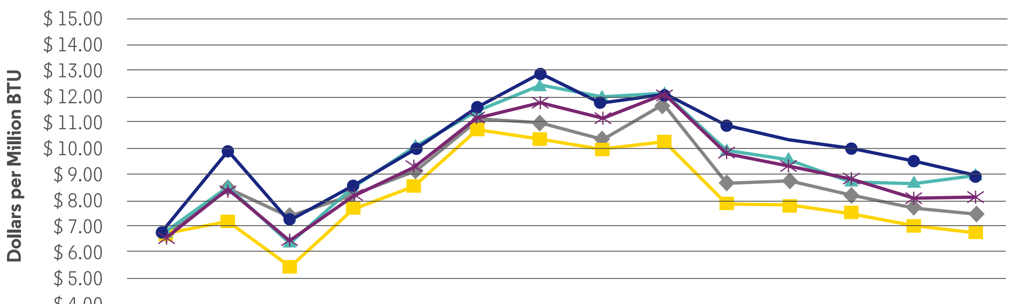
In Missouri, average natural gas prices tend to be higher than the national average price in all sectors. As seen in Figure 6, this difference is most pronounced for the industrial sector, where natural gas prices in Missouri can be anywhere from 10-60 percent higher than the national average. It is important to mention that since 2007, natural gas prices have generally declined in all states as a result of increased natural gas supply at the national level driven by the commercial exploitation of deposits of shale gas through processes such as hydraulic fracturing. In fact, natural gas prices in 2013 were approximately equivalent to 2004 prices.

Residential Natural Gas Price 2000 - 2013



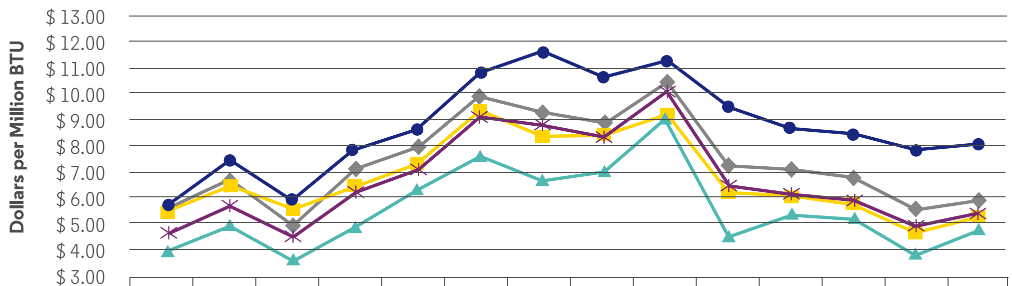
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Illinois	$ 7.17	$ 8.86	$ 6.33	$ 8.52	$ 9.28	$ 11.45	$ 11.01	$ 10.61	$ 11.91	$ 8.86	$ 9.32	$ 9.32	$ 8.17	$ 8.07
Iowa	$ 7.77	$ 8.87	$ 7.06	$ 9.11	$ 10.11	$ 12.22	$ 12.26	$ 11.64	$ 11.79	$ 9.76	$ 9.51	$ 9.51	$ 9.33	$ 8.74
Kansas	$ 7.58	$ 9.34	$ 7.19	$ 8.84	$ 10.59	$ 11.91	$ 12.94	$ 12.74	$ 12.55	$ 10.89	$ 10.41	$ 10.41	$ 9.91	$ 10.01
Missouri	$ 7.73	$ 10.40	$ 7.90	$ 9.36	$ 10.81	$ 12.42	$ 13.96	$ 13.16	$ 13.28	$ 12.54	$ 11.60	$ 11.60	$ 12.15	$ 10.73
US Average	$ 7.63	$ 9.42	$ 7.69	$ 9.24	$ 10.47	$ 12.34	$ 13.35	$ 12.70	$ 13.52	$ 11.81	$ 11.13	$ 11.13	$ 10.44	$ 10.03

Commercial Natural Gas Price 2000 - 2013



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Illinois	$ 6.75	$ 8.38	$ 7.37	$ 8.15	$ 8.98	$ 11.04	$ 10.74	$ 10.25	$ 11.54	$ 8.55	$ 8.69	$ 8.18	$ 7.69	$ 7.45
Iowa	$ 6.66	$ 7.21	$ 5.49	$ 7.69	$ 8.48	$ 10.56	$ 10.25	$ 9.87	$ 10.15	$ 7.83	$ 7.76	$ 7.48	$ 7.03	$ 6.77
Kansas	$ 6.75	$ 8.48	$ 6.45	$ 8.40	$ 9.97	$ 11.29	$ 12.20	$ 11.83	$ 11.82	$ 9.82	$ 9.47	$ 8.71	$ 8.63	$ 8.94
Missouri	$ 6.82	$ 9.76	$ 7.25	$ 8.47	$ 9.81	$ 11.39	$ 12.68	$ 11.59	$ 11.94	$ 10.75	$ 10.23	$ 9.91	$ 9.46	$ 8.87
US Average	$ 6.54	$ 8.32	$ 6.49	$ 8.07	$ 9.19	$ 10.98	$ 11.60	$ 10.99	$ 11.89	$ 9.70	$ 9.20	$ 8.79	$ 8.03	$ 8.05

Industrial Natural Gas Price 2000 - 2013



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Illinois	$ 5.72	$ 6.75	$ 4.91	$ 7.12	$ 7.96	$ 9.87	$ 9.29	$ 8.87	$ 10.44	$ 7.22	$ 7.08	$ 6.77	$ 5.58	$ 5.90
Iowa	$ 5.46	$ 6.46	$ 5.56	$ 6.48	$ 7.31	$ 9.40	$ 8.36	$ 8.47	$ 9.23	$ 6.19	$ 6.06	$ 5.73	$ 4.64	$ 5.28
Kansas	$ 3.97	$ 4.95	$ 3.59	$ 4.89	$ 6.33	$ 7.60	$ 6.70	$ 7.04	$ 9.09	$ 4.50	$ 5.39	$ 5.18	$ 3.86	$ 4.76
Missouri	$ 5.69	$ 7.44	$ 5.94	$ 7.82	$ 8.63	$ 10.78	$ 11.59	$ 10.63	$ 11.25	$ 9.50	$ 8.65	$ 8.47	$ 7.87	$ 8.08
US Average	$ 4.60	$ 5.71	$ 4.48	$ 6.20	$ 7.02	$ 9.08	$ 8.77	$ 8.29	$ 10.06	$ 6.46	$ 6.17	$ 5.96	$ 4.91	$ 5.46

Figure 6. Average Retail Price of Natural Gas by End-Use Sector for Missouri and Comparison Group, 2000-2013.

Source: EIA, "SEDS: 1960-2012 data," accessed March 2015, http://www.eia.gov/state/seds/, Table F20: Natural Gas Price and Expenditure Estimates.

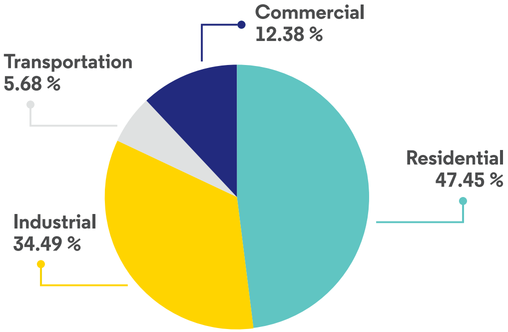
3. Propane Snapshot

Propane, or liquefied petroleum gas, is of importance to Missouri because it is the primary heating fuel for approximately nine percent of households in the state.[18] Demand for propane from the residential sector peaks during the winter heating season, and the extent of the demand depends heavily on the severity of the winter. While most propane used in the state is consumed by the residential sector (47.5%), significant amounts are also consumed by the industrial (34.5%) and commercial (12.4%) sectors. For instance, propane is used in agriculture to dry crops after harvesting. In recent years, there has also been an increased use of propane within the transportation sector as a clean-burning fuel for material-handling equipment, landscaping equipment, public transportation, and other fleet vehicles.

In 2012, a total of 27.2 trillion BTU of propane, at a cost of $580.8 million, were consumed in the state[19] - see Figure 7.

While propane prices have historically been lower in Missouri than the national average, they are unpredictable due to a number of factors that affect supply and demand, including weather events and fluctuations in the price of crude oil. From 1990 to 2014, Missouri's average price per gallon of propane increased by 4.5 percent (compound annual growth rate). As shown in Figure 8, particularly high prices were seen in the winter of 2013-2014 due to the combination of an abnormally cold season, an unexpected increase in agricultural demand for crop drying, and issues related to distribution of the fuel.

Missouri's Propane Consumption by Sector, 2012 (27.2 Trillion BTU)



Missouri's Propane Expenditures by Sector, 2012 ($580.8 Million)

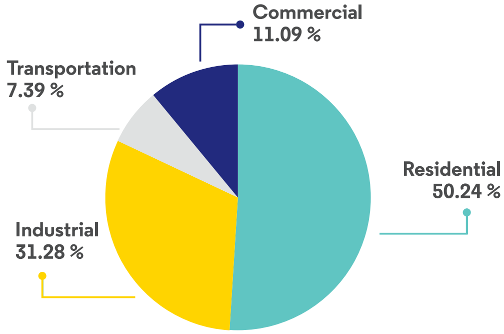


Figure 7. Missouri's Propane Consumption and Expenditures by End-Use Sector, 2012.

Source: EIA, "SEDS: 1960-2012 data," accessed March 2015,
http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=MO#Consumption

Residential Propane Prices

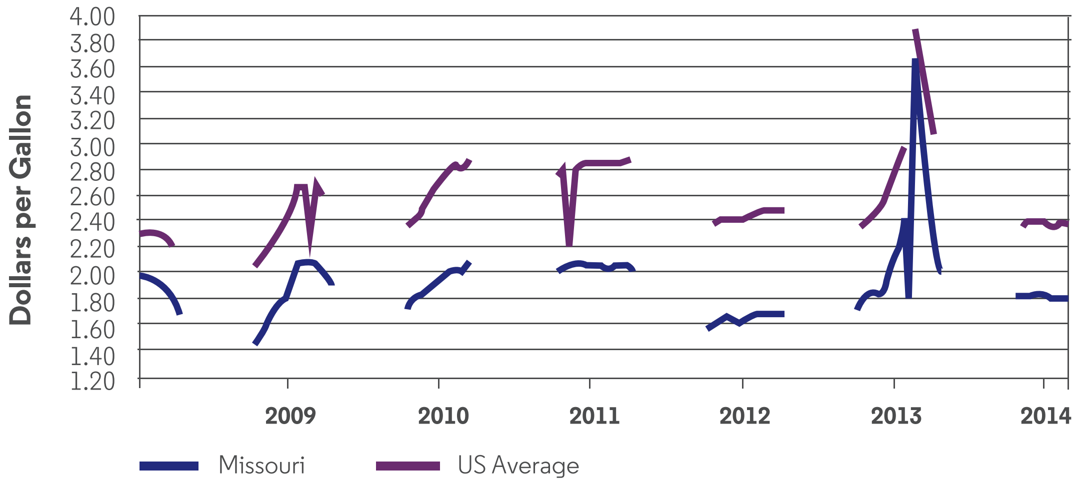


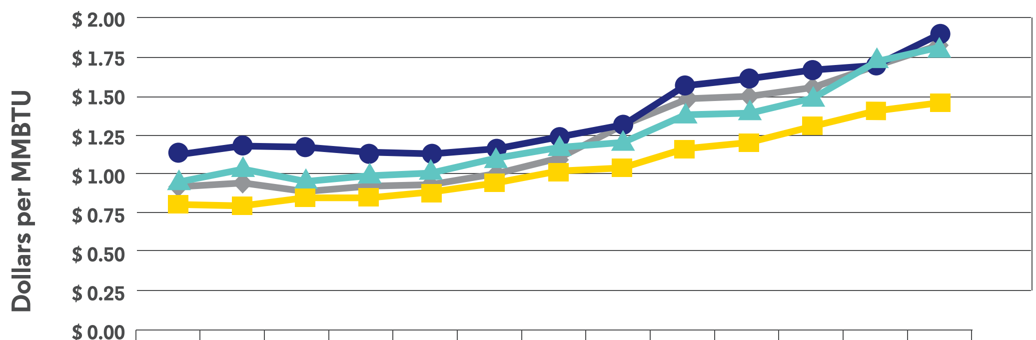
Figure 8. Average Residential Price of Propane Throughout the Heating Season, 2009-2014.

Source: Missouri Department of Economic Development: Division of Energy, "Missouri Energy Bulletin"

4. Coal Snapshot

According to the EIA, Missouri consumes more coal than any other fuel, almost all of which is used to generate electricity. In 2013, the state consumed nearly 806.5 trillion BTU[20] of coal for which it paid a total of $1.6 billion.[21] This is equivalent to an annual average consumption of 7.6 short tons of coal per capita, or 2,919 BTU/$GSP.

Electric Power Sector Coal Price, 2000-2012



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Missouri	$ 0.92	$ 0.96	$ 0.89	$ 0.92	$ 0.92	$ 1.01	$ 1.11	$ 1.33	$ 1.50	$ 1.52	$ 1.57	$ 1.72	$ 1.85
Illinois	$ 1.15	$ 1.19	$ 1.18	$ 1.15	$ 1.14	$ 1.17	$ 1.25	$ 1.33	$ 1.58	$ 1.62	$ 1.69	$ 1.72	$ 1.93
Iowa	$ 0.82	$ 0.81	$ 0.87	$ 0.87	$ 0.90	$ 0.96	$ 1.03	$ 1.06	$ 1.18	$ 1.23	$ 1.33	$ 1.43	$ 1.48
Kansas	$ 0.98	$ 1.05	$ 0.98	$ 1.01	$ 1.03	$ 1.12	$ 1.19	$ 1.23	$ 1.41	$ 1.43	$ 1.51	$ 1.75	$ 1.83

Figure 9. Average Retail Price of Coal for the Electric Power Sector in Missouri and the Comparison Group, 2000-2012.

Source: EIA, "SEDS: 1960-2012 data," accessed March 2015, http://www.eia.gov/state/seds/

5. Petroleum Snapshot

In 2012 Missourians consumed approximately 121 million barrels of petroleum[22] for which they paid a total of $17 billion, ranking 17th in the nation for petroleum expenditures.[23]

The industrial sector consumes 12 percent of petroleum products with additional minimal consumption in the residential, commercial, and electric power sectors. The vast majority (84%) of Missouri's petroleum consumption can be attributed to the transportation sector as a result of its reliance on petroleum-based transportation fuels. Gasoline represents 68 percent of transportation fuel consumption, while diesel represents 27 percent – see Figure 10. Additional details on transportation fuel production are included in Chapter 2: Energy Supply, and information on consumption and prices is included in Chapter 3: Energy Use, Section II. Transportation.

Total Transportation Fuel Consumption in Missouri in 2012 (551.7 Trillion BTU)

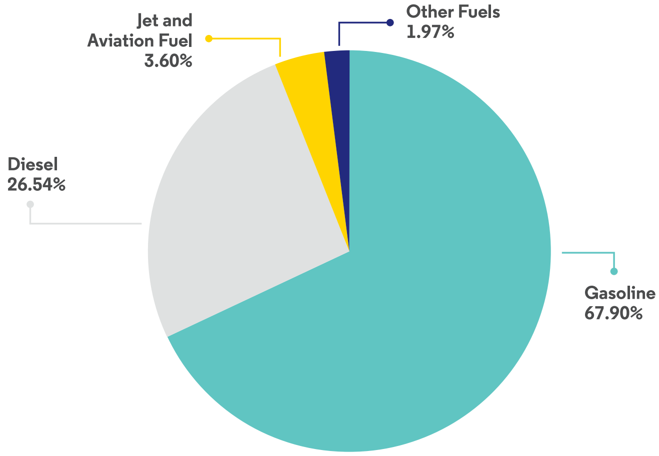


Figure 10. Transportation Fuel Consumption in Missouri, 2012.

Source: U.S. EIA. "Table CT7. Transportation Sector Energy Consumption Estimates: 1960-2012, Missouri," Accessed April 2015.
http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tra/use_tra_MO.html&sid=MO

Chapter 2:
Energy Supply

This chapter provides an overview of Missouri's energy inputs, both natural resources and processed materials. It begins with a description of Missouri's in-state energy resources, including renewable and non-renewable, to offer the reader an understanding of Missouri's historical, current, and potential production of these resources.

Next, the chapter describes the electricity and natural gas infrastructure with a focus on the generation, transmission, and distribution of these resources. The influence of regulation and economics on retail prices is discussed. Finally, the chapter contains an overview of the ways in which electricity and thermal energy may be stored.

Overall, through a better understanding of the resources available to the state, Missourians can plan how to most effectively utilize these resources and also determine what new assets must be developed to ensure reliable and affordable energy for all.

I. Availability of In-State Resources

Missouri has a variety of natural resources that can be used to produce energy in various forms. Although reserves of fossil fuels are limited in the state, the availability of resources such as biomass, minerals, agricultural products and other renewables provides numerous opportunities for portfolio diversification and economic development. The sections that follow provide an overview of the availability and variety of renewable and non-renewable resources in the state, how they are currently being used, and potential options for use in the future.

1. Non-Renewable Energy Resources

1.1 Coal

Coal is an important resource to Missouri. In fact, the state is the sixth largest consumer of coal[ii] in the United States and the eighth largest consumer of coal per capita[24] – see Figure 11. Missouri's high coal consumption is due to the state's strong reliance on coal for electricity generation: in 2014, 82.6 percent of the state's electricity was generated from coal.[25]

Top Ten Coal Consuming States, 2013 (Thousand Short Tons)

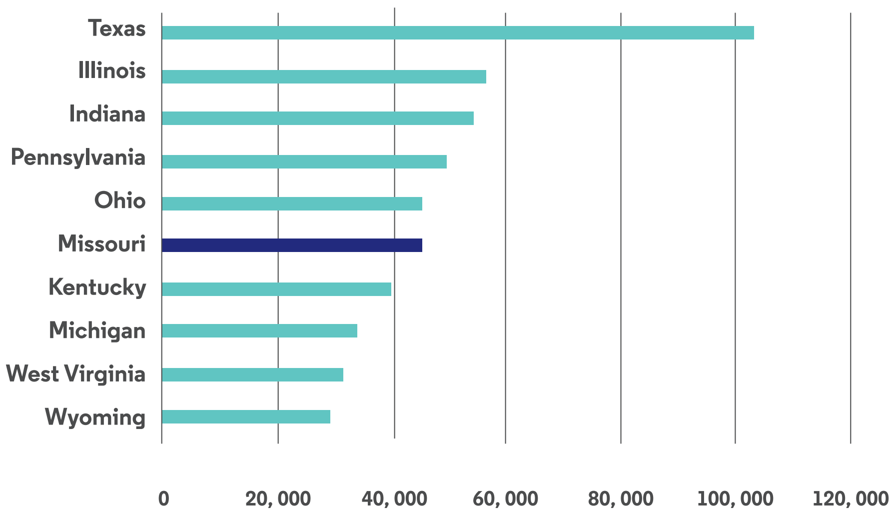


Figure 11. Top 10 Gross Coal Consuming States, 2013.

Source: U.S. Energy Information Administration (EIA), "Form EIA-923, Form EIA-3, Form EIA-5, and Form EIA-7A, 2013," Accessed march 2015, http://www.census.gov/popest/data/state/totals/2013/index.html

[ii]Note: Missouri is the sixth largest consumer of coal on a physical unit basis, and 7th on an energy-equivalent

Despite the fact that Missouri was the first state west of the Mississippi River to produce coal commercially,[26] the state now relies almost exclusively on imports to generate electricity. In 2013, it was estimated that Missouri had 1.5 percent of the United States' total estimated recoverable coal reserves.[27] That same year, Missouri produced 414,000 short tons of coal from a single active surface mine,[28] Hume, located in western Missouri, and most of this coal was exported to Kansas.[29] To put it in perspective, this level of production represents less than one percent of Missouri's total coal consumption for that same year.

As shown in Figure 12, the majority of coal that is available in the state is located in the western and northern regions and ranges from lignite to bituminous. Missouri's coal has a relatively high content of sulfur and when burned, produces sulfur dioxide that contributes to air pollution and acid rain. Since the passing of the 1990 revisions to the Clean Air Act that promotes the use of low-sulfur coal, Missouri's coal has become expensive to burn from a compliance standpoint, using current technology.

Figure 12. Map of Missouri's Coal Resources.

Source: U.S. EIA, "Coal Production and Preparation Report," Accessed April 2015, http://www.eia.gov/survey/, Form EIA-7A

The lack of in-state coal resources has important economic consequences. From 2008 to 2012, Missouri's expenditures on net coal imports have increased by 23 percent to well over one billion dollars. In 2012, Missouri had the 4th largest net expenditures in the country and the 2nd largest per capita expenditures on coal imports.[30] In 2013, Missouri imported 92.5 percent of the coal it used from Wyoming,[31] which has large reserves of low-sulfur coal.

1.2 Natural Gas and Petroleum

Natural gas is a flammable gas, consisting largely of methane and other hydrocarbons, that occurs naturally underground and is often found in association with petroleum. The natural gas that we consume in our homes and businesses is a refined product of its naturally occurring form.

Based on an analysis conducted at a natural gas price of $4 per Million Cubic Feet (MMCF), the U.S. Bureau of Economic Analysis estimates that Missouri has two trillion cubic feet (TCF) of economically recoverable natural gas reserves, all of which are assessed to be shale gas deposits. This is one of the lowest natural gas reserves in the nation, with gas-producing states having hundreds or even thousands of TCF available. While Missouri has produced some amounts of natural gas in the past, particularly through the 1960s and 1970s, production practically ceased in 1998, and the state relies almost entirely on natural gas imports to meet its needs.[32]

Similarly, Missouri's petroleum production can be considered minimal on both a national and regional scale. Missouri's production of crude oil began after the Civil War and peaked in 1984.[33] Since the state's last petroleum refinery closed in 1982, current petroleum production in Missouri consists solely of crude oil drilling, and the resource must be transported to other locations for refining, such as the Wood River Refinery in Illinois or the Gulf Coast.[34] In 2014, eleven companies based in Missouri produced a total of 195,481 barrels of crude oil.[35]

As shown in Figure 13, Missouri is home to five oil and gas fields:

- Lincoln Fold (green): originally developed as a natural gas field, the Lincoln Fold continues to produce oil and is home to Missouri's only underground natural gas storage area: a 13,845 million cubic feet aquifer storage field that is located in northern St. Louis County and is owned by Laclede Gas Company.[36]
- Forest City Basin (orange): located in the northwest corner of the state, the basin has historically produced both oil and gas.
- Bourbon Arch (grey): occupying Vernon County and some surrounding areas, the field has primarily produced heavy oil since the 1960s.[37]
- Mississippi Embayment (blue): limited exploration has occurred in this field, but the embayment potentially holds both oil and gas reserves in Pemiscot and Dunklin counties.
- Chattanooga shale (red): located inthe southwest corner of the state. There is potential for shale gas extraction in this region that has not been thoroughly explored.

Oil and Gas Production Areas

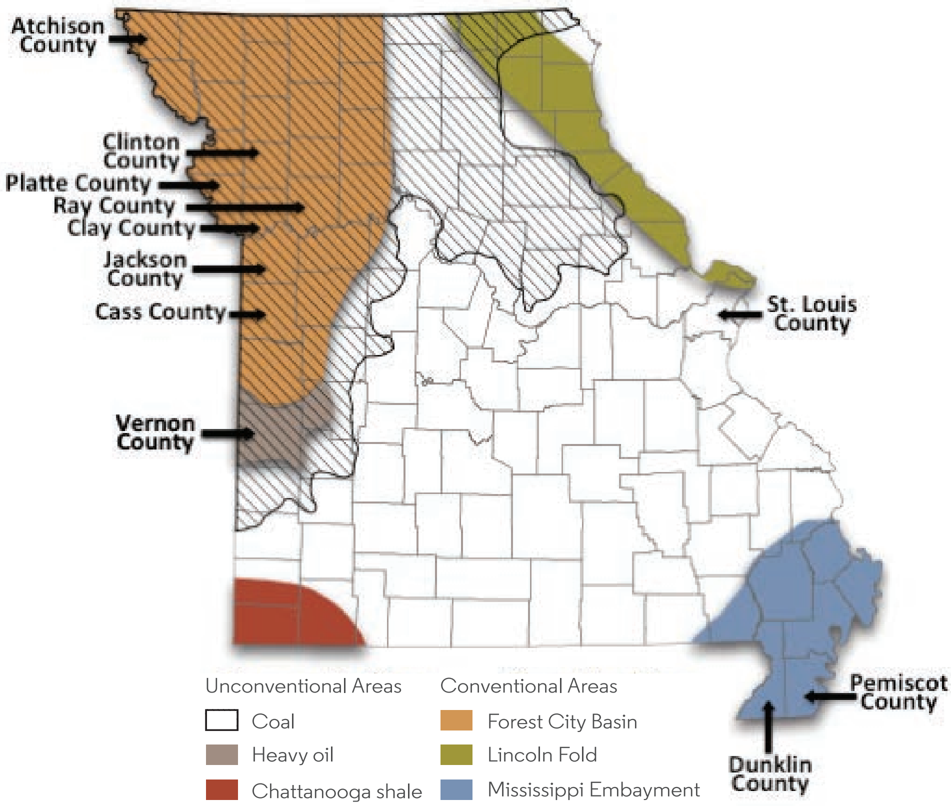


Figure 13. Oil and Gas Production Areas.

Source: Missouri Department of Natural Resources, Division of Geology and Land Survey, "The Geologic Column of Missouri", Summer 2007 Volume 2, Issue 1. Page 2.

In 2013, the vast majority of natural gas originated in Vernon and Clinton counties, and the bulk of crude oil was produced in the western region of the state. Along with commercial natural gas production, the state has 490 private natural gas wells located in five counties: Cass, Clay, Clinton, Platte, and Jackson. Private wells mainly supply individual households or small commercial firms with heating fuel and are not required to report production, thus making production levels unknown.[38]

To meet Missouri's natural gas and petroleum needs, several major crude oil and natural gas pipelines pass through the state and deliver the product to terminals and storage fields. Missouri receives its petroleum products through several pipelines that originate in the Gulf Coast region, primarily in Texas, Louisiana, Arkansas, and Oklahoma. Furthermore, the Mississippi and Missouri Rivers provide important transportation routes for petroleum products moving via barge. Figure 14 shows a map of Missouri's petroleum product pipelines and distribution terminals.

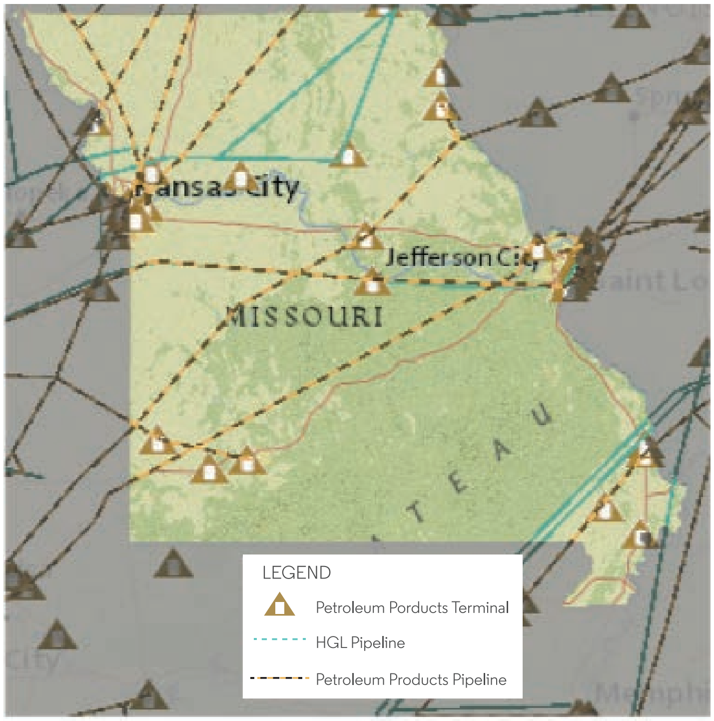


Figure 14. Missouri's Petroleum Product Pipelines and Distribution Terminals.

Source: U.S. EIA "Missouri: Profile Overview", Accessed April 2015, http://www.eia.gov/state/?sid=MO

1.3 Propane

Propane is a byproduct of natural gas processing and crude oil refining. Although propane is not commercially produced in the state, it is an important resource for Missourians as a vital component of agriculture where it is used to dry crops, and for purposes of space heating mainly in residential properties.

Missouri imports propane primarily from Kansas, Oklahoma, and Texas, along with smaller quantities from Arkansas and Illinois. Transportation of propane into the state takes place either by rail or truck, and large stocks of the fuel are typically stored before being delivered to customers. Missouri is home to a single, large underground propane storage cavern: Laclede Gas' 32 million gallon underground propane storage cavern in St. Louis County.[39]

1.4 Lead

Although not a fuel, lead is of particular importance because of its significant availability in the state and the role this mineral plays in the development of batteries for energy storage.

For most of the late 19th and early 20th centuries, Missouri was the global leader in lead production, and even today some of the largest remaining lead deposits in the world are located in southeast Missouri in what is commonly called the Lead Belt.[40] This area includes the counties of Crawford, Dent, Iron, Madison, Reynolds, Washington, and Saint Francois and contains the highest concentration of galena in the world, which is an important ore of lead and the state's official mineral.

Today, Missouri produces about 90 percent of the U.S. primary supply of lead, and significant amounts of the nation's zinc.[41] About 84 percent of this lead is destined to the production of lead–acid batteries,[42] which can be used for energy storage for hybrid vehicles and wind and solar power. For more information on lead-acid batteries please refer to Section V: Energy Storage within this chapter.

2. Renewable Energy Resources

Renewable energy resources can be harnessed either on a utility scale or as distributed generation (DG). Distributed generation represents installations that produce electricity near or at the point where it is used. Photovoltaic panels, combined heat and power units, liquid-fuel generators, biomass facilities, and some micro-hydropower are most commonly used for distributed generation. Utility-scale installations represent large generating facilities that provide power to a utility that later distributes the energy to its customers via an electric grid. Most frequently, these utility renewable energy installations will consist of hydropower facilities, wind farms, and solar farms.

The sections that follow describe availability of renewable energy resources in Missouri and provide examples of both utility-scale and distributed generation deployments.

2.1 Solar Energy

The sun's energy can be harnessed to either produce electric energy through the use of solar photovoltaic (PV) technology, or as a means of generating thermal energy. The National Renewable Energy Laboratory (NREL) estimates that Missouri has moderate solar resources, with over 200 sunny days per year and an annual daily average of 4.5-5.9 kWh/m^2/day. At this level, Missouri's solar resource exceeds that of Germany, the world's leader in solar energy production.[43] Figure 15 shows the solar resource available at the national level and how Missouri compares to other states.

Missouri has a small but rapidly growing solar photovoltaic market. The Solar Energy Industries Association ranks Missouri as 19th in the nation for its 111 MW of installed solar PV capacity.[44] This represents an exponential increase in the last five years from just over a hundred kW installed in 2009 to this present level. In 2014 alone it is estimated that Missouri added 73 MW of capacity, bringing in $187 million of investment – 63 percent more than in 2013.[45]

At the distributed generation level, the recent growth in distributed PV installations is due to a combination of rebates available through the state's utilities and a downward trend in the cost of the equipment at the national level driven primarily by supply and demand dynamics. Data from the Energy Information Administration (EIA) shows that in 2013 Missouri had a combined capacity of 42.8 MW of installed net-metered PV solar. Of this, approximately half came from residential customers and the other half came from commercial customers.

A challenge that some Missouri homeowners face with installation of solar panels is that local ordinances or homeowner's association rules can affect the installation of solar systems on homes or businesses. While these rules are created to ensure uniformity or uphold a community's aesthetic standard, they may inadvertently prohibit the installation of photovoltaic systems. In other instances, some rules may require that solar customers make modifications to their system design, which may unreasonably increase costs, decrease efficiency of the system, or both.

Photovoltaic Solar Resource of the United States

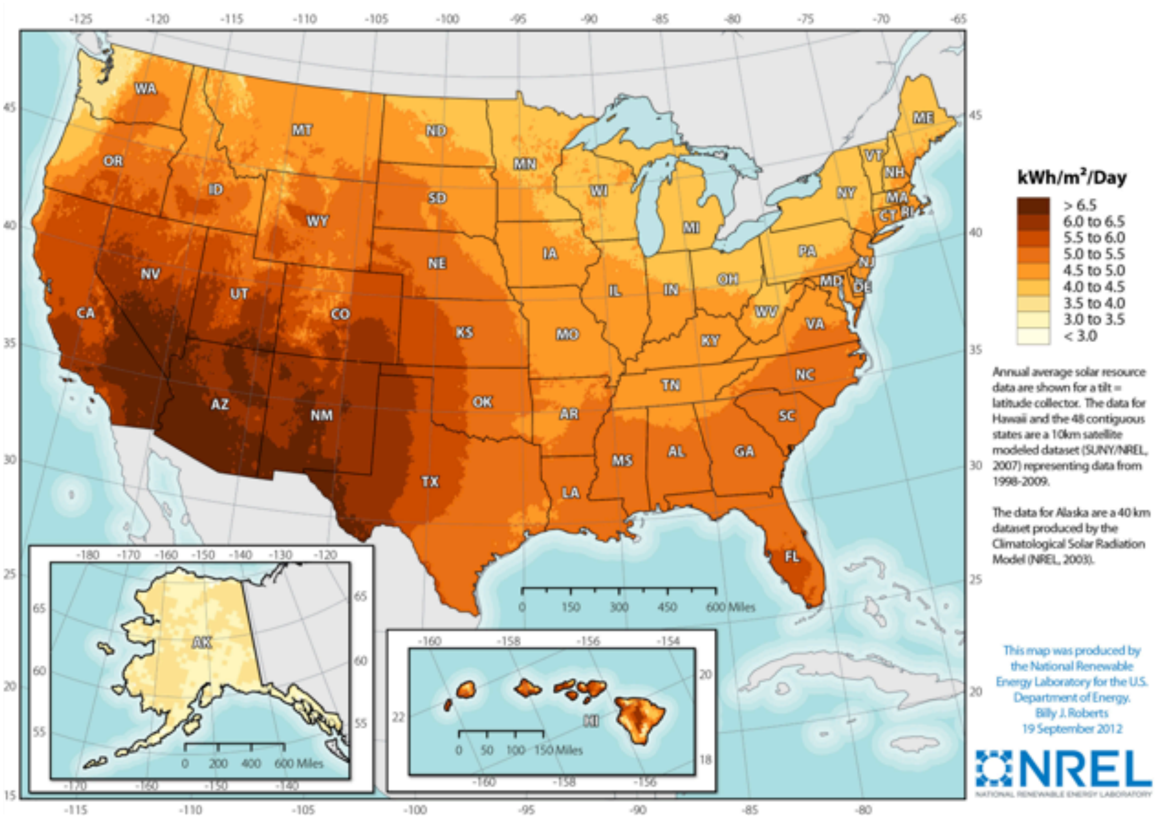


Figure 15. Photovoltaic Solar Resource of the U.S.

Source: National Renewable Energy Laboratory (NREL), "Photovoltaic Solar Resource of the United States," September 19, 2012, http://www.nrel.gov/gis/images/eere_csp/national_concentrating_solar_2012-01.jpg

Missouri law provides that the right to utilize solar energy is a property right but eminent domain may not be used to obtain such property right.[46] In spite of this law, the extent to which this property right can be infringed upon by homeowner associations or local ordinances has not been fully settled. In recent years, several court cases have been filed in Missouri by homeowners against their property associations and also by property associations against member homeowners. Some of these disputes have either led a property owner to abandon plans to install solar panels or have resulted in litigation.[47]

One or more pending cases may, in the near future, provide clarification on the extent to which solar property rights can be restricted. In addition, legislation was introduced in the 2015 session which would permit homeowner associations to impose reasonable rules and regulations, but prohibit them from expressly or effectively outlawing the installation of solar panels by homeowners.[48]

Although there are significant DG solar installations in Missouri, utility-scale installations amount to approximately 17 MW of current capacity. At the utility level, one of the drivers of this growth is the state's Renewable Energy Standard (RES), which is explained further at the end of this section. The RES contains a carve-out for solar resources, requiring that at a minimum two percent of the renewable energy benchmarks be met through solar PV technologies.

Some recent notable utility-scale solar installations and planned constructions in Missouri include:

- The Butler Solar Energy Farm, which became operational in March 2014, was the first utility-scale solar electric installation and has a capacity of 3.2 MW.[49]
- Completed in June 2014, the Springfield Missouri Solar Farm has an installed capacity of 4.9 MW.
- The O'Fallon Renewable Energy Center, owned by Ameren, became operational in December 2014. The facility has more than 19,000 solar panels that combined result in 5.7 MW of capacity.[50] Ameren has made plans to build a utility-scale solar facility in Montgomery County with a capacity of 15 MW.[51]
- The Macon Missouri Solar Farm became operational in July 2015 with a capacity of 3.2 MW.
- The farm is located in Macon's Heartland Industrial Park and will provide a portion of the energy needed by 35 municipalities.[52]
- Platte-Clay Electric Cooperative recently broke ground on a 100-kilowatt solar pilot plant in Kearney. The project was designed as a community solar project, which allows customers of the cooperative to sign up to buy power generated by the facility.

Several additional utility-scale solar installations are reportedly under consideration in Missouri.
Energy from solar thermal projects in Missouri is not distributed to an energy grid and is therefore difficult to track. However, there is a meaningful presence of solar thermal collectors in Missouri with numerous businesses offering installation services for residential and commercial use.

City Utilities' Solar Energy Farm -
Springfield, 2014

On June 26, 2014, a solar farm in Greene County started contributing energy to City Utilities' transmission grid. The 4.95 MW generation system consisting of nearly 22,000 solar panels is located on land City Utilities owns, and the system is operated by North Carolina-based Strata Solar, which financed and constructed the project developed by St. Louis-based Solexus Development.

City Utilities has an agreement to purchase all the energy that is produced from the solar farm for the next 25 years, over which time the system is expected to produce enough energy to power about 902 homes in Springfield annually.

2.2 Wind Energy

Missouri's wind development potential is estimated by NREL to be approximately 275 GW.[53] As shown in Figure 16, the Northwestern corner of the state has annual average wind speeds of 6.5 meters per second or higher at a height of 80 meters, which are generally considered to represent a resource suitable for wind development.

While Missouri is ranked 14th for installed capacity potential,[54] it also currently ranks 23rd in terms of wind capacity installed.[55] Figure 17 provides a comparison of installed wind capacity in the comparison group. The figure shows that Iowa, Illinois, and Kansas have much higher installed capacity than Missouri, at 5,177 MW, 3,568 MW and 2,967 MW, respectively. While Iowa and Kansas do have better wind resources than our state, Illinois has comparable wind speeds.

The first utility scale wind farm in Missouri became operational in 2007 and by 2011 five additional utility scale wind farms started producing electricity. As of 2013, these six farms had a combined installed capacity of 458.5 MW and consisted of 252 wind turbines,[56] primarily ranging from one to two MW in capacity each.[57] Table 3 provides further information on Missouri's utility-scale wind farms.

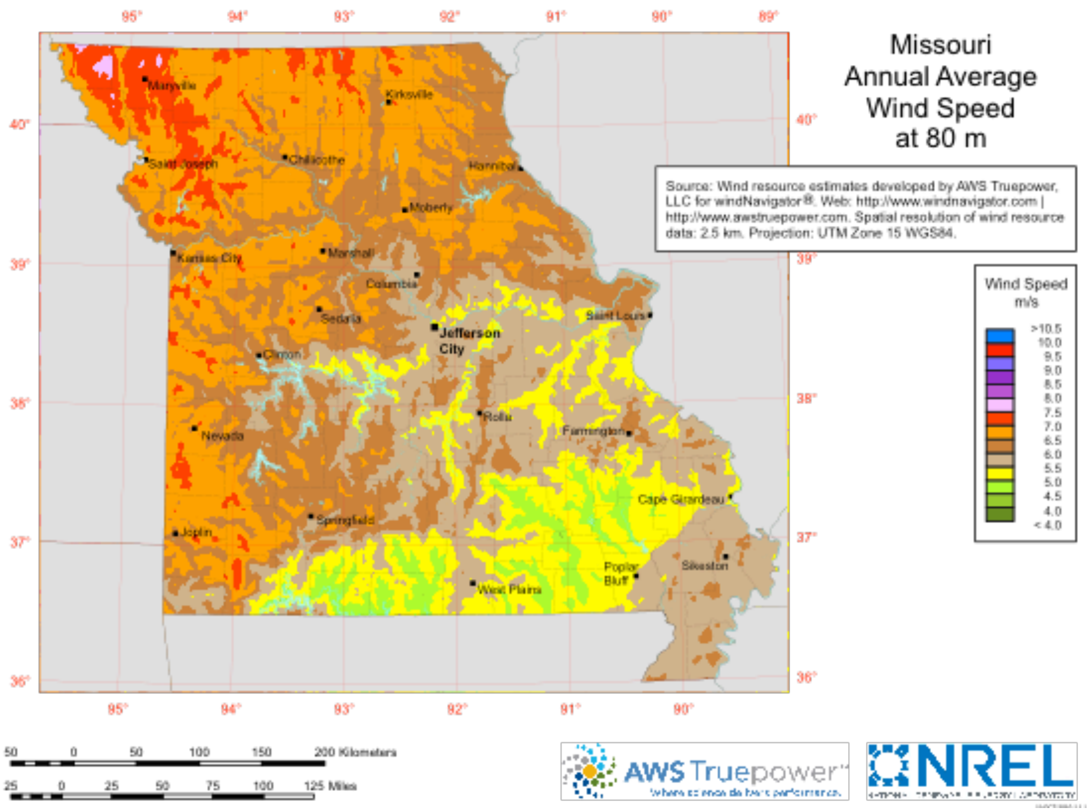


Figure 16. Wind Resource Map Showing Annual Average Wind Speed at 80 meters of Height.

Source: NREL, "Missouri Annual average Wind Speed at 80 m", October 11, 2010.
http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mo

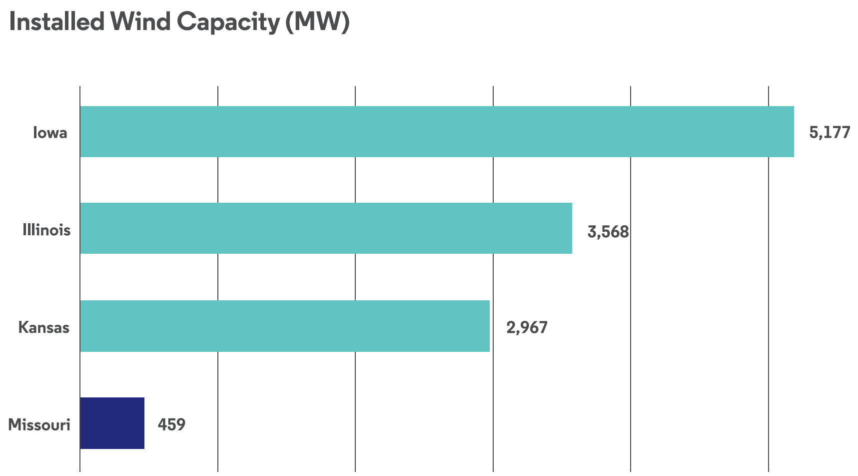


Figure 17. Installed Wind Capacity for Missouri and Comparison Group, 2014.

Source: American Wind Energy Association "U.S. Wind Energy State Facts: 2014," Accessed April 2015. http://www.awea.org/resources/statefactsheets.aspx?itemnumber=890

Table 3. Missouri's Wind Farms, 2014.

Source: Missouri Department of Economic Development, Division of Energy, Missouri Energy Resource Assessment, p. 57-63, 2013.[iii]

Wind Farm Name	City	County	Capacity	Year Online	Developer	Power Purchaser
Blue Grass Ridge	King City	Gentry	57	2007	Wind Capital Group	Associated Electric Cooperative Inc.
Conception	Conception	Nodaway	50.4	2008	Wind Capital Group	Associated Electric Cooperative Inc.
Cow Branch	Tarkio	Atchison	50.4	2008	Wind Capital Group	Associated Electric Cooperative Inc.
Loess Hills	Rockport	Atchison	5	2008	Wind Capital Group	Missouri Joint Municipal Electric Utility Commission
Farmers City	Tarkio	Atchison	146	2009	Iberdrola Renewables	Merchant Facility
Lost Creek Ridge	N/A	Dekalb	150	2010	Wind Capital Group	Associated Electric Cooperative Inc.

[iii] This chart does not reflect data pertaining to utility secured Power Purchase Agreements (PPAs) or ownership of facilities that deliver energy from out-of-state wind to Missourians.equivalent

Other than the farms listed in Table 3, no additional wind farms have been developed in the state and none are currently scheduled for construction. The stall in development of wind resources is partly tied to uncertainty in the implementation of Missouri's Renewable Energy Standard. Other contributing factors are changes in federal policies that supported wind development during the period 2010-2012 and challenges of siting to avoid impacts to migratory birds and other species.

States can encourage further development of wind energy through the establishment of local policies and, in fact, some states have implemented unique tax policies that attract wind development. For instance, Iowa allows a sales tax exemption for the total cost of wind energy equipment and all materials used to manufacture, install, or construct wind energy systems and an exemption from state property taxes for five years, as well as a corporate production tax credit for wind and other renewable technologies. In 2007 Illinois passed a law to provide consistent valuation procedures for commercial wind farm equipment due to the large variations between counties; an allowance for physical depreciation of the commercial wind equipment is also provided. Finally, Kansas provides a property tax exemption for renewable energy equipment.[58]

In addition to utility-scale wind farms, there are numerous small wind farms and single turbine installations owned by individuals and cooperatives in Missouri. The most recent data from the EIA indicates that 0.578 MW of wind power is interconnected to the electric grid through net metering agreements with local utilities.[59]

2.3 Biomass

Biomass is considered to be any organic matter from plants or animals and can include agricultural crops and residues, manure and wastes from animal feeding facilities, forest and wood processing residues, municipal wastes, and terrestrial and aquatic energy crops grown solely for energy purposes. Biomass can be used to generate energy, providing an opportunity for Missouri to create energy in state and reduce dependence on imported fossil fuels.

University of Missouri Biomass System - Columbia, 2010

The University of Missouri's 100 percent biomass fueled boiler uses more than 100,000 tons of waste wood to reduce fossil fuel usage on campus.

On-site construction began in May 2010 and was completed in December 2012 at a cost of $75 million. The project will result in reduced emissions, including greenhouse gases; a 25 percent reduction in the use of fossil fuels; a significant increase in the use of locally available fuel; and expanded opportunities for the university to continue their ongoing research of alternate fuels.

The boiler was placed into operation in 2013 and provides steam to the University's Combined Heat and Power plant.

As a major producer of agricultural and forest commodities, Missouri has an abundant resource base for biomass energy. The American Council on Renewable Energy estimates that in 2012 production capacity for energy from biomass was approximately 9.8 MW, and according to the EIA the state's net electricity generation from biomass resources was 71 GWh in 2013.[60] Although the state has significant biomass resources, Missouri ranked 37th for electricity production from biomass in 2014. Figure 18 benchmarks the net electricity generation resulting from biomass for Missouri and the comparison group and shows that in 2014 Illinois and Iowa produced more electricity than our state. Although not shown in this figure, of relevance is the fact that over half of U.S. states produced more than 500 GWh of electricity from biomass that same year.[61]

NREL estimates that Missouri has approximately 18.4 million tons of yearly available biomass resources, as shown in Table 4, with the majority consisting of crop residues and switchgrass.

Net Electricity Generation from Biomass, 2014 (GWh)

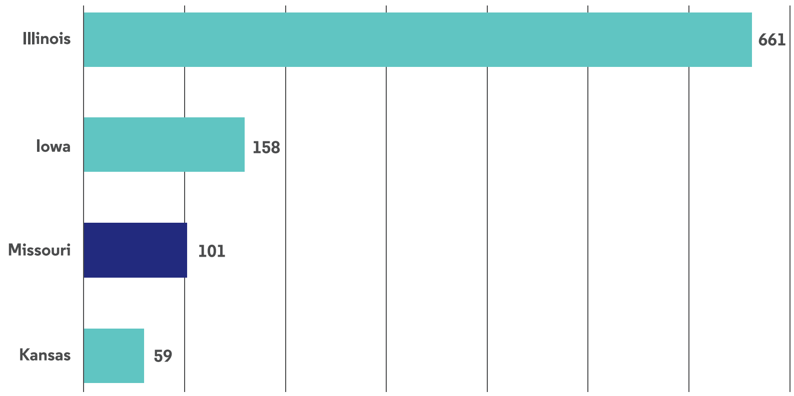


Figure 18. Net Electricity Generation from Biomass for Missouri and Comparison Group, 2014.

Source: U.S. EIA, "Net Generation for Biomass, Annual," Accessed April 2015, http://www.eia.gov/electricity/data/browser/#/topic/0?agg=1,2,0&fuel=0008&-geo=vvvvvvvvvvvvo&sec=g&freq=A&start=2001&end=2014&ctype=linechart&ltype=pin&rtype=s&mapty-pe=0&rse=0&pin=/

Table 4. Total Biomass Resources Available, 2005.

Source: A. Milbrandt, NREL, "A Geographic Perspective on the Current Biomass Resource Availability in the United States", December 2005 , nrel/tp-560-39181, page 49.

Category	Yearly Technical Availability (Thousand tons)
Crop Residues	6,007
Switchgrass	8,473
Forest Residues	1,840
Urban Wood	613
Methane from Landfills	273
Methane from Manure Management	120
Primary Mill Wood	1,036
Secondary Mill Wood	69
Methane from Domestic Wastewater	9
Total	**18,439**

As a near term, low-cost option for efficiently and cleanly converting biomass to electricity, co-firing biomass with coal makes use of the existing infrastructure investments for coal power plants and offers several economic and environmental benefits such as lower fuel costs, more fuel flexibility, reduced waste to landfills, and reduced sulfur dioxide, nitrogen oxide, mercury, and carbon dioxide (CO_2) emissions. While this mature technology has been used in a few small-scale power plants, large deployment in the state has not been realized among most coal-fired power plants, primarily due to non-technical barriers including public misperception, feedstock competition and logistics, and unfavorable economics compared to burning coal alone. Current policies in Missouri do not recognize a number of co-firing's unique benefits including baseload capabilities, high reliability, and flexibility. As one of a very few renewable energy resources that can produce baseload power, various types of biomass, in particular woody biomass, should be incorporated into the state's electricity generation portfolio.

2.4 Biofuels

The term biofuels refers to a wide range of fuels that are derived from biomass or other organic matter. Of these, the most commonly used biofuels are ethanol and biodiesel. Currently, ethanol and biodiesel are produced in geographically diverse areas of the state and have particular significance to Missouri's economy.

a) Biodiesel

Biodiesel is a form of renewable energy that is used as a transportation fuel, either as a complement or as an alternative to diesel. It can be manufactured from vegetable oils, animal fats, or recycled restaurant greases, although in Missouri it is primarily produced from soy oil – see Chapter 3: Energy Use, Section II. Transportation, for additional information.

Enginuity Worldwide LLC - Mexico

Missouri-based Enginuity Worldwide LLC developed a biomass pellet that burns at nearly the same temperature as coal. Known as "eCARB", the pellets are formed by compressing corn stover or other materials under heat for just over three minutes.

The company's patented process allows it to create pellets in varieties that can be co-fired with coal while requiring only minimal power plant retrofits.

Enginuity, Ameren Missouri and ECAP LLC recently announced a partnership that could lead to the production of eCARB for use by the utility. The pellets would extend the lifetime of Ameren Missouri's plants, increase the use of a homegrown renewable resource, and aid the utility with environmental compliance. Use of the pellets is projected to begin in 2017.

Governors' Biofuels Coalition

Governor Jay Nixon serves as the 2015 vice chairman of the Governors' Biofuels Coalition, a 33-state bipartisan organization founded more than 20 years ago to increase the use of ethanol based fuels, decrease the nation's dependence on imported energy resources, improve the environment and stimulate the national economy. Governor Nixon will become chairman of the group in January 2016.

Biodiesel is particularly important for Missouri as the state hosts several national and state trade associations that represent the biodiesel industry and crop sources. For instance, Jefferson City is home to the National Biodiesel Board, as well as the Missouri Soybean Association (MSA), and the Missouri Soybean Merchandising Council (MSMC). Both MSA and MSMC are actively involved in supporting the research, marketing, and commercialization of soybean products including biodiesel.

With a combined production capacity of 191 million gallons a year (MMGY), Missouri ranks fourth in the nation in terms of biodiesel production capacity.[62] In our state, biodiesel is processed in eight plants that are located near soybean production and soybean crushing facilities.

Missouri's recent surge of biodiesel production is due to a Biodiesel Producers Incentive Fund that was established in 2002 and is administered by the Missouri Department of Agriculture to encourage Missouri-owned biodiesel production. Approximately $119 million in incentives have been paid from October 2006 through January 2015 with an additional $21.6 million in queue that are projected to be paid by fiscal year 2019, subject to appropriations.[63] The program has been successful and when compared to neighboring states, Missouri's annual biodiesel production is similar to Illinois' – see Figure 19.

Because additional biofuels will play an increasingly important role in the nation's energy future, the governors recently decided to expand the Governors' Ethanol Coalition's scope to address all biofuels, including ethanol, biodiesel, advanced biofuels, co-products, and new applications and technologies yet to come. The governors changed the coalition's name to the Governors' Biofuels Coalition to reflect its expanded agenda.

Harbor Marina
Lake Pomme de Terre

In September 2015, the Harbor Marina at Lake Pomme de Terre became the first marina in the U.S. to offer gasoline blended with renewable isobutanol.

Produced by the Colorado-based company Gevo, bio-based isobutanol helps meet renewable fuel and clean air standards, while alleviating concerns that boaters have with ethanol-blended fuels, which can damage engine parts.

Gevo intends to extend sales of its isobutanol blend to other lakes including Lake of the Ozarks and Table Rock Lake.

Biodiesel Annual Production Capacity, Jan. 2015 (Million Gallons per Year)

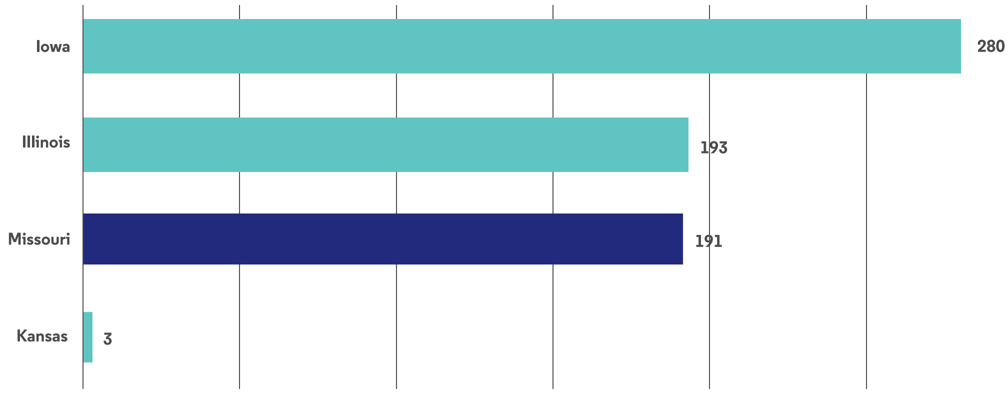


Figure 19. Biodiesel Production for Missouri and Comparison Group, 2015

Source: U.S. EIA, "Biodiesel Production – Table 4," July 2014.
http://www.eia.gov/biofuels/biodiesel/production/table4.pdf

b) Ethanol

Ethanol, also known as ethyl alcohol or grain alcohol, is a clear, colorless liquid that can be used as a transportation fuel. Ethanol can be produced from corn and other plant materials, although in Missouri, ethanol is primarily produced using corn as a feedstock – see Chapter 3: Energy Use, Section II. Transportation for additional information.

Most of the country's ethanol is produced in the Midwest, where corn crops are abundant, and in Missouri it is done in six ethanol plants that are located north of the Highway I-70 corridor and that have a combined production capacity of 271 MMGY - Table 5.[64] As of February 2014, Iowa, Illinois, and Kansas ranked 1st, 3rd, and 9th, respectively, in terms of nameplate capacity and annual production. In comparison, Missouri ranked 12th in nameplate capacity and annual production capacity, producing 256 MMGY or about 1.9 percent of the nation's corn ethanol[65] – see Figure 20.

Table 5. Ethanol Producers in Missouri, 2015.

Source: Renewable Fuels Association. "Biorefinery Locations." January 08, 2015.
http://www.ethanolrfa.org/bio-refinery-locations/

Ethanol Producer	Location	Feedstock	Nameplate Capacity (MMGY)	Operating Production (MMGY)
Golden Triangle Energy, LLC*	Craig, MO	Corn	20	5
Lifeline Foods, LLC	St. Joseph, MO	Corn	50	50
Mid-Missouri Energy, Inc.	Malta Bend, MO	Corn	50	50
POET Biorefining - Laddonia	Laddonia, MO	Corn	50	50
POET Biorefining - Macon	Macon, MO	Corn	46	46
Show Me Ethanol	Carrollton, MO	Corn	55	55

Ethanol Annual Nameplate Production Capacity, As of Feb. 2014 (Million Gallons per Year)

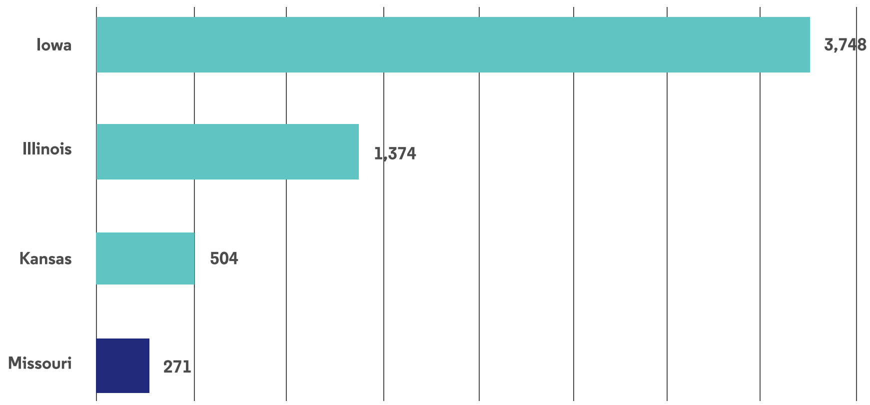


Figure 20. Ethanol Production Capacity for Missouri and Comparison Group, 2014.

Source: Missouri Department of Economic Development: Division of Energy, "2013 Missouri Energy Resource Assessment," revised June 2014, http://energy.mo.gov/energy/docs/RE%20Assessment.pdf, P50-52.

The Missouri Qualified Fuel Ethanol Producer Incentive Fund incentivizes ethanol production in Missouri through December 31, 2019. The Fund supports the research, marketing, and commercialization of biofuels in our state. Additional information on the use of biofuels is presented in Chapter 3: Energy Use, Section II. Transportation.

New non-food feed stocks such as switchgrass and algae are being studied as possible alternatives to food-based feedstock for biofuel production. Switchgrass, a native prairie grass, yields up to 10 dry tons per acre and can be grown on marginal land with little water. Cellulosic ethanol, which is made from crop waste such as corn stover and stalks and non-food plants, is able to generate four-to-ten times as much energy per acre as corn ethanol and does not compete with food supplies. The Missouri Department of Natural Resources (MDNR) estimates that approximately 500 million gallons of cellulosic ethanol could be produced each year solely from crop wastes that are already being produced on Missouri farms.

Jefferson City Landfill CHP Project -
Jefferson City, 2009

The 3.2 MW Jefferson City landfill gas project brought together the City of Jefferson, the City of Columbia, the State of Missouri's Department of Corrections, Ameresco, and Republic Services to meet the needs of all parties. The green power was purchased by Columbia Water & Light through a 20-year contract, which helps the city meet its renewable portfolio standard requirements. In 2014, the landfill produced 22,043 MWh of electricity, which comprised 1.8% of the utility's total electricity generation.

Ameresco also designed and built a system that utilizes the waste heat from landfill gas engine generators for steam and hot water in the Jefferson City Correctional Center

That is enough to provide approximately 15 percent of all automotive fuel used in the state.

2.5 Biogas

Biogas is produced through the biological breakdown of organic matter in the absence of oxygen and typically consists of 60-70 percent methane. Biogas includes landfill gas and the gas produced at livestock operations and wastewater treatment through anaerobic digestion. Biogas can be combusted to generate electricity or used directly as a heating source.

Unless a landfill is capped and the gas captured, the gas, primarily methane (CH_4), will escape into the atmosphere where it acts as a greenhouse gas. Pound for pound, the comparative impact of methane on climate change is over 21 times greater than CO_2 over a 100-year period.[66] Landfills are the third largest sources of methane emissions in the United States.

Landfill gas-to-energy projects are important because they take advantage of a resource that is readily available and that would otherwise be wasted. These projects significantly reduce the carbon equivalent emissions by combusting methane into

and Algoa Correctional Center. This project reduces direct and indirect gas emissions by approximately 23,288 tons of carbon dioxide per year, which is equivalent to removing 30,000 cars from Missouri's roads.

carbon dioxide and using the resulting energy for electricity generation or heating. In addition, landfill gas-to-energy projects can lead to reductions of smog and odor and create jobs associated with the design, construction, and operation of energy recovery systems.

While the use of landfill gas as a renewable resource in the state is relatively small compared to other energy resources, it has been actively recovered in recent years to generate significant amounts of energy. According to the U.S. Environmental Protection Agency (EPA), as of August 2014 there are 17 unique operational landfill gas-to-energy projects in the state capturing methane gas and using it for direct heating and/or electricity generation – see Table 6. Of these, eleven use the landfill gas to produce electricity, with a combined generating capacity of 35.7 MW.

Table 6. Operational Landfill Gas Projects in Missouri, 2014.

Source: EPA Landfill Methane Outreach Program "Energy Projects and Candidate Landfills," Updated March 13, 2015. http://www.epa.gov/lmop/projects-candidates/index.html#map-area

Landfill Project Name	City	Project Start Date	LFG Energy Project Type	Capacity (MW)*	LFG Flow to Project (mmscfd)**	Emission Reductions (MMTCO2e/yr) - Direct	Emission Reductions (MMTCO2e/yr) - Avoided
Electricity Generation							
Black Oak Landfill	Hartville	10/31/14	Reciprocating Engine	1.953		0.0882	0.0078
Central Missouri SLF	Sedalia	4/21/14	Reciprocating Engine	2.4		0.1084	0.0096
Columbia SLF	Columbia	6/16/08	Reciprocating Engine	2.1		0.0949	0.0084
Columbia SLF	Columbia	8/31/11	Cogeneration	0		0	0
Columbia SLF	Columbia	8/31/13	Reciprocating Engine	1		0.0452	0.004
Fulton SLF	Fulton	8/31/11	Reciprocating Engine	0.225		0.0102	0.0009
Champ Landfill	Maryland Heights	6/12/12	Gas Turbine	13.8		0.6235	0.055
Jefferson City Sanitary Landfill	Jefferson City	3/31/09	Cogeneration	3.2	1.3	0.1446	0.0128
Lamar Landfill	Lamar	6/30/10	Reciprocating Engine	3.2	1.87	0.1446	0.0128
Prairie View Regional Waste Facility	Lamar	6/30/10	Reciprocating Engine	3.2	1.87	0.1446	0.0128
Springfield Sanitary Landfill	Willard	5/10/06	Reciprocating Engine	3	1.58	0.1355	0.012
St. Joseph City SLF	St. Joseph	3/30/12	Reciprocating Engine	1.6	0.72	0.0723	0.0064
Direct Use							
Advanced Disposal Oak Ridge Landfill	Ballwin	6/1/09	Direct Thermal		1.15	0.1007	0.0099
Courtney Ridge Landfill, LLC	Sugar Creek	5/1/09	Direct Thermal		1.81	0.1585	0.0156
Courtney Ridge Landfill, LLC	Sugar Creek	1/1/10	Direct Thermal		0.74	0.0648	0.0064
Champ Landfill	Maryland Heights	1/1/83	Direct Thermal			0	0
Champ Landfill	Maryland Heights	1/1/09	Direct Thermal		0.01	0.0009	0.0001
Champ Landfill	Maryland Heights	1/1/86	Greenhouse		0.0576	0.005	0.0005
Champ Landfill	Maryland Heights	1/1/97	Boiler		0.3	0.0263	0.0026
IESI Timber Ridge Landfill	Richwoods	12/14/12	Leachate Evaporation		0.04	0.0035	0.0003
Rumble Landfill #2	Sugar Creek	1/1/09	Direct Thermal		1.07	0.0937	0.0092
Rumble Landfill #2	Sugar Creek	1/1/98	Greenhouse		0.0216	0.0019	0.0002

** Capacity shown only for electricity-generation projects.*
*** LFG Flow to Project (mmscfd): Amount of landfill gas flowing to project or that will flow to the project when it becomes operational in million standard cubic feet per day*

In terms of biogas generated from livestock operations, a 2010 study conducted by the EPA found Missouri to be 5th in the nation in terms of electricity generation potential from swine operations. With 154 candidate farms, Missouri's energy generation potential is 301 GWh per year, which could result in potential methane emissions reductions of 34 thousand tons.[67]

Biogas has also been produced in many wastewater treatment facilities and some industrial facilities such as food processing plants. As of October 2012, approximately 1,200 of 3,300 major wastewater treatment facilities in the U.S. produce biogas from the wastewater sludge. However, only around 300 facilities use biogas to generate electricity. [68]

2.6 Hydropower

With more than twenty hydroelectric plants, including both impoundment and pumped storage facilities, the state has significant hydropower resources that historically have been Missouri's primary renewable resource used to generate electricity. Five of the state's largest hydropower facilities are located in the southwest portion of Missouri, with the exception of Clarence Cannon, which is located in the northeast portion of Missouri – see Table 7. Additional information on pumped storage is available within this chapter in Section V. Energy Storage.

Wastewater Treatment Facilities and Food Processing Biogas to Energy - Various Locations

Several wastewater treatment facilities and food processing facilities in Missouri have been using biogas as an energy source for electricity and heat. For instance, the MSD Missouri River Treatment Plant has an average design capacity of 28 MGD with 80 MGD peak capacity. Biogas from four anaerobic digesters is fed into three 335 kW Waukesha engine generators. Heat recovered from engines is used to maintain a 98°F process temperature in the anaerobic digesters, and to heat the administration building in cold weather.

The Anheuser-Busch brewery in St. Louis has installed a bio-energy recovery system, which converts the nutrients in wastewater from the brewing process into renewable biogas. The system treats 2.5 MGD of brewery wastewater and removes 70,000 lbs/day of biochemical oxygen demand (80 to 90% removal rate). The system generates 800,000 cubic feet of biogas daily, which is combusted in the brewery's powerhouse for heat and power, reducing the brewery's overall energy fuel consumption by 7.5 percent.

Table 7. Major Hydroelectric Facilities in Missouri, 2013. iv

Source: Missouri Department of Economic Development: Division of Energy. "2013 Missouri Energy Resource Assessment," Revised June 2014, http://www.eia.gov/electricity/data/eia860/

Operator	Plant Name	County	Hydro Technology	Current Nameplate Rating (MW)	First Year of Service
Empire District Electric Co	Ozark Beach	Taney	Conventional Hydroelectric	16	1931
Ameren Missouri	Osage	Miller	Conventional Hydroelectric	208	1931
Ameren Missouri	Taum Sauk	Reynolds	Pumped Storage	408	1963
U.S. Army Corps of Engineers	Table Rock	Taney	Conventional Hydroelectric	200	1959
U.S. Army Corps of Engineers	Clarence Cannon	Ralls	Conventional Hydroelectric	27	1984
U.S. Army Corps of Engineers	Harry Truman	Benton	Pumped Storage	161.5	1979
U.S. Army Corps of Engineers	Stockton	Cedar	Conventional Hydroelectric	45.2	1973
Show-Me Power Electric Coop	Niangua	Camden	Conventional Hydroelectric	3	1930

Figure 21 shows the amount of electricity generated by conventional hydropower plants for the period 2001-2014. Recent production peaked in 2008 and thereafter generally decreased, broadly following the trend in annual rainfall. In 2014, Missouri produced 700 GWh of electricity from conventional hydroelectric plants representing 0.8 percent of electricity generation.[69]

Net Electricity Generation from Conventional Hydroelectric Power in Missouri, 2001-2014 (TWh)

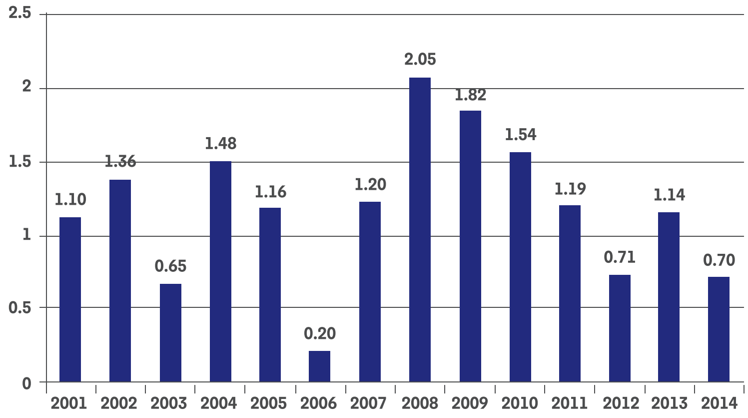


Figure 21. Net Electricity Generation from Conventional Hydropower Facilities in Missouri, 2001-2014.

Source: EIA "Electricity Data Browser," Accessed March 2015. http://www.eia.gov/electricity/data/browser/

[iv]This chart does not reflect data pertaining to utility secured PPAs or ownership of facilities that deliver energy from out-of-state hydropower to Missourians.

According to a 2012 U.S. Department of Energy (DOE) Water Power Program evaluation of the potential for additional hydropower from non-powered dams, there is a technical potential to add up to 12.1 GW in the U.S. While this estimate does not consider economic limitations on facility capacity, it does include assumptions that all of the water passing a facility can be converted to electrical energy and that hydraulic head is constant at facilities. Those economic considerations will be the focus of future DOE investigations and reporting. Most of the technical potential is located at U.S. Army Corps of Engineers lock and dam facilities on the Ohio, Mississippi, Alabama, and Arkansas rivers. However, the following lock and dams along the upper Mississippi River bordering Illinois and Missouri were also identified in the report as having potential for hydroelectric generation:

- The Melvin Price Locks and Dam in Alton, Illinois, which has a generation potential of 299 MW, and has the fifth largest potential of all the non-powered dams in the country.
- Lock & Dams 24 (Winfield, Missouri) and 25 (Clarksville, Missouri), which have 146.5 and 147.3 MW of potential, respectively. They rank 15th and 14th for hydropower potential nationally, respectively.
- Mississippi River Dams 20 (Canton, Missouri), 21 (Quincy, Illinois), and 22 (Saverton, Missouri), with respective potentials of, 92.2, 93.1, and 94.9 MW.[70]

In addition, according to the MDNR Educator's Guide, a total of 29 hydroelectric sites have been identified in Missouri for hydropower development.[71] However, several of these potential sites are located on Ozark riverways where development would be inappropriate for environmental and cultural reasons.

2.7 Hydrogen

Hydrogen fuel cells provide a cleaner, more efficient alternative to the combustion of fossil fuels for energy use in the transportation sector. A hydrogen fuel cell uses hydrogen and oxygen to create electricity, and its only emissions are heat and water as byproducts. The use of hydrogen fuel cells, however, is not currently widespread due to high cost and technical barriers. Chapter 3: Energy Use, Section II. Transportation, provides additional information on hydrogen as a transportation fuel.

Hydrogen can be produced using diverse energy resources, including fossil fuels such as natural gas and coal, nuclear energy, and other renewable energy sources. Though the current commercial hydrogen production is done via steam reforming of natural gas, coal and biomass gasification and renewable liquid fuel reforming are two promising alternatives.

One of the drawbacks of producing hydrogen from coal and natural gas is the production of carbon dioxide during the reforming process, meaning carbon capture will be an important operation for environmentally benign utilization of these resources in the future. Likewise, the environmental profile of hydrogen produced via electrolysis will depend on the feedstock and configuration of the power plant. Renewable electrolysis is not a cost-effective technology today.[72]

2.8 Renewable Energy Standards

In Missouri, it is projected that over the next twenty years there will be a significant increase in renewable energy at the utility level. The growth is partially driven by Missouri's Renewable Energy Standard passed in 2008, which requires that by 2021, 15 percent of Investor Owned

Utilities' (IOUs) retail sales be derived from renewable sources. The RES only applies to IOUs; co-operatives and municipal utilities are currently exempt from its requirements.

Eligible renewable energy technologies, as defined in section 393.1025(5), RSMo include: wind; solar thermal or solar photovoltaic; dedicated crops grown for energy production; cellulosic agricultural residues; plant residues; clean and untreated wood; methane from landfills, wastewater treatment, or agricultural operations; hydropower, not including pumped storage, that does not require a new diversion or impoundment of water and that each generator has a nameplate rating of ten megawatts or less; fuel cells; and other sources of energy that may become certified as eligible renewable energy resources.

The RES contains a carve-out for solar resources, requiring that at a minimum two percent of the renewable energy benchmarks be met through solar PV technologies. In addition, the RES contains a renewable energy credit provision that allows utilities to meet their requirements through the purchase of renewable energy credits (RECs) for energy that is generated out-of-state. The purchase of these out-of-state RECs can substitute in part or in whole for actual in-state energy generation.

An important aspect of the RES is that it contains a cost cap, which provides that customers' rates cannot be increased by any more than one percent because of the implementation of the RES. While this is clearly an important consumer protection, the statutory language defining the way in which the cap is to be calculated is unclear. This definition has been interpreted in a number of different ways and has led to confusion, uncertainty, and contested issues in proceedings with the Missouri Public Service Commission. Stakeholders should recommend possible approaches to clarify the definition of the current one percent investment cap.

Missouri's RES targets are lower than those required in other parts of the country. Currently seventeen states have targets of at least 20 percent of annual electricity sales being generated from renewable energy, and some states require 25 percent or more within similar timeframes. In addition, some states also include non-renewable technologies in their portfolio, such as combined heat and power.

3. Summary of Key Points

- Missouri has limited coal, natural gas, and petroleum resources that are economically and technically viable for commercialization. Although the state has had some production in the past, this has historically been minimal when compared to other states in the country, and existing reserves are not significant enough to support the state's economy.
- As a result of its reliance on imported coal, natural gas and transportation fuels, Missouri sends billions of dollars out of state annually. The further development of in-state renewable resources can keep these dollars in local economies and provide important economic development and a diversified energy portfolio that can improve energy assurance.
- Lead is of particular importance to Missouri because of its significant availability in the southwest portion of the state and the role this mineral plays in the development of batteries for energy storage.
- Missouri has significant availability of in-state renewable energy resources including wind, solar, and biomass. These resources can often be tapped at both the utility-scale level or as distributed generation resources that generate electricity where the customer needs it. Existing policies

such as the state's Renewable Energy Standard and incentives and rebates provided by the state utilities have driven growth in the solar photovoltaic industry, but additional growth for all renewables is possible with the right policy mechanisms.

- Missouri should monitor future DOE evaluations that consider the economic potential and considerations for development of the non-powered damns for hydropower generation that could benefit Missouri.

II. Electricity

As shown in Figure 22, the first step in the electricity process is generation. After electricity is generated it is passed through high-voltage transmission lines, sometimes over long distances, to substations where the voltage is lowered and sent through distribution lines to consumers.

Two important concepts that are used throughout this section include capacity and electricity generation. Capacity refers to the maximum generation capabilities of a unit at a given point in time and is typically measured in megawatts (MW). Electricity generation represents the actual amount of electricity produced at the generating unit, depending on factors such as percentage of time the unit is run and the efficiency of the generating unit. Electricity is typically measured in megawatt hours (MWh).

The sections that follow explain how electricity is generated, transmitted and distributed in Missouri. Additional information on electricity use is available under Chapter 3: Energy Use.

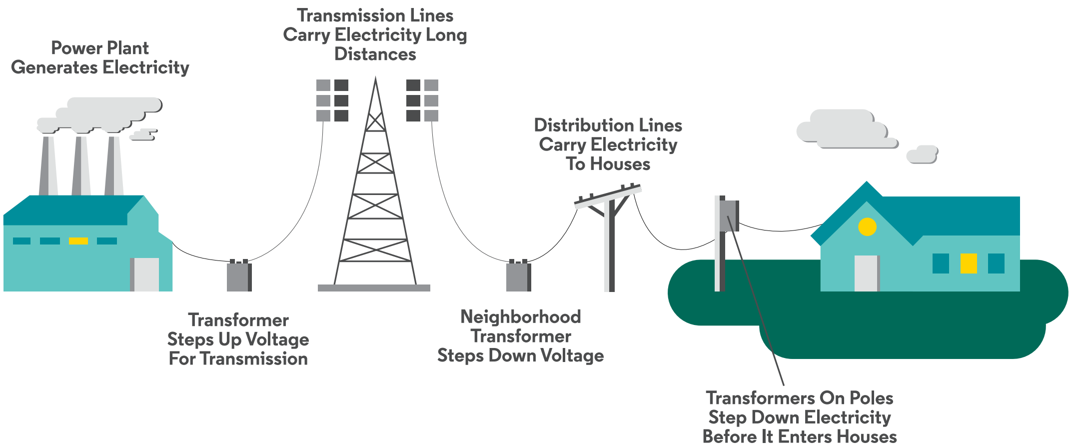


Figure 22. United States Electric System

1. Electric Utilities

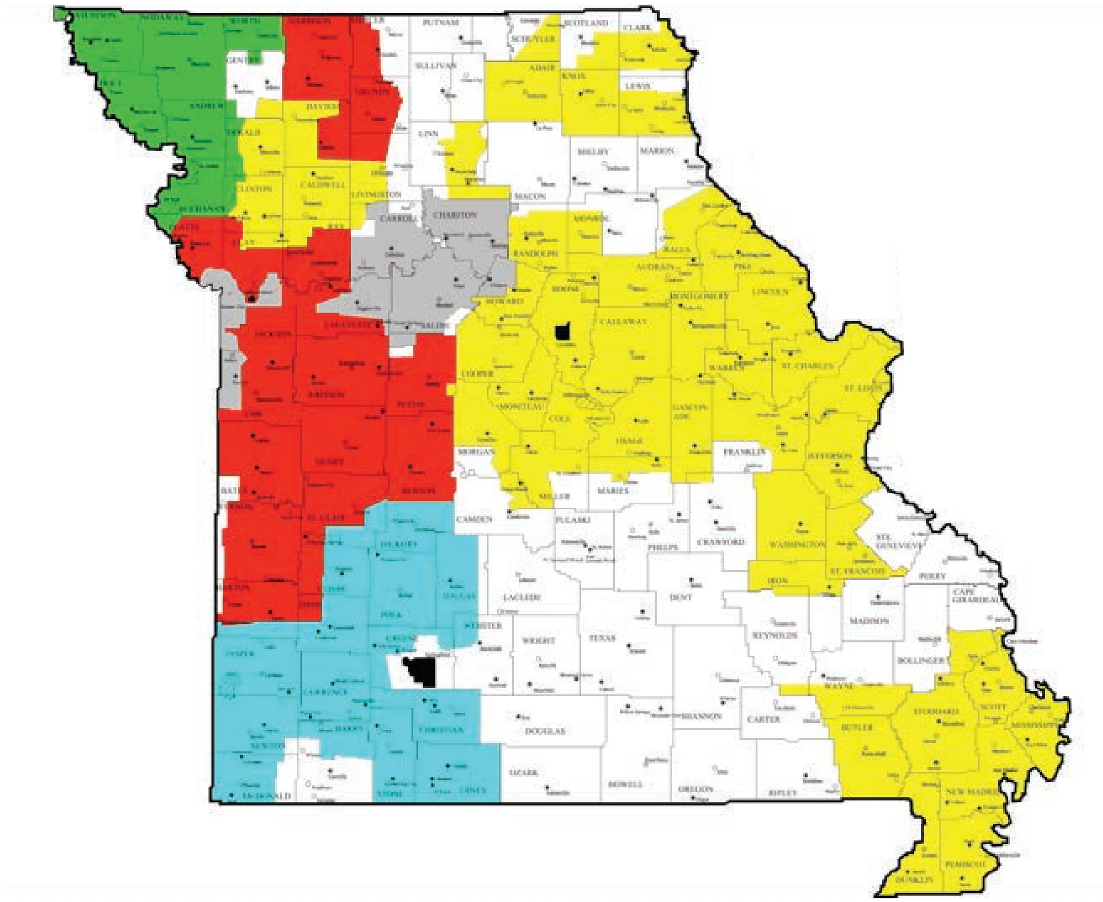
There are 138 different utilities in Missouri providing electric services to residents and businesses. Of the electric utilities in the state, four are investor-owned and regulated by Missouri's PSC. Investor-Owned Utilities (IOUs) include Empire District Electric Co., Kansas City Power and Light Co. (KCP&L), KCP&L Greater Missouri Operations (KCP&L-GMO), and Union Electric Company d/b/a Ameren Missouri. Of the remaining, 47 are electric cooperatives and 87 are municipal utilities.[73] For a complete list of all utilities, please see Appendix D – List of Missouri Utilities.

Missouri's IOUs operate in a regulated market, meaning that these utilities have ownership of generation, transmission, and distribution. By comparison, some other states operate under a deregulated model, where IOUs divest ownership in generation and transmission and are only responsible for the distribution operations, billing the ratepayer, and providing maintenance of the grid. In regulated markets electricity prices are set by a public service or utility commission. More information on electricity generation and rate-setting is available later in this chapter.

Figure 23 shows the service areas for the regulated IOUs.

Missouri Electric Service Areas

Prepared by Missouri Publica Commission - September, 2008



REGULATED

- KCP&L GMO (L&P)
- Kansas City Power & Light Co.
- KCP&L GMO (MPS)
- Union Electric Co. d/b/a AmerenUE
- Empire District Electric Co., The

NON-REGULATED

- Distribution Cooperatives
- Municipal Systems

Figure 23. Missouri Investor-Owned Electric Service Areas, 2008.

Source: Missouri Public Service Commission (PSC), "Missouri Electric Service Areas," September 2009. http://psc.mo.gov/CMSInternetData/Electric/Missouri%20Electric%20Service%20Area%20Map-9-18-08.pdf.

Further detail on the share of customers and sales that correspond to each of the state's IOUs is shown in Figure 24. Detailed sales data is unavailable for municipal or cooperative utilities.

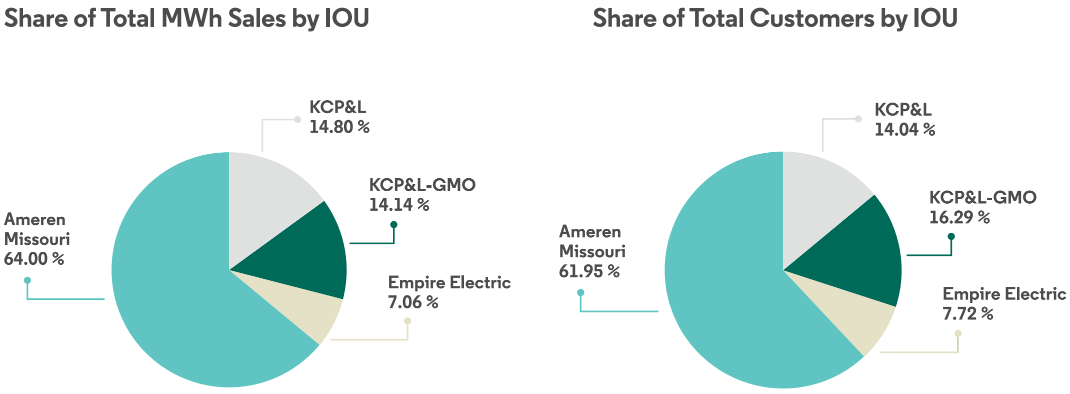


Figure 24. Missouri IOU Electricity Sales and Number of Customers, 2013.

Source: PSC, Federal Energy Regulatory Commission. "Form 1, 2013 Annual Report." Missouri Jurisdictional. Accessed March 2015.
http://psc.mo.gov/CMSInternetData/Annual%20Reports/PSC%20Annual%20Reports/2014%20PSC%20Annual%20Report.pdf

Electric cooperatives have an interesting history throughout the United States. In 1935, the Rural Electrification Administration (REA) was created to promote rural electrification by providing loans to local electric cooperatives. Prior to the creation of the REA, private power companies had been unwilling to serve farmsteads because it was not profitable for them and, therefore, the vast majority of rural areas of the country were left without electricity. Most of Missouri's electric cooperatives were incorporated after the creation of this agency.

Electric cooperatives are private, not-for-profit businesses owned and governed by their customers. Electric cooperatives primarily serve rural customers and are generally smaller than other utilities, with much lower population densities in their service territories. As a result of this low density, the costs associated with meter reading, outage response, distribution system losses, and system maintenance tend to be higher than for IOUs or municipalities serving more concentrated areas.

2. Generation

Electricity can be generated using a variety of fuel sources: from coal, natural gas, and nuclear power to renewable resources such as wind, hydropower, and solar. It is typically generated using turbine technologies that rely on a fuel source to generate steam that propels a turbine. The turbine then turns a generator that converts the mechanical energy of the spinning turbine into electrical energy. Other non-turbine systems, such as nuclear fission, solar thermal, and geothermal technologies, use the same steam heating process but do not burn fuel. Still other turbine systems, such as hydropower and wind turbines, do not require the creation of steam at all but rather use natural forces to generate electricity.

Base-load facilities generate electricity to meet some or all of a region's continuous energy demand. They operate continuously and also produce energy at a constant rate. Base-load plants typically use nonrenewable fuels such as nuclear, coal, and natural gas as the source fuel. Peaking plants are different from base-load plants in that they typically are run only when there is high demand for electricity. Peaking plants usually operate on natural gas.

An existing challenge with some renewable energy technologies is that they tend to generate electricity on an intermittent basis. However, electricity grid operators use a variety of tools to meet the challenge of integrating higher levels of intermittent renewable energy such as wind and solar with baseloads.

Electricity generation in the state is done primarily by retail suppliers consisting of vertically integrated IOUs regulated by the Missouri Public Service Commission (PSC), publicly owned municipal systems serving a city or region, and not-for-profit customer-owned electric cooperatives primarily serving rural areas of the state. Independent power producers that own or operate facilities for the generation of electricity for use primarily by the public, and that are regulated at the federal level, generate additional electricity that is either consumed at their own facilities or sold back to the grid through purchase agreements.

2.1 Inventory of Electric Generating Units

As of 2013, there were 452 electricity generating units in the state with a capacity of 1 MW or greater. Combined, Missouri's electricity generators have a total maximum capacity of 23,804 MW.

As is common throughout the country, the majority of the generation capacity in the state is attributed to units operated by IOUs – see Table 8. Cooperative-owned assets account for the next largest portion of installed capacity, followed by municipal utilities, and then independent power producers and other market participants. Mentioned in this table, Combined Heat and Power (CHP) units operate much like other electricity-generating turbine technologies, except the CHP units capture the waste heat from an engine, turbine, or boiler to generate on-site heating and cooling. Additional information on CHP systems and their benefits is available in Chapter 3: Energy Use.

Table 8. Summary of Missouri Electricity Generating Units by Generator Type, 2013.

Source: U.S. EIA "2012 Form EIA-860 Data - Schedule 3, 'Generator Data'", Accessed December 2014[v]

Generator Type	Number of Generating Units	Nameplate Capacity (MW)	% of Total Capacity
Investor-Owned Utilities	98	15,598	65.54%
Electric Cooperative	19	3,659	15.38%
Municipal Utility	281	2,761	11.59%
Independent Power Producers Non-CHP	15	1,143	4.81%
U.S. Army Corps of Engineers	13	464	1.95%
Commercial CHP	16	108	0.46%
Independent Power Producers -CHP	6	38	0.16%
Industrial CHP	4	29	0.12%
Totals	452*	23,800	100.00%

*Notes: *Total does not include 2014 solar editions.*

Figure 25 shows the generation capacity portfolio of state IOUs, cooperatives, and municipal utilities. The portfolios are similar in that all three utility types rely primarily on coal and then on natural gas for their source fuels. Wind energy is not shown in this figure because wind farm developments in Missouri are owned by independent power producers and not by the utilities. The utilities purchase the electricity generated from wind through power purchasing agreements.

[v]Does not include generating units located in other states that may be owned or operated by Missouri utilities.

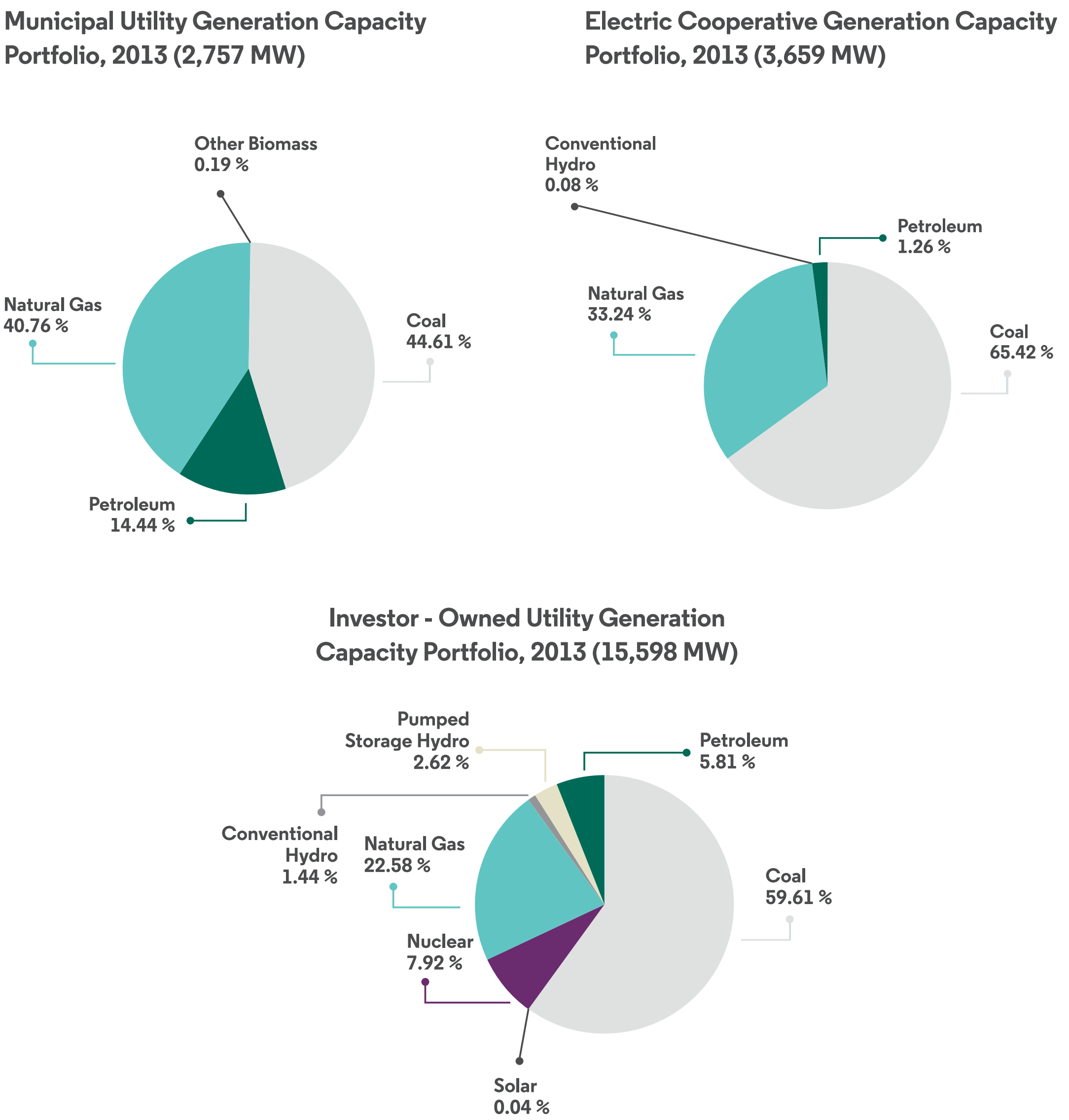


Figure 25. Generation Portfolio of IOUs, Cooperatives and Municipalities in Missouri, 2013.[vi]

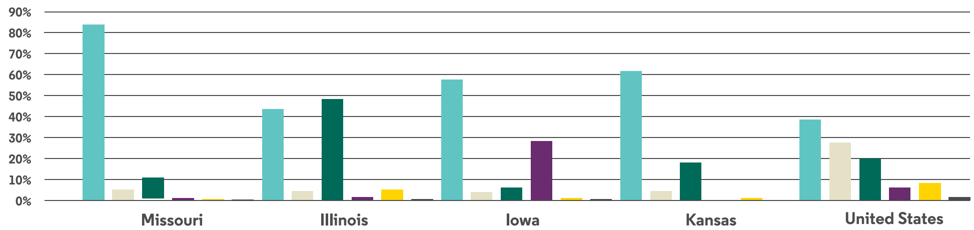
Source: U.S. EIA. "Form EIA-860, Schedule 3, 'Generator Data'." 2012. Accessed April 2015. http://www.eia.gov/electricity/data/eia860/

2.2 Current Generation Profile

Missouri's electric generation portfolio is dominated by coal-fired power plants with 82.6 percent of electricity generated from this fuel source in 2014. In contrast, other states in the region have a more diversified portfolio that relies on other renewable and non-renewable fuel sources – see Figure 26 for a comparison of generation portfolios in the region and the U.S. average.

[vi]Does not include generation located in other states that may be owned or operated by Missouri utilities.

Municipal Utility Generation Capacity Portfolio, 2013 (2,757 MW)



	Missouri	Illinois	Iowa	Kansas	United States
Coal	82.60%	43.18%	59.89%	57.45%	38.74%
Natural Gas	4.49%	2.74%	2.58%	3.53%	27.41%
Nuclear	10.53%	48.36%	7.27%	17.10%	19.47%
Hydroelectric	0.82%	0.06%	1.26%	0.00%	6.17%
Other Renewables	1.41%	5.34%	28.80%	21.79%	6.87%
All Other Sources	0.15%	0.32%	0.20%	0.10%	1.34%

Figure 26. Electricity Generation Mix for Missouri and Comparison Group, 2014.

Source: U.S. EIA. "2014, Electricity Data Browser:' 2013" Accessed April 2014. http://www.eia.gov/electricity/data/browser/#/topic/0?agg=0,2,1&fuel=g4&geo=000002&sec=g&freq=A&start=2001&end=2014&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin

Missouri's reliance on coal for electricity generation is not a new trend. Coal has fueled over 70 percent of the state's electricity generation since 1966 and approximately 80 percent since 1984, with most of the remaining generation fueled by nuclear reactors and natural gas. The state is home to a single nuclear power plant: Ameren's Callaway Plant in Callaway County. This 1,235 MW pressurized light water reactor began operations in December 1984 and its original license was set to expire in December 2024. However, the plant was recently granted an extension of its license and can now operate through December 2044.[74] KCP&L is a joint owner of the Wolf Creek Generating Station, a nuclear power plant in Burlington, Kansas, consisting of one Westinghouse pressurized water reactor which came online on June 4, 1985. Following the installation of a new turbine generator rotor in 2011, the plant's capacity is approximately 1,250 MW. The plant's operating company is owned by Westar Energy (47%), KCP&L (47%), and Kansas Electric Power Cooperative, Inc. (6%).[75] A portion of KCP&L's ownership share is attributed to KCP&L's Missouri operations, and as a result, KCP&L's Missouri operations counts nuclear power as 12 percent of its capacity mix.[76]

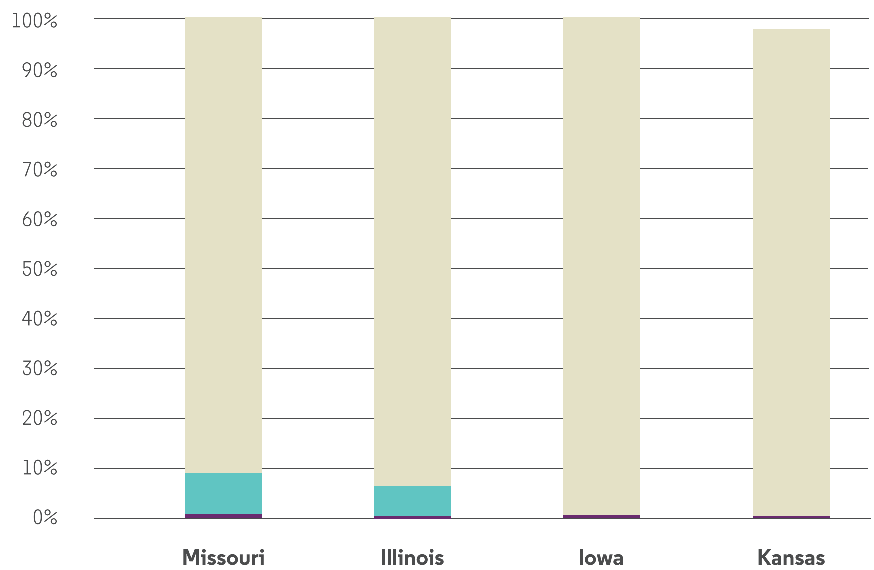
Although small in comparison to other fuel sources, the remaining electricity generation in Missouri has generally come from a combination of hydropower, other petroleum products, and renewable sources. At present, Missouri falls behind other Midwestern states in terms of non-hydropower renewable energy generation with 0.2 MWh per capita– See Table 9. In contrast, Iowa generates 5.3 MWh per capita, while Kansas and Illinois generate 3.8 and 0.8 MWh per capita, respectively. Similar to neighboring states Kansas, Illinois, and Iowa, on a percentage basis the majority of Missouri's renewable energy generation comes from wind resources – see Figure 27.

Table 9. Per Capita Renewable Electricity Generation, 2013.

Source: U.S. EIA. "Electricity Data Browser: 2014," Accessed April 2014. http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=02fo&geo=0000gq-&sec=g&linechart=ELEC.GEN.BIO

	Units	Missouri	Illinois	Iowa	Kansas
Net Electricity Generation for all Sectors	GWh	1,245	10,798	16,454	10,902
Per Capita Net Generation	MWh per person	0.21	0.84	5.30	3.80
Per GSP Generation	kWh per dollar GSP	0.004	0.015	0.099	0.076

Net Generation from Other Renewables, 2014 (GWh)



	Missouri	Illinois	Iowa	Kansas
Wind	1,131	10,077	16,295	10,844
Biomass	101	661	158	59
Solar	13	60	0	0

Figure 27. Renewable Energy Generation by Source for Missouri and Comparison Group, 2014.

Source: U.S. EIA "Electricity Data Browser: 2014," Accessed April 2015. http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=02fo&geo=g000gq&sec=g&-freq=A&start=2012&end=2013&ctype=columnchart&ltype=pin&columnvalues=0&rtype=s&mapty-pe=0&rse=0&pin

2.3 Future Projections

Based on an assessment of Missouri's IOUs' Integrated Resource Plans, which include information about the utilities' anticipated changes in generation based on fuel mix, load forecast, power purchasing agreements, and effectiveness of energy efficiency programs, it is projected that over the next twenty years there will be a significant increase in renewable energy within the state at the utility level. The growth is partially driven by Missouri's Renewable Energy Standard passed in 2008, which requires that by 2021, 15 percent of IOUs' retail sales be derived from renewable sources. Over the next 20 years approximately 444 MW of natural gas capacity and 1,321 MW of renewable energy generation, mainly wind capacity, will be added while approximately 2,940 MW of coal will be retired. As shown in Table 10, these planned changes will impact the fossil-fuel mix by reducing the state's coal-based generation capacity by 23 percent and shifting it to other resources including efficiency.

Contrary to the assumption that energy demand would continue to increase significantly in our state, which was used as the Joint Interim Committee developed the Missouri's Energy Future report in 2009, current trends in demand growth show lower growth rates than expected. Three of Missouri's largest IOUs project annual load growth or retail sales of approximately 0.6 percent and retail peak demand to grow by 0.4 – 0.7 percent over the next 20-year period with no plans for additional baseload generation.

Table 10. Impact of Planned Generation Changes to the Resource Mix (Actual 2013 vs. Planned for 2033).

Source: The Empire District Electric Company (Empire), Volume 1 Integrated Resource Plan (IRP) Executive Summary, 4 CSR 240-22 Case No. EO-2013-0547 July 2013 KCP&L Greater Missouri Operations Company (GMO), Integrated Resource Plan 2014 Annual Update EO-2014-0257, March, 2014 Ameren Missouri, 2014 Integrated Resource Plan, EO-2014-0257, March, 2014

	2013		2033		Difference	
Fuel Type	**Nameplate Capacity (MW)**	**% of Portfolio**	**Nameplate Capacity (MW)**	**% of Portfolio**	**Nameplate Capacity Difference (MW)**	**Change in % of Portfolio**
Coal[1]	13,003	55%	10,063	47%	-2,940	-23%
Petroleum	1,372	6%	1,372	6%	0	0%
Natural Gas	6,611	28%	7,055	33%	444	7%
Nuclear	1,235	5%	1,235	6%	0	0%
Conventional Hydro	499	2%	539	3%	40	8%
WInd	459	2%	1654	8%	1,195	260%
Solar	13.75	0%	99.75	0%	86	625%
Other Biomas	10.6	0%	10.6	0%	0	0%
Pumped Storage	600	3%	600	3%	0	0%
Energy Efficiency	N/A	0%	-1114	-5%	-1,114	N/A
Total	**23,802**	**100%**	**21,514**	**100%**	**-2,289**	**-10%**

Note 1: The negative entry represents reductions in capacity as a result of either retirement of generation units or fuel switching.
Note 2: Energy efficiency reduces the capacity needed to meet demand. The capacity reduction cannot be attributed to a reduction in the projected use of a specific fuel or resource. Therefore, the capacity reduction associated with energy efficiency is presented separately and appears as a negative entry in Table 12.
Note 3: Information only applies to the state IOUs, and does not include municipal utilities, electric cooperatives and independent power producers.

2.4 Distributed Generation

Distributed generation refers to electricity generated at or near the same location where consumption occurs. As explained in previous sections, DG technologies are varied and can include solar, biomass, smaller fossil-fueled generation, CHP, and wind power. Distributed energy resources also include storage energy sources such as batteries, flywheels, and compressed air. According to the most current data, in 2013 the state had an installed distributed generation capacity of 134.1 MW, of which 33.6 MW were net-metered systems.[77]

Net metering and interconnection policies allow consumers with distributed generation resources to earn credits from any electricity generated by their resource that they do not consume and thus can encourage the growth of DG renewables by providing consumers revenue streams from the resource. To date, more than thirty states have adopted comprehensive interconnection standards that allow customer-sited renewable energy systems to connect to the electric grid, regardless of system size. In addition, more than forty states allow customers to bank electricity they have generated but not consumed, often through the form of bill credits.

In 2007, Missouri passed the Net Metering and Easy Connection Act, requiring utilities to allow certain distributed generation resources of 100 kW or less grid interconnection and to provide net metering to these systems.[78] Missouri's interconnection rules are intended to allow owners of distributed renewable generation systems to contribute excess generation to the electric grid system when they are generating more than they consume and to continue to take service when they are generating less than they need. It is important to note that the 100 kW size required under the rule is somewhat restrictive and smaller than that allowed in other states.

The University of Missouri's Combined Heat and Power Plant

- Columbia

The University of Missouri's (MU) power plant consists of a combined heat and power system with 66 MW of capacity and the capability to produce 1.1 million pounds of steam per hour, enough to supply a daily population of over 40,000 people. It supplies electricity, cooling, and heating for numerous buildings totaling more than 13 million square feet, including three hospitals, a research reactor, several research facilities, and both academic and residential buildings.

While conventional power plants operate, on average, at 30 percent efficiency, MU's CHP system has an efficiency factor of approximately 76 percent. This translates to a reduction in total fossil fuels used as well as reduced emissions of air pollutants and carbon dioxide. MU's CHP system reduces CO2 emissions by an estimated 107,000 tons per year. Due to the plant's energy efficiency and pollution reduction, the EPA recognized the University of Missouri with a 2010 EPA Energy Star Combined Heat and Power award.

In 2012, MU added a new biomass boiler to the CHP system, which further reduces fossil fuel use by 25 percent.

The Net Metering and Easy Connection Act also requires that consumption and generation be netted every monthly billing cycle, meaning that net metered customers are compensated at the full retail value for all generation up to their monthly usage, but generation in excess of their own monthly needs is compensated at the utility's avoided cost, which is much less than the retail rate paid by the customer. This provision effectively acts as an incentive for customers to install smaller generating systems sized to meet their needs on the lowest-production month of the year and does not act as an incentive for customers to install larger systems that would generate electricity matching 100 percent of their consumption on an annual basis. The Act does not provide for virtual, community or aggregated net metering, or third-party ownership of net-metered systems on the customer premises.

Distributed Generation is becoming more common throughout Missouri, and as increasing numbers of customers purchase less utility-produced electricity and therefore contribute less to the short-run fixed cost of operating the utility, IOUs are concerned about the effect of DG on their rate of return. Lower payments from customers with DG systems may shift costs onto other customers. Utilities also have concerns about the operation of the distribution grid if DG increases significantly. While these concerns are legitimate, DG is a valuable tool for providing affordable, reliable, and clean energy, and so the utility business model and the grid itself must adapt to accommodate it.

3. Transmission & Distribution

3.1 The Transmission System

The electricity transmission system in the United States is coordinated, controlled, and monitored by Regional Transmission Organizations (RTO) and Independent System Operators (ISO) under the authority of the Federal Energy Regulatory Commission (FERC). There are currently seven operational RTOs and ISOs in the country.

Functionally RTOs and ISOs are the same: they separate transmission infrastructure into geographical regions in which a single entity is responsible for transmission planning and are also responsible for running the regional wholesale power markets, which are designed to ensure a competitive market in the electricity supply. RTOs and ISOs help ensure consumers are provided with reliable and affordable electricity, including improved operational control of the electricity grid, expansion of supply options, and development of demand response programs.

As seen in Figure 28, Missouri is located in both the Southwest Power Pool's (SPP) territory, an RTO, and the Midcontinent Independent System Operator's (MISO) territory, an ISO. The borders where their territories adjoin are referred to as seams. Relevant to Missouri is the fact that MISO and SPP maintain a Joint Operating Agreement that was specifically designed to manage the impact of the seam and coordinate operations under normal and emergency conditions to minimize any increased congestion, facilitate exchange of critical data, and ensure reliable services. The PSC regularly participates in the transmission planning activities with the two RTOs to ensure their plans enhance the reliability of electric service at reasonable rates.

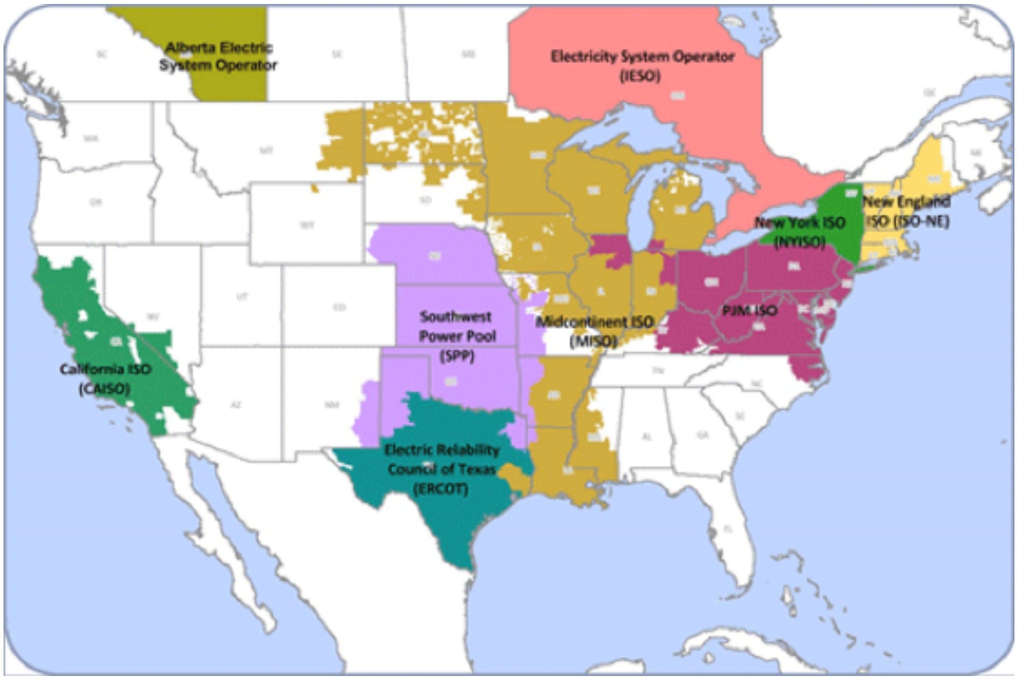


Figure 28. RTO & ISO Regional Territories.

Source: North American Electric Reliability Corporation

RTOs and ISOs are not the only entities that participate in grid management and transmission planning. Missouri is also part of the SERC Reliability Corporation, which manages the reliability and adequacy of the bulk power system in a region that covers all or portions of 16 central and southeastern states.

In addition, the Associated Electric Cooperative, Inc., an independent organization that provides wholesale power generation and distribution for 51 electric cooperatives in Missouri, Iowa, and Oklahoma, has a Joint Operating Agreement with SPP and actively participates in the Southeastern Regional Transmission Planning. This is a forum where stakeholders and transmission utilities can engage in transmission planning.

3.2 The Distribution System

Maintenance and upgrades to the region's distribution network are necessary not only because of the aging infrastructure, but also because roughly 90 percent of outages occur along distribution lines.[79] To maintain reliability, Missouri utilities are investing in improvements that include upgrading or replacing substations and distribution lines. Utilities are also incorporating smart grid technologies into their upgrades of distribution systems.

Another type of upgrade that utilities are undertaking involves improving the efficiency of the distribution grid by optimizing voltage on the feeder lines that run from substations to homes and businesses. This process is called Conservation Voltage Regulation (CVR) or voltage optimization. Nationally, deployment of CVR on all distribution feeders would provide a 3.0 percent reduction in annual energy consumption. If deployed only on the highest value distribution feeders, which amounts to approximately 40 percent of distribution feeders, the annual energy consumption could be reduced by 2.4 percent.[80] However, because the benefits of CVR accrue mainly to customers and the costs of implementing CVR falls mainly on utilities, CVR is not being adopted as widely as it could be.

3.3 Smart Grids

Smart grids are a key solution to issues associated with aging transmission and distribution systems. While the term "smart grid" does not have a standard definition, it generally refers to the installation of technologies that use telecommunication and data processing to facilitate two-way communication on the electric grid. This in turn allows real-time computer-based automation and remote control, as well as data collection and efficient load management.

These technologies increase the efficiency, reliability, flexibility, and efficacy of the grid infrastructure. They include smart meters, information technology, and industrial control systems, and facilitate concurrent sensing and monitoring, dynamic pricing, and microgrid systems. Other benefits include: more options for customer choices and incentives, accommodating all generation and storage options, enabling new products and services, more reliable power with fewer interruptions, more efficient operation and asset optimization, automatic responses to system disturbances, and resilience against natural disasters or attacks.[81]

The Federal Government has passed several laws to promote the development of smart grids. First, the U.S. Energy Independence and Security Act of 2007 (EISA) Title XIII, discusses the development of a "smart grid" or the "modernization of the country's electric power transmission and distribution system aimed at maintaining a reliable and secure electricity infrastructure that can meet the increasing demand for electricity".[82] Then, in 2009, as part of the American Recovery and Reinvestment Act, $3.4 billion in grant funding was designated for smart grid investments in several states.[83] The U.S. Department of Energy estimates that for every $1 million of direct spending on smart-grid deployment from 2009-2012, Gross Domestic Product increased by $2.5 to $2.6 million.[84] During the same period, U.S. Department of Energy (DOE) estimates that 47,000 full time equivalent jobs were supported by investments in smart-grid technology.[85] While there are currently a number of smart grid initiatives across the U.S., they remain largely in the pilot stage. Utilities are hesitant to move forward without a clear path to cost recovery, and regulatory agencies are hesitant to give approval without proof of prudent investments.

Laclede Electric Cooperative
- Lebanon, 2008-2010

Laclede Electric Cooperative deployed a wireless advanced metering infrastructure system in 2008, as its first step toward the development of a smart grid that will enhance customer service, improve overall electrical network efficiencies, reduce operating costs, and automate the way energy is monitored and managed.

The smart grid initiative includes a full change-out of approximately 36,000 existing electromechanical meters with solid-state meters that will monitor consumption and power quality, pinpoint outages by individual meter or in aggregate and integrate customer data into backend billing, load forecasting, and other applications.

In Missouri, utilities have begun smart grid projects that are currently at various stages of implementation. The state has seen progress in advance meter infrastructure (AMI) installations as well as several demonstration projects. AMI meters, also known as smart meters, are updated, digital versions of the traditional electric meter. These new meters not only measure how much electricity is used, but also at what times during the day, and are also designed to transmit pricing and energy information from the utility to the consumer via two-way communication. These smart grid improvements go hand-in-hand with other necessary transmission and distribution system upgrades, which is why most of the projects in Missouri involve a suite of upgrade technologies and are occurring concurrently with general infrastructure upgrades such as new distribution substation construction and overhead wire updates.

Despite some advancements in smart grid implementation, IOUs in Missouri face several planning and implementation issues that include cost effectiveness, cost recovery, security, privacy, customer relations, and reliability. In February 2014, the Missouri Public Service Commission staff updated the Missouri Smart Grid Report. Among other items, staff recommends the opening of a new docket to address cost recovery issues and periodic workshops or technical conferences to share best practices.

KCP&L SmartGrid Demonstration Project
- Kansas City and various demonstration sites, 2010-2014

KCP&L is demonstrating an end-to-end smart grid that includes advanced generation, distribution, and customer technologies. The project covers a demonstration area that spans two square miles and is home to approximately 14,000 commercial and residential customers located in an economically challenged area of Kansas City.

The SmartGrid Demonstration Project integrates current technologies and renewable energy generation to help reduce energy delivery costs and area power outages. In addition, the project gives customers access to advanced energy information so they can manage their usage and potentially save money on their monthly bills.

4. Summary of Key Points

- There are 138 different utilities providing electric services to residents and businesses in Missouri: four investor-owned utilities are regulated by Missouri's Public Service Commission, and 47 electric cooperatives and 87 municipal utilities provide services to the remainder of the state. Missouri's IOUs operate in a regulated market, meaning that the utilities have ownership of generation, transmission, and distribution of electricity. By comparison, some other states operate under a deregulated model, where IOUs divest ownership in generation and transmission.
- As is common throughout the country, the majority of the generation capacity in the state is attributed to units operated by IOUs. Cooperative-owned assets account for the next largest portion of installed capacity, followed by municipal utilities, and then independent power producers and other market players. The generation portfolios are similar for all three utility types in that they rely

primarily on coal and then on natural gas for their source fuels.

- The electric generation portfolio of Missouri's IOUs is dominated by coal-fired power plants with 82.6 percent of electricity generated from this fuel source in 2014. Most of the remaining in-state generation can be attributed to nuclear and natural gas sources. In contrast, other states in the region have a more diversified portfolio that relies on other renewable and non-renewable fuel sources.

- Based on an assessment of Missouri's IOUs' Integrated Resource Plans over the next twenty years, there may be a significant increase in renewable energy within the state at the utility level. Approximately 444 MW of capacity are expected to transition from coal to natural gas; 1,321 MW of renewable energy generation, mostly wind, will be added; and 2,940 MW of coal will be retired.

- The development of DG resources depends partly on the effectiveness of interconnection and metering policies. In 2007, Missouri passed the Net Metering and Easy Connection Act, requiring utilities to allow grid interconnection of certain distributed generation resources of 100 kW or less and to provide net metering to these systems; however, the 100 kW size required under the rule is somewhat restrictive and smaller than that allowed in other states.

- Smart grid development is a key driver in the modernization of Missouri's grid infrastructure. Not only do these updates increase the reliability and efficiency of Missouri's transmission and distribution networks, but they can also help ensure and promote a greater penetration of renewables in Missouri as well as increase cybersecurity of the grid infrastructure. While advancements have been made by utilities, no regulatory action has occurred that explicitly addresses the smart grid.

III. Natural Gas

Natural gas is a versatile source of energy that can be used to heat our homes and businesses, as a generating source for electricity, as a transportation fuel, and as a heat source for generating steam used in numerous industrial and commercial applications.

Given that Missouri has limited natural gas resources, the content that follows is focused on how natural gas is distributed within the state and delivered to customers.

1. Natural Gas Utilities

Natural gas utilities in Missouri are comprised of six IOU service areas and 40 different municipal utilities. For a full list of utilities, please refer to Appendix D – List of Missouri Utilities.

The six IOUs provide natural gas services to customers across most of Missouri. Laclede Gas Company (Laclede), with the largest share of sales and customers, serves customers on the eastern side of the state, primarily in St. Louis and surrounding areas. Missouri Gas Energy (MGE), which since 2013 is a division of Laclede, serves the western portion of Missouri including the Kansas City metropolitan area. Areas of the northeast and southeast corners of the state, as well as the western side just south of Kansas City, are served by Liberty Utilities. Empire District Gas Co. serves in west central Missouri and in the northwest quadrant, while Summit Natural Gas serves areas north to south along and near I-65 in the Lake of the Ozarks and Branson areas. Ameren Missouri serves areas in the eastern half of the state. For a complete look at natural gas pipelines used by these IOUs, see Figure 29.

According to the Missouri Public Service Commission's 2014 Annual Report, Missouri's IOUs sold over 225 billion cubic feet (BCF) of natural gas in 2013. The bulk of natural gas retail sales for investor-owned utilities are split between Laclede and MGE. In 2013, the two utilities alone shared nearly 82.6 percent of total gas sales for IOUs. As shown in Table 11, the other five utilities held much smaller sales percentages, under 10 percent each.

Table 11. Missouri Natural Gas IOUs Statistics, 2013.

Source: PSC, Federal Energy Regulatory Commission, "Form 1, 2013 Annual Report," Missouri Jurisdictional. Accessed March 2015, http://psc.mo.gov/CMSInternetData/Annual%20Reports/PSC%20Annual%20Reports/2014%20PSC%20Annual%20Report.pdf

Company Name	MCF Sold	%	Residential Customers	%	Non-Residential Customers	%	Total Customers	%
Laclede Gas Company	109,018,871	48.4%	602,410	48.2%	40,791	30.1%	643,201	46.4%
Missouri Gas Energy - Division of Laclede Gas	76,911,442	34.2%	440,372	35.2%	62,665	46.2%	503,037	36.3%
Ameren Missouri	19,016,140	8.4%	114,019	9.1%	13,303	9.8%	127,322	9.2%
Empire District Gas Co.	8,728,441	3.9%	37,777	3.0%	5,434	4.0%	43,211	3.1%
Liberty Utilities	8,525,127	3.8%	47,682	3.8%	6,919	5.1%	54,601	3.9%
Summit Natural Gas-Former SMNG Service Area	2,402,777	1.1%	5,109	0.4%	6,331	4.7%	11,440	0.8%
Summit Natural Gas-Former MGU Service Area	458,066	0.2%	3,577	0.3%	122	0.1%	3,699	0.3%
Totals	225,060,864	100.0%	1,250,946	100.0%	135,565	100.0%	1,386,511	100.0%

2. Distribution

As described in Section I. Availability of In-State Resources, Missouri does not have sufficient indigenous natural gas reserves to meet state needs. Because of location, large quantities of natural gas from Kansas, Arkansas, and Nebraska come through Missouri on their way to Illinois and Iowa.[vii,86] Of the nearly two TCF of natural gas handled by these pipelines in Missouri, only roughly 14 percent is used in the state.[87] Natural gas moving through Missouri is transported by a series of eleven interstate pipelines that are shown in Figure 29. Three pipelines are particularly important and serve the majority of Missouri's local distribution companies (LDCs):

- Panhandle Eastern Pipeline: serves Kansas City, Central Missouri, and St. Louis;
- Southern Star Central Gas Pipeline: serves the Kansas City, St. Joseph, Springfield, and Joplin areas, as well as St. Louis;
- Mississippi River Transmission: serves St. Louis and southeast Missouri.
- Other parts of the state are served by Gas Pipeline Company of America, Ozark Gas Transmission, Texas Eastern Transmission, ANR Pipeline Company, Tallgrass Interstate Gas Transmission, and MoGas Pipeline.

In addition to these interstate pipelines, one of the country's largest pipelines, the Rockies Express (REX), crosses the state of Missouri. The REX, which became fully operational in 2009, is a 42-inch diameter, 1,679-mile natural gas pipeline stretching from Colorado to Ohio. The pipeline's western section originates in Colorado and passes near Kansas City before interconnecting in northeastern Missouri with the REX pipeline's eastern section.[88] The pipeline only handles gas being transported to states beyond Missouri.

Since Missouri only has one large-scale natural gas storage facility, Laclede Gas Company's 13,845 million cubic feet aquifer storage field in northern St. Louis County,[89] some LDCs contract with out-of-state companies for additional natural gas transportation and storage. For example, Missouri Gas Energy, Ameren Missouri, and Laclede Gas all contract with out-of-state companies for additional natural gas storage to meet peak and winter demand.

[vii] State imports are tracked by where the natural gas was shipped from, not necessarily where it was produced.

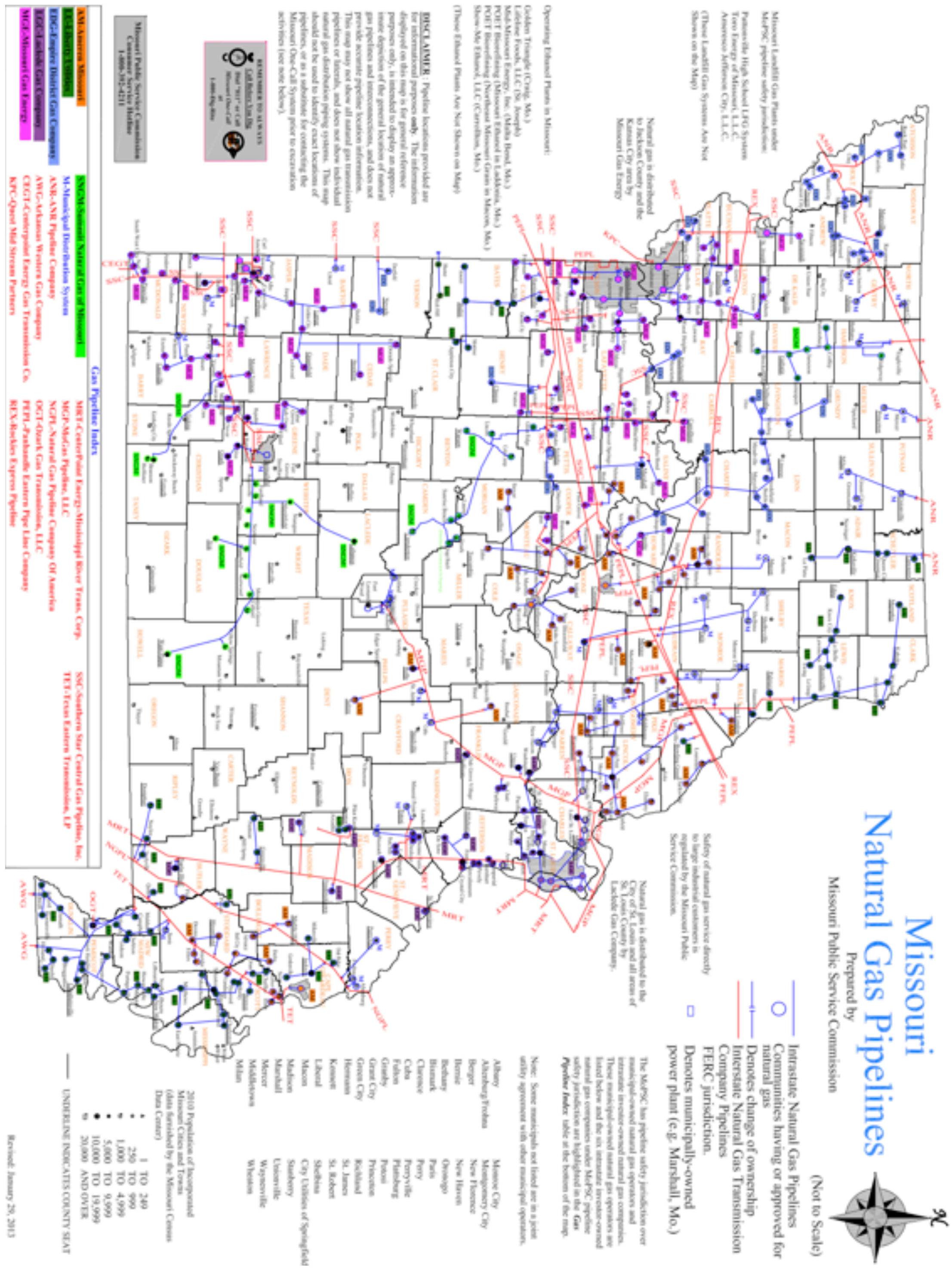


Figure 29. Major Missouri Natural Gas Pipelines, 2013.

Source: PSC, "Missouri Natural Gas Pipelines," Updated January 29, 2013. http://psc.mo.gov/CMSInternetData/NaturalGas/Missouri%20Natural%20Gas%20Pipeline%20Map.pdf

3. Summary of Key Points

- Natural gas utilities in Missouri are comprised of both IOUs and municipal utilities. There are 47 entities providing natural gas to customers in Missouri, six of which are IOUs.
- Missouri relies on imports to fulfill its natural gas needs and is home to a well-developed network of natural gas distribution pipelines and LDCs. Large quantities of natural gas from Kansas, Arkansas, and Nebraska pass through Missouri on their way to Illinois and Iowa and are transported through a series of eleven interstate pipelines. In addition, one of the country's largest pipelines, the Rockies Express, also crosses the state of Missouri. Of the nearly two TCF of natural gas that enters Missouri every year, the state only uses roughly 14 percent.
- Missouri only has one large-scale natural gas storage facility: Laclede Gas Company's 13,845 million cubic feet aquifer storage field in northern St. Louis County. The lack of large-scale storage in the state requires these distributors to rely on out-of-state storage solutions.

IV. The Regulation and Economics of Energy Pricing

1. Rate-Setting Processes

The energy industry has been highly regulated through most of its history. These regulations are designed to protect consumer interests as well as to ensure that investor-owned utilities are provided the opportunity to earn a fair return for their investments in energy infrastructure and for meeting the energy needs of consumers.

In our state, the Missouri Public Service Commission (PSC) oversees every aspect of ratemaking for investor-owned electric, natural gas, and water utilities. The PSC is composed of five commissioners who are appointed by the Governor with advice and consent of the Missouri Senate. The PSC staff is a party to all PSC cases, takes positions on issues, and files recommendations to the Commission. The Public Counsel is the official state utility consumer advocate and is also a party to all PSC cases. Other parties may include individual energy consumers or their trade associations, environmental organizations, or other interest groups. The PSC itself is responsible for ruling on these proceedings, although parties may come to agreement during negotiations. Those agreements frequently go beyond simple compromises on the amount of rate increases and have included multi-year construction and cost-recovery plans, tracking and recovery of certain expenses, earnings-sharing plans, and other mechanisms to lessen the effects of regulatory lag. The Division of Energy intervenes in many PSC cases related to energy in order to advocate for the efficient use of diverse energy resources.

Through the extensive stakeholder process that was undertaken in the development of this Plan, the Division of Energy has identified a number of areas that have the potential to improve the ratemaking process and which merit investigation or implementation by the PSC.

Performance-based Rates

In traditional ratemaking, rates are set based on expenses and investments: the PSC calculates a revenue requirement by adding together the utility's prudent expenses plus a reasonable return on the utility's investments in facilities that provide service and then designs rates intended to recover that revenue requirement. In performance-based ratemaking, rates are initially set using the traditional method, but then can vary depending on how well the utility performs in meeting certain objectives, such as minimizing costs, maximizing reliability, or achieving high customer satisfaction measures. Performance-based rates should provide financial incentives to utilities that do well in meeting the stated objectives and assess penalties to those that do poorly.

Time-differentiated Rates

Traditional rates reflect highly averaged costs, e.g., across diverse customers in broad rate classes, and over many different hours of the year.[90] In reality, the cost to provide service varies dramatically at different times of the day and in different seasons. Rates can be designed to reflect these varying costs in a number of ways, from simply charging a higher rate at times of system peaks to charging different rates every hour or even every few minutes. Time-differentiated rates increase the overall efficiency of the system by sending more accurate and more granular price signals.

Decoupling

Decoupling is a rate adjustment mechanism that separates or decouples a utility's fixed cost recovery from the amount of electricity, gas, or water it sells. Under decoupling, utilities collect revenues based on the regulatory determined revenue requirement, most often on a per-customer basis. On a periodic basis revenues are trued-up to the predetermined revenue requirement using an automatic rate adjustment.[91] Decoupling removes the "throughput disincentive," or revenue erosion that utilities experience when customers use less energy because of utility energy efficiency programs. In Missouri, there have been efforts to reduce the throughput disincentive by lost revenue recovery mechanisms for the electric utilities that have implemented energy efficiency programs under the Missouri Energy Efficiency Investment Act (MEEIA).

Forward Test Years

Utility rates are determined using a "test year", which is simply a 12-month period of revenue and expense data. Missouri uses an historical test year, typically the most recent 12-month period for which data is available. A forward test year uses estimates of revenues and expenses for the period in which the rates are expected to be in effect. This involves forecasting revenues and expenses for generally about two years. Using an historical test year is appropriate if the balance between revenues and expenses found in the test year will likely continue into the period in which the rates will be in effect. Utilities argue that costs are increasing faster than revenues, making historical test years inappropriate. They contend that, in a rising unit cost environment, the uncertainty of forecasts is less of a concern than the bias of historical test year rates.[92]

1.1 Electricity

Electricity prices generally reflect the costs to build, finance, maintain, and operate power plants and the electricity grid. For more information on actual energy prices in Missouri, please refer to Chapter 1: Missourians and the Energy Outlook.

To set electric base rates, Missouri electric IOUs currently undergo a ratemaking process that can last up to 11 months. The ratemaking process takes place in two-stages: first establishing a revenue requirement and rate of return before moving into a rate design phase that determines how revenues will be recovered from various classes of customers. This rate design phase also determines how the recovery of revenues will be divided between fixed and volumetric charges.[93] The process involves a set of public hearings and, if a formal settlement on all issues cannot be reached, an evidentiary hearing with the PSC.

There are a number of adjustment mechanisms that Missouri's electric IOUs may use to adjust their rates outside of the general ratemaking process. These mechanisms allow utilities to adjust rates more quickly than they could by following the regular ratemaking process, under certain circumstances as prescribed by law. In each case, the PSC staff reviews the application and it must be ruled upon by the PSC. Rate adjustment mechanisms include:

- The Demand-Side Programs Investment Mechanism;
- The Fuel Adjustment Clause or an Interim Energy Charge;
- The Renewable Energy Standard Rate Adjustment Mechanism; and,
- Nuclear Power Plant Decommissioning Expense.

a) Electric Demand-Side Programs Investment Mechanism

The Electric Demand-Side Programs Investment Mechanism (DSIM) allows electric utilities to recover costs for programs that could include energy efficiency, demand response, load management, and interruptible or curtailable load programs. The DSIM allows utilities to recover costs through a line item on customers' utility bills or by capitalizing the program investment.[94] The costs that utilities can recover are:

- Program costs;
- Accelerated depreciation;
- Lost revenues; and
- Utility performance incentives.

b) Electric Fuel Adjustment Clause and Electric Interim Energy Charge

The Electric Fuel Adjustment Clause (FAC) and Electric Interim Energy Charge (IEC) are mechanisms established in a general ratemaking proceeding that allow periodic rate changes outside of those proceedings, so that the utility may recover its prudent fuel and purchased power costs. These costs could also include the prudent costs of hedging instruments intended to guard against price volatility. The utility must request that the FAC be updated at least once and up to four times each year. Both the FAC and the IEC may not stay in effect for more than four years, unless the PSC authorizes extension (4 CSR 240-20.090).

c) Renewable Energy Standard Rate Adjustment Mechanism

The Renewable Energy Standard Rate Adjustment Mechanism (RESRAM) allows electric utilities to recover prudent costs and to pass through benefits associated with Missouri's Renewable Energy Standard to their customers. The utility may apply for a RESRAM either during or outside a general ratemaking proceeding. The RESRAM must be calculated as a percentage of customers' energy charge, and customers must be notified of the purpose of the RESRAM on an annual basis.[95]

1.2 Natural Gas

Similar to the rate-setting process for electric utilities, Missouri's natural gas IOUs currently undergo a two-stage ratemaking process that can last up to 11 months. Natural gas utilities have two adjustment mechanisms that allow them to adjust rates more quickly: the Infrastructure System Replacement Surcharge (ISRS) and the Purchased Gas Adjustment/Actual Cost Adjustment (PGA/ACA). The ISRS allows accelerated cost recovery for projects that:

- Replace or extend the useful life of existing infrastructure;
- Do not connect to new customers;
- Were not included in the base rates determined during previous general ratemaking proceedings; and
- Are currently in use.[96]

To qualify for ISRS treatment, the projects must be one of three types:

- Replacement of mains, valves, or other pipeline system components;
- Relining of mains or other projects that extend the useful life of existing infrastructure, or
- Relocation of facilities due to road construction.

The revenues collected through the ISRS must be trued-up to costs at least once per year. Utilities may not request a change in the ISRS more often than twice during every year. In addition, utilities may not request an ISRS unless they have undergone a general ratemaking proceeding in the past three years.

While the technicalities of Missouri's PGA clause have varied over the years, the clause's basic function has remained the same: a PGA clause allows a local distribution company to automatically adjust the rates it charges its customers in proportion to the change in the rate the local distribution company is charged by its wholesale suppliers. At the end of every twelve-month period, the local distribution company then makes an actual cost adjustment filing with the PSC so that the PSC can determine whether the estimated amount previously charged customers accurately reflects the actual cost to the utility of the gas supplied.[97]

As a matter of policy, the Missouri Public Service Commission also encourages natural gas utilities to mitigate the price volatility of their natural gas supply through prudent hedging activities. Missouri PSC staff actively monitors these activities during ratemaking and other proceedings in an effort to stabilize and reduce the price of natural gas in the state.[98]

2. Levelized Costs of Energy

While different fuel sources use the same base technology for electricity generation, they have different relative advantages and disadvantages, including costs and technical constraints. These characteristics influence the rates set in the rate-setting process and need to be taken into account while making decisions about future generation capabilities.

To provide a cost comparison of the advantages and disadvantages of different technologies and fuels, Table 12 and Table 13 analyze the Levelized Cost of Energy (LCOE) for utility-scale and distributed generation technologies. The LCOE is a summary measure of the overall competitiveness of different generating technologies. It represents the cost per kilowatt-hour of building and operating a generating plant over an assumed lifetime. Key inputs to calculating LCOE include capital costs, fuel costs, operations and maintenance costs, financing costs, and other factors. The ranges found in these tables reflect different assumptions that include installation costs, integration costs, and the regulatory environment. In general, the wider the range, the more sensitive prices are to the various assumptions.

Table 12. Analysis of LCOEs of Utility Scale Technology and Sources, 2014.

Source: "Lazard's Levelized Cost Of Energy Analysis—Version 8.0,"September 2014. http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf

Technology/Source	LCOE ($/MWH)**	Dispatch Ability	Technical Constraints & Considerations
Coal	$61 - $158	Baseload	Costs could significantly increase depending on future regulations of carbon dioxide emissions.
Natural Gas Combined Cycle	$52 - $96	Baseload or Load-Following	Costs could significantly increase depending on future regulations of carbon dioxide emissions.
Nuclear	$90 - $134	Baseload	The majority of costs are capital costs. Once a plant is constructed the marginal cost per MWh is low. Estimates do not include costs of decommissioning a plant.
Solar PV*	$72 - $86	Intermittent or Peaking	Cost per MWh is projected to decrease to $60 by 2017. Intermittency of energy production can require additional quality assurance requirements.
Wind*	$37 - $61	Intermittent	Intermittency of energy production can require additional quality assurance requirements.
Energy Efficiency	$0 - $50	-	Actual cost for individual initiatives can vary and savings can be hard to accurately quantity for certain projects.

Notes: LCOE: Levelized Cost of Energy – 2014 estimates
** Solar PV and Wind LCOE Midwest region specific*
*** Unsubsidized Costs*

Table 13. Analysis of LCOEs of Distributed Generation Technologies and Sources, 2014.

Source: "Lazard's Levelized Cost Of Energy Analysis—Version 8.0,"September 2014. http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf

Technology/ Source	LCOE ($/MWh)*	Dispatch Ability	Technical Constraints & Considerations
Solar PV – Rooftop Residential	$180 - $265	Intermittent or Peaking	By 2017 the price per MWh is projected to be between $109 and $151. There can be certain grid connection considerations regarding energy balancing.
Solar PV – Rooftop Commercial & Industrial	$126 - $177	Intermittent or Peaking	Considered a commercial technology in terms of maturity, DG solar PV still requires policy support to be well integrated and at a reasonable LCOE. By 2017 the price per MWh is projected to be between $83 and $136. There can be certain grid connection considerations regarding energy balancing to address when DG solar PV claims a large market share.
Fuel Cell	$115 - $176	Baseload	Considered an emerging commercial technology.
Battery Storage	$265 - $324	Peaking or Load Following	Considered an emerging technology, price per MWh is projected to decrease to $168 by 2017.
Microturbine	$102 - $135	Baseload	Considered an emerging commercial technology in terms of its maturity.

3. Summary of Key Points

- The Missouri PSC oversees every aspect of ratemaking for investor-owned electric, natural gas, and water utilities. The PSC is composed of five commissioners who are appointed by the governor. The PSC staff is a party to all PSC cases, takes positions on issues, and files recommendations to the Commission.

- Electricity prices generally reflect the costs to build, finance, maintain, and operate power plants and the electricity grid. For-profit or investor-owned utilities also include a return for owners and shareholders in their prices. To set electric base rates, Missouri electric IOUs currently undergo a ratemaking process that can last up to 11 months. In addition, several adjustment mechanisms allow utilities to adjust rates more quickly than they could by following the regular ratemaking process.

- To calculate revenue requirements and billing determinants, rate cases use "test years". An historical test year relies upon updated actual information from past years, whereas a forward test year relies upon forecasted information intended to be representative of the period in which rates are expected to be in effect. In Missouri, rate cases currently use historical test years to set electricity prices.

- When discussing Missouri's ideal generation portfolio, it is important to consider the relative costs of each generation source and how these costs will influence the prices that consumers pay. The Levelized Cost of Energy is a summary measure of the overall competiveness of different generating technologies and can aid with this analysis. It considers the cost per kWh of building and operating a generating plant over an assumed lifetime. Key inputs to calculating LCOE include capital costs, fuel costs, operations and maintenance costs, financing costs, and other factors.

V. Energy Storage

1. Overview

Energy may be stored in different states. One method of energy storage is in the physical state, such as with propane, natural gas, and liquid fuels. Energy can also be stored in an electrical state after it is generated.

Utilities plan how much energy to generate and distribute onto the grid each day through predictive models, but the companies often generate more or less energy than is needed. Energy storage technologies can help with this problem by storing electrical energy so it can be available whenever it is needed to help meet demands.

Energy storage can be deployed throughout the entire electric power system, effectively functioning as generation, transmission, or distribution. As emphasis on carbon dioxide reduction in energy systems increases, storage technologies are becoming more prevalent as a way to increase resource use efficiency and balance variable renewable energy generation. Another key benefit to energy storage is its ability to increase the reliability of electric grids without the need for additional infrastructure by:

- Alleviating supply shortage;
- Relieving congestion;
- Postponing the need for new capacity; and
- Deferring transmission additions.

Energy storage technologies can be built and operated in a wide variety of applications, including both centralized applications connected to a transmission grid and decentralized applications that are connected to the distribution grid. These decentralized storage facilities are especially useful for reducing grid capacity requirements, as they help manage

EaglePicher HQ PowerPyramid: Located in Joplin, EaglePicher's PowerPyramid energy storage system uses both lead-acid and lithium-ion battery technologies to assist with power facility loads as well as peak demand shaving and frequency regulation. This system has a capacity of 1 MW and consists of several inverters, multiple lead-acid and lithium-ion batteries, and both wind and solar PV renewable energy resources. The PowerPyramid is a demonstration project and is offered as an integrated system to customers on a commercial scale.

Carthage Water & Electric Plant: In August 2013, the Carthage Water & Electric Plant contracted EaglePicher Technologies to design a Renewable Energy Storage System to demonstrate the potential utility savings of energy storage to local customers. Completed in March 2014, the goal of this demonstration project is to integrate renewable energy sources and lower peak demand. An advanced lead-acid battery is used with a turnkey storage system using a single-point connection to make the system grid-tied. The system is rated at 100 kW and includes 20 kW of PV solar as well as 10 kW of wind turbines.

KCP&L SmartGrid Demonstration Project: Encompasses two square miles and serves 14,000 commercial and residential customers. In this demonstration area, KCP&L

fluctuations near their origin. Decentralized applications are also used at customer-generator sites such as thermal energy storage for peak shaving, where energy is used at night during off-peak times to chill a coolant, which is then used to keep a building cool during the day.

Some storage technologies such as pumped hydroelectric storage, thermal storage, and compressed air are fully commercialized. Other types of storage, such as liquid-flow batteries and flywheels, are still maturing in terms of their technology as well as their functions for the power grid.

has partnered with Exergonix to use lithium-ion battery technology to create a grid-scale energy storage system that integrates renewables into the distribution system and supplies peak-shaving and demand management. This battery has a 1 MW storage capacity and is being tested in the SmartGrid to determine its effectiveness for managing energy on the electric grid.

1.1 Batteries

Solid-state batteries store energy in electrochemical cells. There are four main types of solid-state batteries that are used for storing energy: lead-acid, lithium ion, nickel-cadmium, and sodium sulfur batteries. Of these, lead-acid battery technology has been around for over 100 years[99] and may represent an opportunity for Missouri as the state has one of the world's largest deposits of lead.[100] Today, Missouri produces about 90 percent of the U.S. primary supply of lead,[101] and approximately 84 percent of this lead is destined to the production of lead-acid batteries.[102]

In addition to solid-state batteries, flow batteries, which have a longer cycle life and quick response times, utilize chemical compounds as the anode and cathode and an electrolyte liquid to allow the flow of energy out of the battery. There are three varieties of flow batteries currently in commercial and industrial use: iron-chromium, vanadium, and zinc-bromine. Finally, there are a number of emerging technologies, such as lead-carbon batteries, that are further being explored at the national and international level.

1.2 Pumped Storage

Pumped hydropower is currently the most widely used form of energy storage that is employed at the utility scale. In order to store energy to be used at a later time, pumps are used to raise water up a hillside to a retaining pool behind a dam. This water can be released from the retaining pool to flow downhill into the turbines to produce electricity. This process can be deployed within seconds, helping to balance potentially large electrical load changes.

In Missouri, there is one pumped hydrostorage facility in operation, the Taum Sauk Hydroelectric Plant, which was one of the first pumped storage projects in the United States. It is located in the St. Francois Mountains and has a capacity of 440 MW. Operated by Ameren Electric Company since 1963, the pumped hydropower plant was designed to help meet peak power demands during the day. Electric generators use excess electricity available at night to pump water to the top of Proffit Mountain, where it is stored in a 1.5 billion gallon capacity reservoir.[103] The generators and turbines are reversible: when energy is desired during peak power demands, the water is allowed to flow from the upper reservoir to a lower reservoir on the Black River, which turns the same electric generators that are used to pump water to the upper reservoir. This plant is unique in that it is a pure pump-back operation; there is no primary flow of water available for hydroelectric electricity generation. Following a catastrophic failure of the upper reservoir in December 2005, a new upper reservoir dam was rebuilt from the ground up and the plant resumed operation in April 2010.[104]

1.3 Compressed Air Energy Storage

Compressed air energy storage (CAES) plants function similarly to pumped storage plants in their applications, output, and storage capacity and could be used as an alternative to pumped storage plants. Large-scale CAES plants compress ambient air and store it under pressure in underground caverns, which are most commonly man-made salt caverns. The compressed air is then heated and expanded in an expansion turbine, which drives a generator to produce power. Large-scale applications are more common for CAES, but small-scale applications on site are also possible. For example, a small-scale CAES could be combined with a solar farm to satisfy local energy demand. CAES technologies are currently not used in Missouri.

1.4 Thermal Energy Storage

Thermal energy storage is one of the most widely used storage technologies and allows for the temporary storage of energy in the form of heat or cold. The most common use of thermal storage is in buildings or facilities, where it is used to maintain a comfortable temperature for occupants. During periods of off-peak electricity demand, usually at night when prices are lower, thermal storage chills a coolant. Air is then cooled by the storage medium and circulated through the building the following day. This process helps to reduce electricity costs by deferring the time of day when a building's cooling system is run. Thermal energy storage is also used for heating in the same way it is used for cooling.

A second use for thermal storage is at solar thermal power plants. The thermal storage offers an option to save energy produced during the day when the sun is shining, typically in a molten salt, which can then be used at night to generate steam to drive a turbine, producing electricity.

2. Summary of Key Points

- Energy storage technologies are under-utilized in Missouri. Additional integration of storage technologies can help Missouri in its grid modernization efforts as well as help provide more affordable, reliable energy to consumers.
- Because of Missouri's vast lead resources, the state is uniquely situated to become the world's hub for the research, development, production, and advancement of lead-acid batteries. Lead-acid batteries currently provide energy storage solutions for vehicles, traditional and renewable power, telecommunications, and more. By taking a holistic approach to the development of this industry, the state can put Missouri in the position to continue to be the leader in lead battery development.

Chapter 3: Energy Use

Chapter 3 provides an overview of energy use within the two largest energy-consuming sectors in the state: buildings and transportation. The chapter begins with a characterization of energy usage in residential, commercial, and other building types and describes energy efficiency opportunities such as building codes, government initiatives, demand-side management programs, and efforts by the private sector.

The chapter also covers a description of the transportation sector, including how Missourians move around the state and how goods are transported. It discusses transportation fuels and several initiatives that are currently underway to promote alternative fuels and more efficient transportation modes.

Finally, as it relates to the cities and towns that we live in, there is a discussion of energy assurance and reliability: how Missouri plans for emergency response in the face of unexpected natural or man-made disasters and the steps that the state has undertaken to ensure that energy services and fuels are reliable and available to all Missourians.

I. Buildings and Energy Efficiency

1. Building Energy Usage

Buildings are responsible for approximately 50 percent of energy use in Missouri.[105] The U.S. Energy Information Administration (EIA) forecasts that energy consumption within the building sector will grow 12.3 percent by 2040, primarily driven by population growth and the need for additional structures.

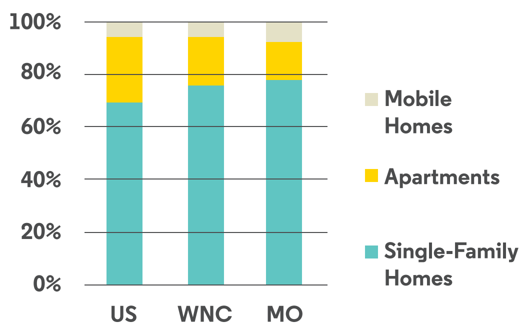
Because of the large amount of energy consumed by buildings and the forecasted continued growth, it is critical to understand how energy is used in these spaces and identify opportunities for more efficient use of electricity, natural gas, and other resources. Different building types will show different energy consumption patterns within a given day and throughout a yearlong cycle. For instance, energy consumption in a residential building is very different from that of an industrial facility or even a hospital. Factors that influence a building's energy consumption include, but are not limited to, outside weather conditions, hours of operation, building occupancy patterns, and production and throughput of products for manufacturing facilities.

1.1 Residential Building Energy Use

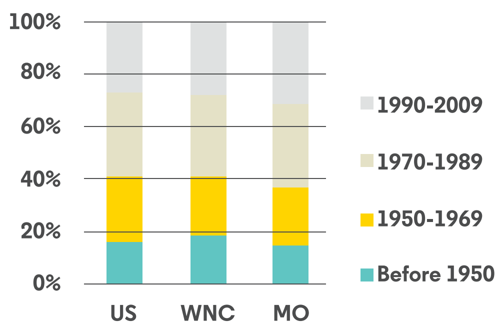
a) Characterization of Energy Use

In 2012, Missouri's residential properties accounted for a little more than half of the energy consumed by buildings. In 2000, Missouri's households were more likely to be attached or detached single-family units (71.5%), rather than multifamily properties (20%). There is also a small percentage of manufactured homes in the state (8.2%).[106] As seen in Figure 30, Missouri homes also tend to be larger than the average U.S. home and consume more energy per square foot than houses in other regions of the country.[107]

Housing Types



Year of Construction



Average Square Footage

US	1,970
WNC	2,317
MO	2,344

All Energy *usage per household (excl. transportation)*

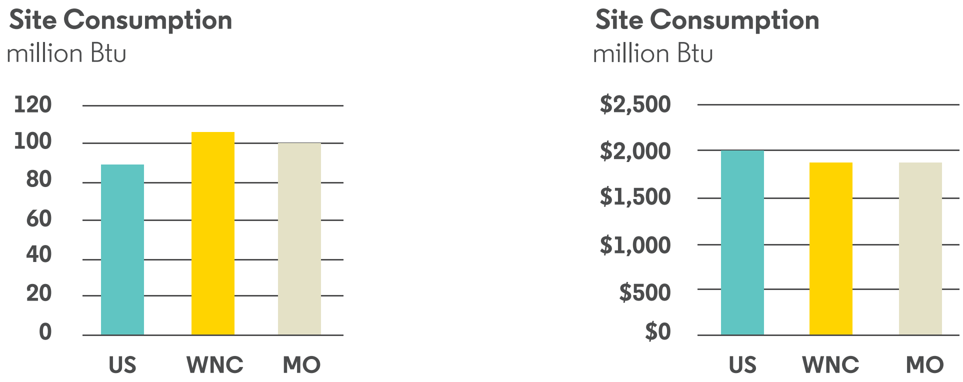


Figure 30. Household Energy Use in Missouri, 2009.

Source: U.S. Energy Information Administration (EIA) "Residential Energy Consumption Survey (RECS) http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/mo.pdf

Characterizing Missouri's housing stock is important because the energy consumption profiles of single-family homes and apartments in multifamily complexes are very different. For instance, when seen at the household level a multifamily apartment may require significantly less energy than a single-family home – see Figure 31. This difference is most pronounced for multifamily homes in buildings with five or more units, which in Missouri represented 11 percent of residential properties in 2000,[108] and is primarily due to structural differences such as exposure to the exterior and other housing characteristics.

Multifamily housing has a number of characteristics that should make energy efficiency improvements an appealing investment, but only a fraction of the potential energy savings in the multifamily sector has been realized. One reason for this is that in the multifamily sector there is a "split incentive" problem, by which a building owner pays for projects and improvements to the building, but cannot recover savings from reduced energy use that accrue to the tenant. Improving the energy efficiency of multifamily housing could lead to improved stability of vulnerable households, most of which are renters whose annual income is typically lower than that of homeowners and therefore spend a higher percentage of their income on energy. Recommended best practices include tailoring energy efficiency programs to meet specific challenges of multifamily affordable homes (such as subsidized housing, master-metered buildings, and high-use customers), ensuring an equitable share of available efficiency program resources for these buildings, and structuring incentives to achieve comprehensive whole-building savings.

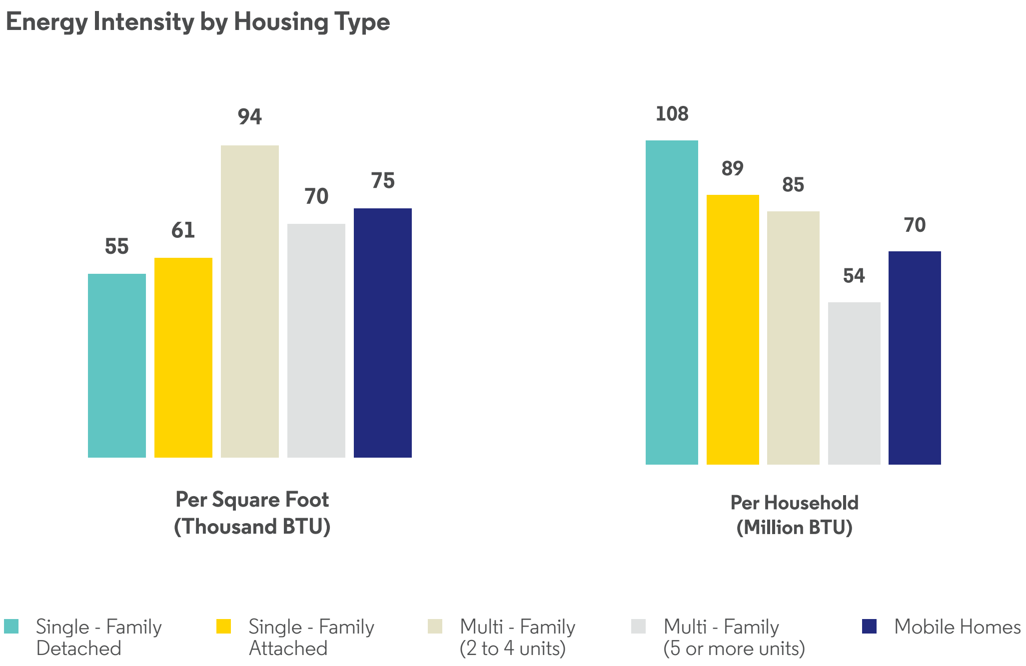


Figure 31. Residential Energy Intensity by Housing Type, 2010.

Source: U.S. Department of Energy "Buildings Energy Data Book: 2.1: Residential Sector Energy Consumption", Accessed April 2015, http://buildingsdatabook.eren.doe.gov

Nationally, most of the residential energy consumed in 2009 was used for space heating and cooling, and therefore opportunities to reduce energy expenditures associated with these activities can be a good investment. As shown in Figure 32, at the national level, the energy used for space heating and cooling in an average home decreased from 1993 to 2009 due to the increased adoption of more efficient equipment, better insulation, and more efficient windows. However, energy consumption for appliances and electronics has risen. Non-weather related energy use for appliances, electronics, water heating, and lighting now accounts for 52.3 percent of total consumption, up from 42.3 percent in 1993. The majority of devices in the fastest growing category of residential end uses are powered by electricity, increasing the total amount of primary energy needed to meet residential electricity demand.[109]

In Missouri, 51.0 percent of homes use natural gas as their heating fuel, while 34.8 percent use electricity. Of significance is the fact that 9.3 percent of residential households in Missouri rely on propane as the source of their heating, which is lower than the average for the West North Central division estimated at 10.3 percent of total households - see Table 14. Propane is primarily used in rural areas that do not have access to natural gas distributed by utilities. These customers typically contract with local propane retailers to receive tanks containing propane at their property. The tank is typically provided for a lease fee and is returned to the retailer after use.

Energy consumption in homes by end uses
Quadrillion Btu and percent

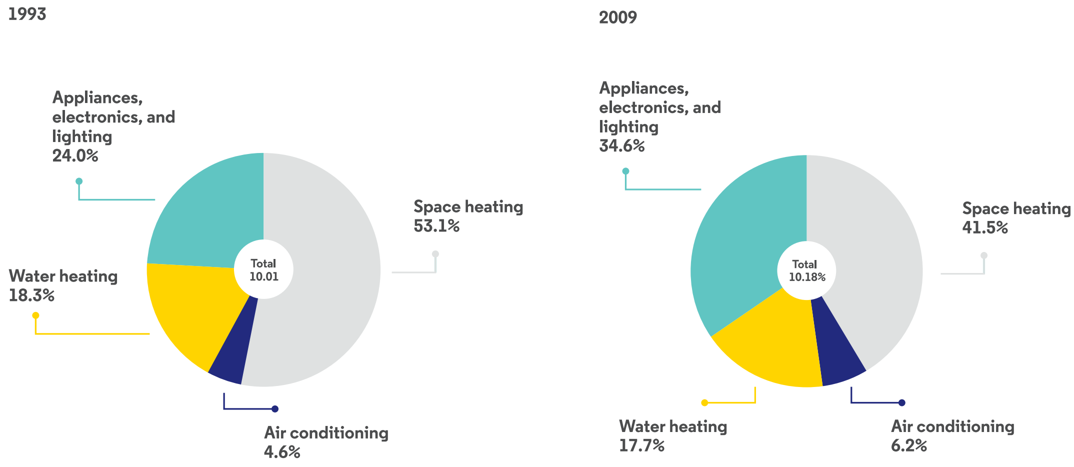


Figure 32. Residential Energy Consumption by End Use, 2009 vs. 1993.

Source: U.S. EIA "Residential Energy Consumption Survey (RECS)," Accessed April 2015, http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/mo.pdf

Table 14. Residential Heating Fuel Used, 2009-2013.

Source: U.S. Department of Commerce, Census Bureau. "2009-2013 American Community Survey 5-Year Estimates," Accessed April 2015. Table B25040: House Heat Fuel - Universe: Occupied housing units.

	Missouri		Kansas		Illinois		Iowa		West North Central Division	
Heating Fuel	Number of Households	%	Number of Households	%	Number of Households	%	Number of Households	%	Number of Households	%
Natural gas	1,205,979	51.04%	735,134	66.01%	3,757,212	78.55%	775,699	62.75%	4,932,057	60.59%
Electricity	822,051	34.79%	259,854	23.33%	734,516	15.36%	249,151	20.15%	1,961,738	24.10%
Propane	218,963	9.27%	87,427	7.85%	204,784	4.28%	163,459	13.22%	837,055	10.28%
Wood	95,809	4.05%	20,096	1.80%	25,245	0.53%	20,468	1.66%	207,776	2.55%
Other fuel	7,362	0.31%	4,821	0.43%	23,835	0.50%	12,599	1.02%	103,092	1.27%
Fuel oil, kerosene, etc.	4,664	0.20%	1,884	0.17%	8,689	0.18%	7,228	0.58%	63,944	0.79%
Solar energy	755	0.03%	70	0.01%	1,112	0.02%	430	0.03%	30,992	0.38%
Coal or coke	398	0.02%	80	0.01%	710	0.01%	134	0.01%	1,679	0.02%
No fuel used	6,872	0.29%	4,363	0.39%	27,318	0.57%	7,041	0.57%	2,210	0.03%
Total:	**2,362,853**	**100.00%**	**1,113,729**	**100.00%**	**4,783,421**	**100.00%**	**1,236,209**	**100.00%**	**8,140,543**	**100.00%**

Note: West North Central (WNC) division is defined by the U.S. Census as: North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas and Missouri.

b) Trends

EIA recently examined how factors such as housing type, housing size, regional distribution, and weather influenced total residential energy use between 1980 and 2009 and found that changes in the number of housing units and average size of homes have led to an increase in total residential energy consumption but that energy use per square foot has generally decreased. The decrease in energy intensity is attributed to changes in regional distribution, specifically population shifts from the Northeast and Midwest to warmer regions in the South and West, as well as changes in housing type mix, specifically a shift away from single family detached homes and apartments in smaller buildings to attached single family homes and apartments in larger buildings.[110] The EIA also noted that demand for electricity grew faster than total energy consumption between 1980 and 2009, partially due to the increased penetration of household appliances that rely on electricity, such as microwave ovens, as well as computers and other electronic devices.

In addition, the U.S. Department of Energy (DOE) has identified a trend towards increasing energy efficiency in residential housing. In fact, homes built between 2000 and 2005 used 14 percent less energy per square foot than homes built in the 1980s and 40 percent less than homes built before 1950. To put it in perspective, in Missouri 20 percent of all residential buildings were constructed before the 1950s and over 60 percent were built before the 1980s. This means that there is ample potential for energy efficiency improvements in these properties that can come from the installation of more efficient technologies and products, as well as from increased adoption of building energy codes.

There is also a national trend toward larger home sizes. Specifically, single-family homes built between 2000 and 2005 are 29 percent larger on average than those built in the 1980s and 38 percent larger than those built before 1950.[111] To some extent, the greater average floor space of new homes has offset their improved efficiency in terms of energy consumption. In addition, although some appliances that are subject to federal efficiency standards, such as refrigerators and clothes washers, have become more efficient, the increased number of devices that consume energy in homes has largely offset these efficiency gains.

1.2 Commercial Building Energy Use

a) Characterization of Energy Use

In 2012, Missouri's commercial properties accounted for approximately 44.7 percent of Missouri's energy use or the equivalent of 397.6 trillion BTU of energy. Commercial buildings have high energy needs and can put great strain on Missouri's power grids during peak periods. Implementing cost-effective energy efficiency processes and technologies is a proven method of reducing spending, and making commercial buildings more efficient significantly lowers operating costs for businesses.

The type of building activity undertaken in a commercial space plays a significant role in how energy is consumed within the building. Low-energy-intensity buildings typically include warehouses, storage facilities, those used for religious worship, and those that are vacant or semi-vacant. Medical buildings and food sales and service buildings tend to contain energy-intensive end uses, such as scanning, refrigeration, and cooking, and also tend to be occupied more hours per day and more days per week. Therefore, floor space devoted to health care, food sales, and food service has high site energy intensity.

In general, space heating and cooling combined accounted for 37 percent of energy consumption within the commercial buildings sector in 2010, with lighting accounting for 14 percent of use – see Figure 33.

Site Energy Consumption by End Use

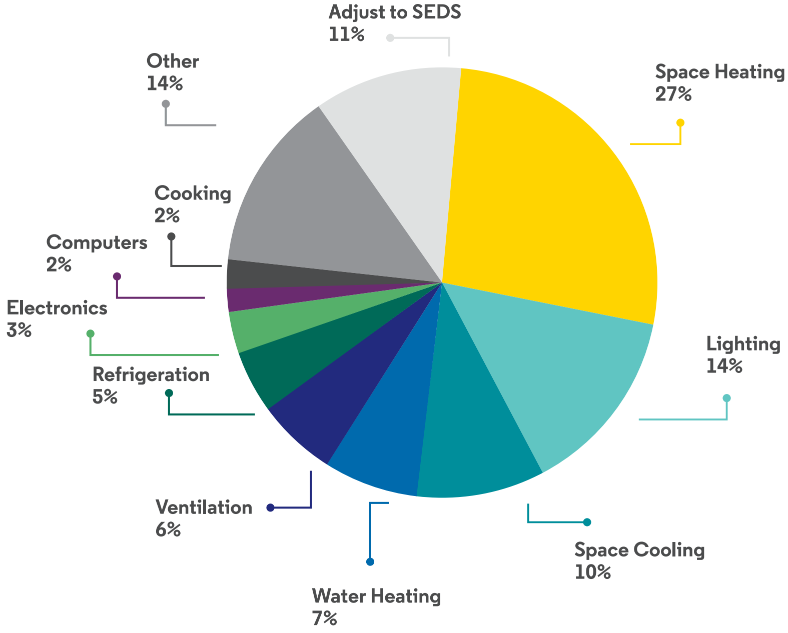


Figure 33. Commercial Building Energy Consumption by End Use, 2010.

Source: U.S. DOE "Buildings Energy Data Book," Accessed March 2015, http://buildingsdatabook.eren.doe.gov

Note: "Adjust to SEDS" represents an energy adjustment that the EIA uses to relieve discrepancies between data sources. it represents energy attributable to the commercial buildings sector, but not directly to any specific end uses.

b) Energy Use Intensity Benchmarking

Benchmarking the energy performance of buildings represents a key first step to understanding how energy is used and potentially reducing building energy consumption. In the late 1990s, the U.S. Environmental Protection Agency (EPA) created an online tool, the ENERGY STAR Portfolio Manager®, which can be used to measure and track energy and other key performance indicators for either a single building or a collection of commercial properties. The Portfolio Manager tool is now a comprehensive platform that contained information for nearly 40 percent of the commercial building market in the United States as of 2011.[112]

To benchmark buildings the Portfolio Manager uses a metric called energy use intensity (EUI). Essentially, the EUI expresses a building's energy use as a function of area and time per year, usually in BTU per square foot per year. This metric serves as a good point of comparison both between individual buildings and similar buildings within a category, as well as for a specific building's energy use through different points in time. The information shown in Figure 34 gives an enhanced national perspective of energy use intensity within different building types.

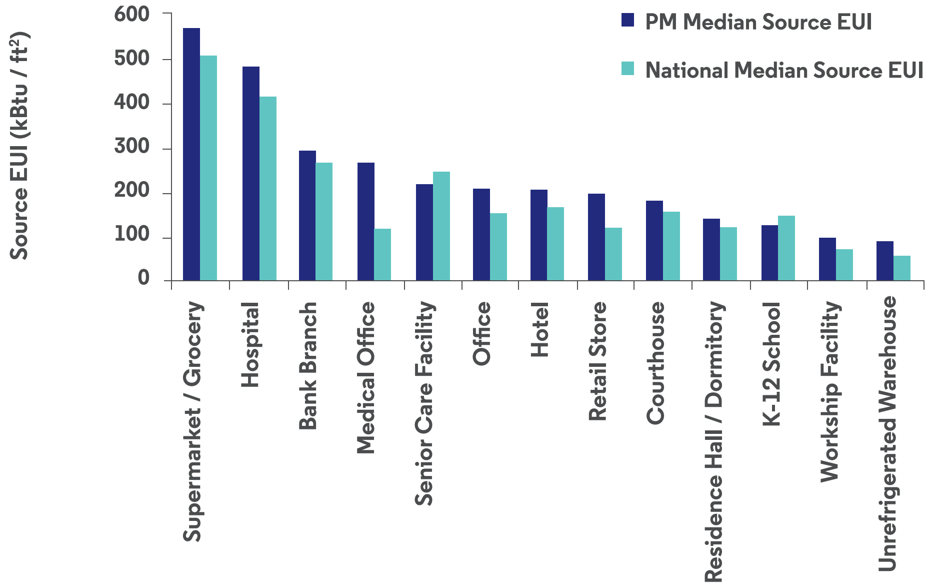


Figure 34. Typical National Energy Use Intensity Values for Different Building Types.

Source: U.S. Environmental Protection Agency (EPA) "ENERGY STAR Portfolio Manager," Accessed February 2015. http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/what-energy

Note: PM Median Source EUI: Represents the median value for source energy use intensity for over 100,000 buildings benchmarked in Portfolio Manager between 2006 and 2012.
National Median Source EUI: Represents the median value for source energy use intensity derived from the DOE's nationally representative Commercial Building Energy Consumption Survey, which forms the basis of most of the ENERGY STAR energy performance scales.

In addition to voluntary benchmarking, some cities around the country have issued benchmarking ordinances requiring that buildings with energy use over a certain amount disclose their use and other key metrics. Benchmarking ordinances are rare in Missouri and only implemented by a few cities. For instance, Kansas City has a voluntary benchmarking program, called the Mayor's Energy Challenge.

c) Trends

Just as in the residential sector, recently built commercial buildings tend to be larger than older buildings. For example, the average size of buildings constructed before 1960 is 12,000 square feet; buildings constructed between 1960 and 1999 average 16,300 square feet; and buildings constructed in the 2000s average 19,100 square feet.[113]

EIA expects that energy intensity of new buildings will decrease 0.4 percent per year through 2040 due to stronger building and energy codes, efficiencies in building operations, and more efficient systems and equipment.

2. Energy Efficiency

For several years conversations about energy use in the United States have included a discussion of relying on energy efficiency as a resource for meeting some of the nation's growing energy demand. In essence, energy efficiency allows users to meet their energy needs by using less energy for the same activity. In this way, energy efficiency saves money and reduces the environmental impacts of the energy production system.

Energy efficiency is a low-cost energy resource and investing in efficiency can provide economic opportunities in all sectors of the economy. Investment in energy efficiency not only saves money for businesses by controlling costs and improving the bottom line but also helps spur the economy. Analyses of California, Ohio, and most of the northeastern states have found economy-wide benefits to energy efficiency investment in part because consumers and businesses spend the money they saved on other goods and services.[114]

National estimates show that energy efficiency improvements cost only a fraction of new energy supply, whether electric or natural gas, and even with the relatively low prices in the state, energy efficiency can be a critical resource to foster a secure and sustainable energy future for Missouri. Furthermore, energy efficiency provides numerous benefits to consumers, utilities, and to society as a whole that go beyond the avoided costs of additional generation, transmission and distribution. Benefits include reductions in water usage, reduced air emissions, job creation, and public welfare. Some of these benefits include[115]:

Utilities

- Avoided costs associated with reduced production, transmission, and distribution
- Avoided costs of compliance with environmental regulations
- Minimizing reserve requirements
- Decreased risk
- Reduced credit and collection costs

Customers

- Reduced energy bills
- Operation and maintenance cost savings
- Participant health impacts
- Increased employee productivity
- Effect on property values
- Improved comfort

Society

- Public health and welfare benefits
- Air quality impacts
- Water quality impacts
- Decrease in coal ash ponds and coal combustion residuals
- Improved economic development
- Job creation
- Increased energy security
- Benefits for low-income customers

Kansas City Energy Initiative
Kansas City, 2014

The Greater Kansas City Chamber of Commerce, the city of Kansas City, and KCP&L partnered in 2014 to create the Kansas City Energy Initiative, a program targeting an energy usage reduction in Kansas City of 5 percent by 2030. The goal is to make the area a leader in the nation for energy efficiency.

The initiative helps building owners save energy with more efficient lights, equipment upgrades, heating and cooling monitoring systems, and other improvements. Additionally, KCP&L is increasing its rebate cap from $50,000 to $250,000 for commercial customers who make energy efficiency improvements in their buildings. The initiative expects the program to expand to surrounding areas and become a bi-state effort between Missouri and Kansas in 2015.

Much work has been done to identify and quantify some of these non-energy benefits in economic terms. Best practices recommend that these non-energy benefits be considered in cost-effectiveness tests used by public service commissions and utilities to screen technologies for inclusion in energy efficiency programs. This type of benefit can often be the difference in justifying costs of energy efficiency and demand-side management programs. For example, an analysis for Xcel Energy in the state of Colorado found that the utility's low-income programs were more valuable because of their benefits for health, economic development, and financial savings than they were because of the energy saved and bill reductions for customers.[116]

Benefits, however, are only one part of the equation, as there are clear costs associated with the implementation of energy efficiency and demand-side management programs. Some costs are borne by program administrators in managing, reporting, marketing and implementing these programs as well as the actual financial incentive provided to participants. Other costs are borne by ratepayers and participants including their portion of costs associated with energy efficiency measures.

A 2014 report by the American Council for an Energy-Efficient Economy (ACEEE) found that energy efficiency is the least-cost method of providing Americans with electricity. According to the report, energy efficiency programs aimed at reducing energy waste cost utilities on average 2.8 cents per kWh - about one-half to one-third of the cost of new supply-side options.

In Missouri, the retail average price of electricity increased 51.3 percent for the residential sector, 49.7 percent for the commercial sector, and 41.0 percent for the industrial sector from 2001 through the end of 2014.[117] In addition, at the national level EIA forecasts that electricity prices will continue to grow and will increase by approximately 13 percent from 2012 to 2040.[118] To manage similar increases, some states are placing more emphasis on energy efficiency and implementing policies such as Energy Efficiency Resource Standards (EERS), building codes, and building ordinances that result in a better use of electricity and natural gas resources.

The sections that follow describe how the federal, state, and private sectors promote energy efficiency, with a focus on Missouri activities.

2.1 Federal Initiatives

National policies to improve energy efficiency can improve energy security, save consumers money, create jobs, and benefit the environment through reduced air pollution. Policies instituted at the federal level have the advantage of scale. Federal energy policy can take various forms: from tax credits for individuals and corporations to loan programs, appliance and vehicle efficiency standards, and energy goals for federal public buildings. Some of the most relevant energy efficiency federal policies include:

- **Energy Policy Act of 2005:** established several goals and standards to reduce energy use in existing and new federal buildings.
- **Energy Independence and Security Act of 2007:** extended an existing federal energy reduction goal to 30 percent by fiscal year 2015; directed federal agencies to purchase ENERGY STAR and Federal Energy Management Program-designated products; and required new federal buildings to be built 30 percent below ASHRAE standards or the International Energy Conservation Code.

Federal agencies such as the DOE and EPA provide essential nationwide energy efficiency programs, technical assistance, education, and information to consumers. Programs managed by these agencies include:

- **ENERGY STAR:** an EPA voluntary program established in 1992 that identifies and promotes energy–efficient products and buildings through voluntary labeling of products and buildings that meet the highest energy efficiency standards. In Missouri, as a means of incentivizing the purchase of ENERGY STAR appliances, every year there is a one-week period where certified new appliances are exempt from state sales tax. Called the Show-Me Green Sales Tax Holiday, local jurisdictions can choose whether they want to participate in this program.

- **State Energy Program:** Managed by DOE, the program provides funding and technical assistance to state and territory energy offices to help them advance their clean energy economy while contributing to national energy goals.

- **Weatherization Assistance Program:** Since 1976 the program provides grants to states, territories, and some Native American tribes to improve the energy efficiency of the homes of low-income families. These governments, in turn, contract with local governments and nonprofit agencies to provide weatherization services to those in need using the latest technologies for home energy upgrades.

- **Energy Efficiency and Conservation Block Grant (EECBG):** Through the 2009 American Recovery and Reinvestment Act, the EECBG program managed by DOE provided $3.2 billion in grants to cities, communities, states, U.S. territories, and Indian tribes to develop, promote, implement, and manage energy efficiency and conservation projects that ultimately created jobs.[119]

State Buildings' 2% Annual Reduction on Energy Consumption
2009-Present

In April of 2014 Missouri state agencies were ahead of target for reducing energy usage, at an annualized decrease of 4.45 percent, double that of the 2 percent goal identified in Executive Order 09-18.

In a comparison between calendar years 2012 and 2008, electric usage was reduced by approximately 13.6% (or 49,184,396 kWh), and gas usage was reduced by 33.49% (or 616,818 MBTU).

In order to achieve these reductions, efforts included adjusting thermostats to save energy, retro-commissioning heating, ventilation, and air conditioning systems, automating systems to eliminate simultaneous heating and cooling and ensure equipment operation is aligned with building occupancy, and applying for incentives offered by utility companies to make upgrades.

2.2 State Initiatives

State governments usually influence energy efficiency through the establishment of building codes, mandated programs for public buildings, state-level tax credits and incentives, and the establishment of specific long-term energy reduction targets through Energy Efficiency Portfolio Standards that apply to energy savings that utilities must meet through customer energy efficiency programs.

Missouri has taken steps to improve efficiency in government-owned facilities through a number of executive orders and legislative actions that include:

- Senate Bill 1181 (2008): required the Department of Natural Resources to establish energy savings standards for state buildings at least as stringent as the 2006 International Energy Conservation Code (IECC) by January 1, 2009. The standard applies equally to state-owned and state-leased buildings over 5,000 sq. ft. for which the design process or the lease began after July 1, 2009.

- Executive Order 09-18 (2009): requires that state agencies whose buildings are managed by the Office of Administration adopt policies to reduce energy consumption by two percent each year for 10 years. Additionally, the order requires that all new construction projects by agencies whose buildings are managed by the Office of Administration must be at least as stringent as the most recent IECC. In response to the Executive Order, the Office of Administration, Division of Facilities Management, Design and Construction developed and adopted a State Building Energy Efficiency Design Standard.

Our state has also developed energy efficiency programs separate from those offered by utilities. For example, the state received funding through the American Recovery and Reinvestment Act of 2009 that was used for a variety of initiatives marketed under the umbrella name of Energize Missouri and that targeted the residential, commercial, agricultural, and public sectors. The Energize Missouri programs were implemented through the Division of Energy and resulted in 167 million kWh of savings and over $15 million in energy efficiency grants awarded to individuals and businesses across the state. In addition, over $11 million was provided to 62 counties and municipalities for implementation of projects at government-owned buildings that resulted in a 49.4 million kWh annual savings.

Missouri's Home Energy Certification Program
Statewide, 2015

On February 20, 2015, Governor Jay Nixon announced the Missouri Home Energy Certification (MHEC) program, which encourages Missourians to reduce energy usage by making improvements or upgrades to their homes. MHEC is a voluntary program designed to promote energy efficient homes through clear and meaningful recognition. It is intended to help homeowners convey the invested value of the energy efficient features of their home to potential buyers, and recent research suggests that third-party green certifications may help homes sell faster or for a premium.

Both new and existing single-family homes in Missouri are eligible for MHEC program. An eligible home can achieve one of two levels of certification under this program: Gold level or Silver level.

Common home energy improvements include measures such as air sealing and installing insulation in attics and walls.

Examples of additional programs offered by the Division of Energy include the Missouri Energy Loan Program, which provides loan financing for public schools, public and private colleges and universities, city and county governments, public water and wastewater treatment facilities, and public and private not-for-profit hospitals. Another example is the Missouri Home Energy Certification Program, which encourages Missourians to reduce energy usage by making improvements or upgrades to their homes.

Although not detailed in this section, local governments play a significant role in driving energy efficiency initiatives and have put in place both ordinances and programs that focus on improving energy efficiency in their communities.

a) Utility Energy Efficiency Programs

The concept of demand-side management (DSM) was introduced in the 1980s in the electricity industry to refer to a set of programs that allows customers to reduce their energy consumption and shift their own demand for electricity during peak periods. DSM programs include two principal activities: energy efficiency programs and demand response programs or 'load shifting'. By the turn of the millennium, these programs were on the rise nationwide, driven by the development of integrated resource planning for utilities, which evaluates demand-side resources (energy efficiency and demand response programs) on an equivalent basis with supply-side resources, the implementation of Energy Efficiency Portfolio Standards, the development of funding mechanisms such as public benefits charges, and public concerns around energy availability, prices, and system capacity. Energy efficiency programs can focus on electric and or natural gas savings. Currently, all 50 states and the District of Columbia offer energy efficiency programs for a variety of customer sectors.

Some energy efficiency programs require the evaluation, measurement, and verification (EM&V) of tracked energy savings as an approach to ensure that energy savings claimed are accurate and that they are being delivered in the most cost-effective manner. EM&V can also create a documented record of success that encourages additional investment in the future. Several ongoing national efforts aim at standardizing EM&V approaches. In addition, other efforts focus on developing common frameworks to determine the amount of energy savings associated with a certain technology or measure, such as lighting, boilers, furnaces, or air conditioning units. These frameworks, called technical reference manuals, are typically developed at the state level in a collaborative manner by utilities and government and list standard energy efficiency values for certain measures, or approved formulas for calculating these savings. Of significance for Missouri is the fact that the state does not currently have a technical reference manual that standardizes the energy savings and calculation methods associated with individual measures across all utilities.

Energy efficiency programs typically focus on promoting and incentivizing only the purchase and installation of measures that are deemed cost-effective. Cost-effectiveness is a ratio that compares the benefits and costs associated with the implementation of an energy efficiency measure. If the benefits are greater than the costs, then the measure is considered cost-effective. At the national level, there are standardized formulas that assist in calculating cost-effectiveness; however, jurisdictions tend to adapt these formulas to include certain costs and non-energy benefits that may be relevant to them. The inclusion or exclusion of these non-energy benefits can change the results of a cost-effectiveness test.

Every year the ACEEE publishes a State Energy Efficiency Scorecard that evaluates and ranks states on different attributes related to energy efficiency, including policy and program efforts. The scorecard provides an annual benchmark of the progress of state energy efficiency policies and programs. In the 2014 edition of the scorecard, Missouri was ranked 44th in the nation.

According to the 2014 Scorecard, Missouri utilities' 2013 budgets for energy efficiency programs were approximately $48.2 million for electric efficiency, representing 0.65 percent of statewide electric utility revenues, and $9.1 million for natural gas efficiency. To put it in perspective, in that same year electric utilities in 30 states spent over one percent of their revenues on electric efficiency programs and, of those, 16 states spent over two percent. Based on its review of state energy efficiency policies, ACEEE has found that by far the most effective state policy in producing efficiency savings by utilities has been the EERS, through which states set an energy savings target for utilities to meet. In terms of other policies that are available, ACEEE ranks decoupling as the next most effective. States with decoupling were found to achieve higher savings because decoupling effectively addresses the throughput disincentive. The best-performing states with the highest levels of energy savings tend to have a strong EERS in combination with a strong decoupling policy to assist utilities in better adapting the business model to accomplish the target savings associated with an EERS.[120] Table 15 shows that there is room for Missouri to invest more funds in energy efficiency and achieve greater levels of savings. It is important to mention that in 2013, program efforts as a result of the Missouri Energy Efficiency Investment Act (MEEIA) were just beginning to ramp up, and therefore results are not reflected in ACEEE's 2014 Energy Scorecard. If Missouri's electric utilities continue to increase their efforts, it is expected that Missouri's overall ranking will improve in the coming years. The 2015 Scorecard should be released in October 2015, and the score is based on an evaluation of data, activities, and achievements that occurred during the 2014 calendar year.

Table 15. Comparison of States' Energy Efficiency Programs Budget and Net Incremental Savings, 2013.

Source: Annie Gilleo et al. "2014 State Energy Efficiency Scorecard," American Council for an Energy-Efficient Economy (ACEEE), U1408, October 22, 2014. Table 14 and Table 16.

	Budgets for Electricity Efficiency Programs		Budgets for Natural Gas Efficiency Programs		Net Incremental Savings* from Electricity Efficiency		Net Incremental Savings* from Natural Gas Efficiency	
State	2013 Budget ($million)	% of Statewide Utility	2013 Budget ($million)	$ Per Residential Customer	2012 Net Incremental Savings	% of Retail Sales	2012 Net Incremental Savings	% of Retail Sales ***
Missouri	48.2	0.65%	9.1	6.56	406,897	0.49%	-	-
Illinois	283.8	2.51%	98.9	26.25	1,318,916	0.99%	29.3	0.52%
Iowa	106.7	2.83%	50.6	59.71	491,543	1.06%	7.92	0.78%
Kansas	0.7	0.02%	0	0.00	8,907****	0.02%	-	-
United States Median	43.4	1.09%	4.0	9.00	219,612	0.56%	-	-

**Net incremental savings represent new savings from programs in each program cycle, without accounting for savings accrued over the life of a particular program. In addition, they have been adjusted to account for freerider and spillover effects.*
***States that did not provide natural gas savings data were treated by ACEEE as having no 2013 savings.*
****Sales include only those attributed to commercial and residential sectors.*
*****Savings reported are for 2012.*

In 2011, with the objective of investigating the potential for energy efficiency in Missouri, ACEEE published a report titled Missouri's Energy Efficiency Potential: Opportunities For Economic Growth and Energy Sustainability. According to this report, studies of Missouri and the Midwest between 2008 and 2011 showed that annual electricity savings between approximately 1.4 to 2.5 percent per year are economically achievable– see Figure 35.

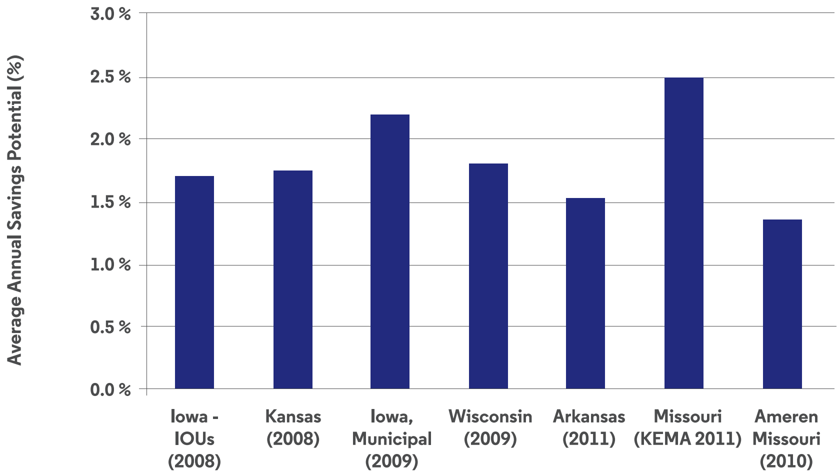


Figure 35. Economic Potential Results for Electricity Efficiency in Missouri and the Midwest.

Source: Maggie Molina et al. "Missouri's Energy Efficiency Potential: Opportunities For Economic Growth And Energy Sustainability," ACEEE, E114, August 24, 2011.
http://aceee.org/sites/default/files/publications/researchreports/e114.pdf

b) The Missouri Energy Efficiency Investment Act

Operating under long-standing requirements for Integrated Resource Planning and other agreements surrounding new generation, most utilities in Missouri have offered energy efficiency programs to electric and natural gas customers. However, spending levels had historically not been significant and therefore the level of energy savings had also been relatively low.

In 2009, the Missouri Energy Efficiency Investment Act was passed and signed into law to boost investments in electric energy efficiency, thereby saving utilities and utility customers money, creating jobs, and improving environmental quality. MEEIA directs the Missouri Public Service Commission (PSC) to permit investor-owned electric utilities (IOUs) to implement commission-approved programs with a goal of achieving all cost-effective demand-side energy savings. In order to be approved by the PSC, proposed energy efficiency programs must be deemed cost-effective, with the exception of programs targeting low-income customers or general education.

In essence, MEEIA creates a voluntary mechanism through which utilities may elect to implement DSM programs and propose performance incentives that are based on the net-shared benefits resulting from the programs they implement. MEEIA also provides for timely recovery of DSM program costs by allowing adjustments to the funds collected between rate cases.

Provisions of MEEIA allow a customer to opt out of all cost-recovery mechanism charges if it has had a demand of at least 5,000 kW in the previous twelve months. A customer with a demand of at least 2,500 kW may opt out if it is an interstate pumping station of any size, or if it demonstrates that it has a comprehensive energy efficiency program in place that is saving an amount of electricity at least equal to the savings expected from utility-provided programs. Customers that opt out are required to submit their plan to the PSC for review.

As a result of MEEIA, in 2012 Ameren Missouri and KCP&L GMO ramped up energy efficiency efforts and initiated a variety of customer energy efficiency programs targeted at both the residential and non-residential sectors. In addition, in the summer of 2014, KCP&L received approval on a plan that would double its early energy efficiency efforts and result in over 103 GWh of savings.[121] In the fall of 2013, the state's other electric IOU, Empire District Electric Co., filed a request with the PSC to implement a portfolio of programs under MEEIA; however, in July 2015 Empire requested to withdraw its application.

Although not covered under MEEIA, several municipal utilities and electric cooperatives also have offered and continue to offer energy efficiency programs to their customers. For example, City Utilities of Springfield, the largest municipal utility in the state, offers incentives for commercial and residential customers to conduct retrofits of technologies and conduct energy audits. Columbia Water and Light, another large municipal utility, identified energy efficiency as the least-cost power supply option in its 2008 Integrated Resource Plan, and its 2013 update shows that DSM programs resulted in 7.6 GWh of energy saved in 2012.[122]

Similarly, natural gas utilities such as Liberty, Ameren Gas, Missouri Gas Energy, and Laclede Gas, offer energy efficiency programs for different customer types to cover the cost of installation of efficient furnaces, boilers, and water heaters.

2.3 Private Sector Initiatives

In addition to government-mandated initiatives and requirements for public buildings and utility energy efficiency programs, the private sector has made considerable strides in undertaking voluntary initiatives both at the residential and non-residential level.

a) Non-Residential Energy Efficiency

Reasons why businesses decide to participate in voluntary programs can range from a need to reduce expenditures related to energy use and other operating costs, to alignment with corporate social responsibility or sustainability strategies. Missouri businesses have shown a commitment to these initiatives and have long participated in several efforts. Some of the initiatives that Missouri businesses participate in are listed in Appendix E – Private Energy Efficiency Initiatives in Missouri and briefly summarized below:

- Conducting energy audits or energy efficiency projects to reduce operating costs;
- Development of corporate strategic goals and sustainability plans to operate companies in a more environmentally and socially responsible manner;
- Participation in ENERGY STAR Portfolio Manager for benchmarking purposes;
- Participation in the ENERGY STAR Pledge campaign by which partners pledge to take certain actions related to lighting, electronics, appliances and water heaters, heating and cooling, and sealing/insulating.
- Design and operation of buildings under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification for sustainable buildings.
- Design and construction of zero net energy buildings. These buildings are defined by the New Buildings Institute as "buildings with greatly reduced energy load such that, averaged over a year, 100 percent of the building's energy use can be met with onsite renewable energy technologies."[123] There is a recently built certified net zero building located in Eureka with a square footage of 2,968.[124]

Missouri Baseball Solar Energy
Kansas City and St. Louis,
2012

In 2012 Busch Stadium, the home of the St. Louis Cardinals, added 106 solar panels producing approximately 32,000 kilowatt hours of solar energy per year. The solar installation powers food and beverage stands as well as retail shops which could all be powered from these panels.

That same year, the Kansas City Royals installed solar panels at Kaufmann Stadium, creating the largest in-stadium solar array in Major League Baseball. The 28.8 kW solar array is comprised of 120 panels and generates approximately 36,000 kWh of electricity each year, enough to cook three million hotdogs. In addition to the solar panels, the stadium underwent a significant renovation that brought many systems up to date and focused on efficiency and tracking of energy and water usage. The added technology has significantly reduced energy use. In the first year, energy use dropped 15 percent, and by the second year it dropped an additional eight percent.

In addition to these ongoing efforts that are focused on whole-building approaches, there are other energy efficiency opportunities that the private sector should consider to improve the performance of their buildings and reduce costs associated with energy consumption. For instance, commercial buildings can put strain on the power grid during peak periods, and implementing cost-effective energy efficiency processes and technologies such as retro-commissioning helps them become more energy efficient and significantly lowers operating costs for businesses. Two other opportunities that are worth discussing in more detail include combined heat and power (CHP) systems and geothermal or ground source heat pump (GSHP) systems.

CHP systems are integrated energy systems that provide on-site generation of electrical or mechanical power and waste-heat recovery that can be used for heating, cooling, dehumidification, or process applications at industrial or some commercial facilities. CHP can be classified as a form of distributed generation. CHP's higher efficiency comes from recovering the heat normally lost in power generation or industrial processes to provide heating or cooling on site, or to generate additional electricity. In addition, CHP has inherent higher efficiency by eliminating transmission and distribution losses.

DOE estimates that 20 to 50 percent of industrial energy input is lost as waste heat, and recovering those losses would provide an opportunity for a new energy resource.[125] When sized and operated correctly, a CHP system can provide the electricity and thermal energy at fuel-use efficiencies in the 70 to 85 percent range compared to 45 percent and 55 percent when the electricity and thermal energy are produced and delivered separately.[126] For the private sector CHP systems can provide significant financial savings on fuel costs used to provide electricity and heat. In addition they can provide a stable supply of electrical power that, if needed, can be isolated from the local electricity grid. CHP systems can result in higher efficiencies, lower energy costs, increased business competitiveness, reduced greenhouse gas emissions, and enhanced opportunities for energy resilience.[127]

DOE's Midwest CHP Technical Assistance Partnership found that Missouri has a technical potential of over 2,500 MW of CHP. The analysis indicated that commercial buildings have the highest technical potential for CHP in Missouri because of the large number of buildings and diverse building stock. Other market sectors such as chemicals, food processing, colleges and universities, hospitals, and the pulp and paper industry are also

University of Missouri Hybrid Ground Source Heat Pump/ Waste Heat Recovery

Sponsored by the U.S. Department of Energy, researchers and engineers at the University of Missouri are developing and evaluating a waste heat recovery (WHR) assisted ground source heat pump (GSHP) system in a broiler farm in Hughesville, a turkey farm in Bunceton, and a turkey farm in Northfield MN. Recovering waste heat from high temperature ventilation exhaust is one of the most economical ways to reduce heating fuel cost. This hybrid GSHP system can reduce the energy cost by 55 percent compared to propane heating, making these systems affordable with investment return periods of three to seven years depending on several variables. In addition, the GSHP system reduces the moisture content of the air in the barn, reduces harmful gas generation and could improve poultry production and food quality through fewer antibiotics to maintain bird health. A new GSHP manufacturing facility is scheduled to start in 2015 in Boonville, a rural area experiencing high unemployment.

good candidates for CHP because of high-energy demands and long hours of operation.[128] Interconnection with the grid was cited as one of the biggest challenges to CHP deployment in Missouri due to lack of interconnection standards and lack of restrictions on standby rates.[129] In addition, some states include CHP as an eligible technology under their energy efficiency resource standards or renewable energy standards to facilitate development of CHP projects. Neither Missouri's MEEIA nor RES explicitly identify CHP as eligible.

Ground source heat pumps are another technology that provides benefits to commercial or residential buildings. These are electrically powered systems that use the earth's relatively constant temperature to provide heating, cooling, and hot water for buildings. This allows the system to reach efficiencies of 300 percent or more, compared to a traditional air source heat pump.[130] There are different types of GSHPs including open and closed loops in vertical and horizontal structures. The type of GSHP is chosen depending on the available land areas and the soil and rock type at the installation site.

GSHPs are appropriate for new construction as well as retrofits of older commercial buildings and residential properties. These systems are highly durable and assist in energy conservation while having low operating and maintenance costs.

b) Residential Energy Efficiency

By undertaking initiatives to improve the energy efficiency of their homes, Missourians can benefit from improved comfort in their properties, as well as reduced energy bills. This can be done by replacing inefficient technologies with more efficient products, taking steps to better insulate their properties, or modifying their behaviors to use energy more efficiently. A home energy assessment or audit can help homeowners determine which purchases and improvements will save them money and energy.

Columbia, Missouri's Net Zero House
Columbia, 2015

Show-Me-Central Habitat for Humanity, along with a coalition of groups, completed the first net-zero house in Columbia in early 2015.

The house uses 32 solar panels to generate electricity, as well as one 4-foot by 10-foot solar thermal panel to heat water. There are many energy efficient installations in the house in order to keep energy usage down. Four inches of rigid foam lie beneath the home's slab foundation to keep cold air from seeping in through the bottom of the house. Tight sealing doors and triple-pane windows help keep the house insulated. Additionally, mini-split system units controlled by remote are used to efficiently heat and cool the house. Finally, the house exclusively uses LED lights except one bathroom light, all of which are entirely solar powered.

Missourians have the option of taking advantage of utility rebates and government programs that promote energy efficiency. One such program is ENERGY STAR, a voluntary program established by the EPA in 1992 that sets standards for energy efficient consumer products. Products that meet the program requirements are labeled with the ENERGY STAR service mark, signaling consumers that the product is more energy efficient than other non-labeled alternatives. ENERGY STAR products are sold across Missouri and include equipment such as lighting, home electronics, computers, and heating and cooling systems.

Given that most of the energy consumed in a residential property is used for space heating and cooling, significant benefits can result from replacing inefficient systems in this category with more efficient ones. As an option, ground source heat pumps provide a very economic alternative to electric and fossil fuel powered heating, ventilation and air conditioning systems. Even though the installation price of a GSHP can be several times that of an air-source system of the same heating and cooling capacity, the systems have a documented payback rate of five to ten years, and system life is estimated at 25 years for the inside components and over 50 years for the ground loop.[131]

Geothermal conditions in Missouri are permissive for both residential and commercial use of these systems; however, the systems are currently underutilized in the state. For residents interested in installing a GSHP system, several electric cooperatives offer a rebate for the installation of the unit, and a federal tax credit is also available until December 2016.[132] In addition, a law requires that all GSHP dealers in Missouri be certified by the Department of Natural Resources or be operating under a certified contractor to install certain outdoor loop configurations.

2.4 Water-Energy Nexus

Significant amounts of energy are required in the treatment of water and wastewater and its delivery and distribution. Water and wastewater utilities are typically the largest consumers of energy in municipalities, often accounting for 30 to 40 percent of total energy consumed.[133] As such, the linkage between water and energy and efforts to increase efficiencies in water treatment, transportation, and usage by residents and businesses requires special attention.

Missouri has 2,722 water treatment systems that are regulated by the Missouri Department of Natural Resources (MDNR). Of these, 1,433 are community-run systems, and the remaining systems are either transient or non-transient, non-community systems. As shown in Table 16 the vast majority of these systems use groundwater as a primary source, 61 systems use surface water as a primary source, and the rest use a mix of surface water and groundwater.

Table 16. Missouri Community Water Treatment Systems and Population Served, 2015.

Source: Missouri Department of Natural Resources, "Census of Missouri Public Water Systems," January 26, 2015, http://dnr.mo.gov/env/wpp/pdwb/docs/2015-census.pdf

Water Source	Total # of Systems	Total Population Served
Primary Groundwater	1,062	1,813,992
Systems Using Groundwater	1,058	1,796,667
Systems Using Groundwater under Direct Influence	4	17,325
Primary Surface Water	61	2,462,333
Systems Using Surface Water-Streams	61	2,462,333
Secondary	310	1,072,623
Secondary System Using Groundwater	152	183,604
Secondary System Using Groundwater under Direct Influence	2	15,068
Secondary System Using Surface Water	156	873,951
Grand Total	**1,433**	**5,348,948**

Across the U.S., four percent of power generation is used for water supply and wastewater treatment,[134] and electricity costs represent approximately 80 percent of municipal water processing and distribution costs.[135] Given these issues, a variety of strategies and tactics are being proposed to increase efficiency at water treatment facilities through the installation of more efficient pumps, motors, and other equipment.

MDNR administers the State Revolving Fund (SRF) that provides low-interest loans to public water and sewer districts and political subdivisions for wastewater and drinking water infrastructure projects. The fund is capitalized with federal funding from EPA and was authorized by the federal Clean Water Act. In 2009 a Green Project Reserve (GPR) became a provision of the SRF as a result of the American Recovery and Reinvestment Act. Since then certain federal capitalization grants have required that a portion of the SRF funds address sustainable green infrastructure, water efficiency, energy efficiency, or other environmentally innovative solutions.[viii] While this is an important step and should continue to be implemented even if no longer required by EPA, more can be done through prioritizing projects or giving credit for projects that meet the GPR criteria in MDNR's funding allocation formula.

Minimum energy efficiency standards for applicable projects that include equipment, motors, and systems funded by the SRF are also an effective way to increase the energy efficiency of the energy-intensive processes of delivering water and wastewater. Establishing a minimum standard for efficiency would ensure that federal and state funds are being maximized and are achieving the greatest possible benefits of reducing operating energy costs, assuring more efficient use of water supplies. Identifying opportunities to combine and fully utilize existing funding streams for water and wastewater infrastructure, such as the Division of Energy's Energy Revolving Loan program, would also allow for more energy and water efficiency or green projects and bring all available resources to the table.

In addition to improvements at treatment plants, water distribution systems also present a significant opportunity for water savings. Clean water is transported from treatment plants to homes through a vast network of pipes. Leakage that occurs during that transportation process not only results in the loss of purified drinking water but also means wasting the energy and material resources used in abstraction, transportation, and treatment. According to the EPA, the average water distribution system will leak over 16 percent of the water it transports every year.[136]

End-use water efficiency is also seen as a way to capture energy savings. Promoting the efficient use of water by consumers, including water for domestic uses such as showers and laundry and water for watering and other outdoor purposes, is critical to ensuring that end use is appropriate. Water that is wasted is not only an ill-spent resource, but it is also a waste of significant resources in the form of the energy used to treat and pump the water, as well as a waste of water treatment chemicals and products to make the water potable. A study conducted by the California Energy Commission found that energy consumption associated with water end use is greater than the energy required for the supply and treatment of water.[137]

[viii]This requirement ended for drinking water projects in 2012 but continues for wastewater projects, where there is still a requirement of 10 percent under EPA provisions of the Green Water Reserve which states that "not less than 10 percent of the funds made available under this title to each State for Clean Water State Revolving Fund capitalization grants shall be used by the State for projects to address green infrastructure, water or energy efficiency improvements, or other environmentally innovative activities"(Public Law 112-74).

2.5 Energy Efficiency Education

In addition to programs and initiatives to improve energy efficiency in buildings, governments, utilities and nonprofits can promote energy efficiency education and deliver consumer awareness programs. The goal of these programs is to educate residents and businesses on the multiple benefits of energy efficiency and building practices that support these principles. In addition, programs can be focused on developing behavior-based energy conservation, such as turning lights off or setting thermostats at appropriate levels.

In Missouri several organizations and utilities have implemented education programs: from K-12 initiatives that incorporate energy efficiency into student curricula, to awareness programs at the community level and training sessions focused on building capacity.

3. Building Codes

Energy codes that provide minimum requirements for efficient design and construction for new and renovated residential and commercial buildings are important for both economic and environmental reasons. Buildings constructed to meet the model energy codes use less energy, which reduces utility bills and puts money back into consumers' pockets. Money not spent on energy bills boosts the economy as consumers and businesses can reinvest in other goods and services.

Every state has its own process for enacting energy codes. In 41 states, codes are enacted at the state government level, whereas in other states, municipalities, counties, or other units of local government have the power to act without prior authorization by the state legislature.[138] This is called home rule, and since Missouri is a home-rule state, there is no mandatory or voluntary statewide energy code for private residential and commercial construction.

Energy Projects at Water and Wastewater Facilities
Pulaski County, 2013

Partnering with the Division of Energy, the Missouri Rural Water Association designed and implemented the Energy Efficiency for Water and Wastewater Operations Training Project that included demonstration energy audits and training at ten locations across the state. The objective was to help water and wastewater personnel identify energy savings opportunities and implement energy efficiency and conservation measures at the facilities they operated. The training included audit and energy management system information, case studies, and software and audit demonstrations. A total of 178 water and wastewater staff attended the training.

The following are examples of projects to reduce energy use at water and wastewater facilities:

Pulaski County Sewer District, because of its topography, constructed lift stations to move wastewater from lower to higher elevations. Utilizing the Division of Energy's Energy Loan Program, the district replaced inefficient pumps at six lift stations with new design pumps proven to be more efficient, resulting in expected savings of approximately 162,466 kWh or $11,211 annually.

The City of Harrisonville's wastewater treatment facility serves 10,000 residents in Harrisonville. Equipment for aeration basins included four

In the United States, the most widely accepted energy codes are written by the International Code Council (ICC) and ASHRAE.

The ICC is a non-profit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes and standards used in the design, build, and compliance process to construct structures. The ICC publishes the International Energy Conservation Code (IECC), which establishes baselines for residential and commercial development and operations. The IECC contains separate provisions for commercial and low-rise residential buildings that are three stories or less in height above grade and addresses the design of energy-efficient building envelopes and installation of energy-efficient mechanical, lighting, and power systems through requirements emphasizing performance.[139] The IECC is updated every three years.

In addition to the IECC, the ASHRAE Energy Standard for Buildings except Low-Rise Residential Buildings (Standard 90.1) provides minimum energy efficiency requirements for the design and construction, and a plan for operation and maintenance of buildings and their systems.[140] The standard does not apply to residential buildings that are less than three stories above grade. The ASHRAE Standard 90.1 is also updated every three years.

The most recently published versions of the IECC and ASHRAE codes are the 2015 IECC and the ASHRAE 90.1-2013. Although the 2015 IECC was published in 2014, many states are just now adopting the 2012 IECC code.

3.1 Building Codes in Missouri

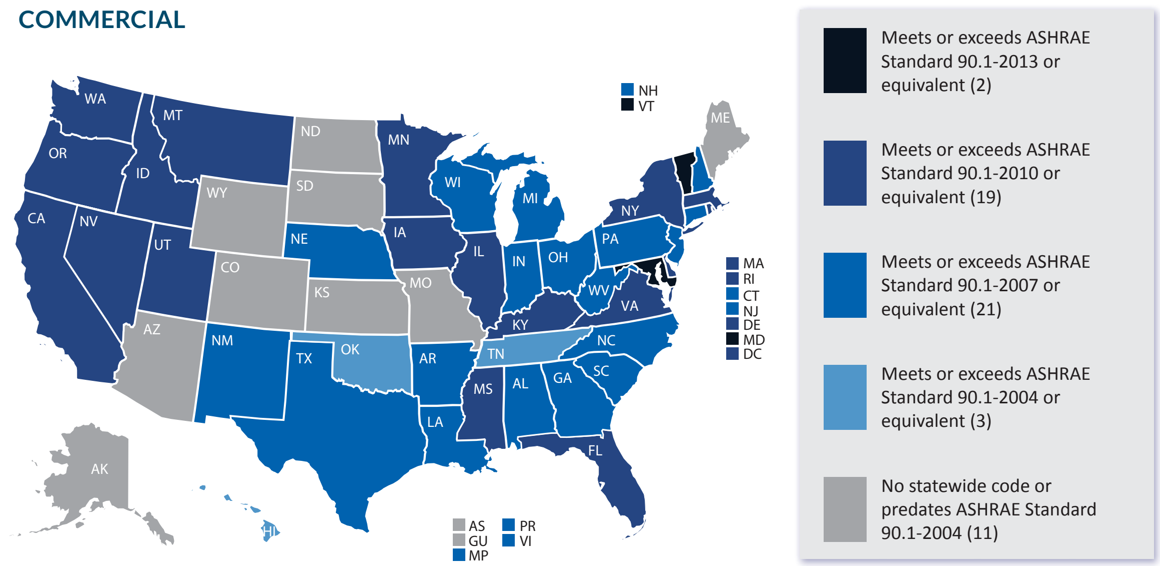
Missouri is one of nine states that do not have mandatory statewide energy codes: Alaska, Arizona, Colorado, Kansas, Mississippi, Missouri, North Dakota, South Dakota, and Wyoming - see Figure 36. In our state, building energy codes are adopted and enforced at the county or municipal level. It should also be noted that requiring a county to adopt a building code and enforce the provisions of the code could require state funding to pay that county for activities or services necessary to implement such a requirement. Article X Section 21 of the Missouri Constitution, commonly known as the Hancock Amendment[ix], adopted by initiative petition in 1980, prohibits unfunded state mandates.

With the exception of Class 3 and Class 4 counties, local jurisdictions in Missouri have the authority to adopt an energy code. Since approximately 80 percent of Missouri's counties are classified as Class 3, the majority of counties do not have this authority. Local municipal governments are classified differently and all municipalities are authorized to adopt codes if they choose to. A city may adopt a code even if located in a county that is not authorized to do so, as the county only has jurisdiction in unincorporated portions of the county.

fine bubble diffusion blowers and a dissolved oxygen and temperature monitoring system. The blowers' controls and sequence were rarely adjusted. The Energy Loan Program assisted with funding to replace the four blowers with one energy efficient turbo blower that can handle the minimum for mixing as well as average and peak designs. The blower, lagoon pump, basin motor and variable frequency drive raw water pump upgrades at this facility are expected to save 442,879 kWh or $42,833 annually.

[ix] The complete amendment is found in Article X Sections 18-24.

COMMERCIAL



RESIDENTIAL

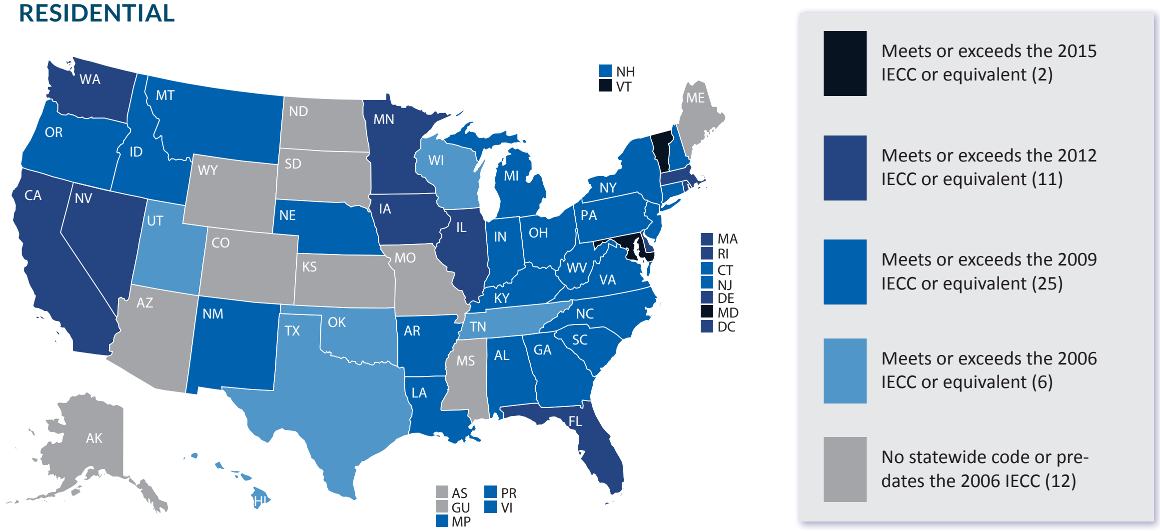


Figure 36. Code Adoption Status, September 2015.

Source: Building Codes Assistance Project, "Code Adoption Status," updated September 2015

3.2 Initiatives Underway

A recent survey of local jurisdictions and municipalities found that approximately 100 jurisdictions in Missouri have adopted the 2009 or 2012 IECC or equivalent codes, representing approximately 50 percent of the state's population. Below is a list providing examples of local ordinances and code adoptions:

- The City of Marshall and Jackson County adopted the 2009 IECC without amendment.
  St. Louis has adopted an amended version of the IECC 2009 code.
- Kansas City has adopted an amended version of the 2012 IECC.
- Kansas City enacted a Green Building Ordinance requiring that new city-funded construction and renovation of more than 5,000 square feet must earn LEED Silver certification and adopted an ordinance requiring housing projects funded by the city, including affordable housing, to be constructed to meet federal ENERGY STAR qualifications.[141]
- The City of Clayton passed a Municipal Building Standard in 2006 that requires new construction and major renovations of city-owned, occupied, or funded buildings over 5,000 ft^2 to attain LEED Silver certification.[142]
- The City of Columbia adopted the 2012 IECC in 2014 for residential buildings.
- On November 7, 2012, The City of Hazelwood in St. Louis County adopted the 2009 IECC.
- The City of University City has adopted an energy efficiency, renewable energy, and greenhouse gas reduction policy for city building projects including new buildings, building additions, major remodels, and renewable energy production facilities.

Table 17 shows building codes adopted by counties throughout the state as listed on the State of Missouri Data Portal. Only those counties with enacted building codes are identified in the table. Note that this does not reflect code amendments that may have been adopted that affect the stringency of the energy code provisions.

Table 17. Missouri Counties with Enacted Building Codes, 2015.

Source: State of Missouri Data Portal, "County Building Codes for Missouri," updated June 23, 2014, https://data.mo.gov/Economic-Development/County-Building-Codes-for-Missouri/iq7s-izvt

County	County Class	Energy Building Code	Residential Code	Commercial Code	Population
Boone	Class 1		2009 IRC	2009 IBC	2009 IRC
Cape Girardeau	Class 1	2009 IECC		2009 IBC	75,674
Cass	Class 1		2006 IRC	2006 IBC	99,478
Christian	Class 2	2006 IECC	2006 IRC	2006 IBC	77,422
Clay	Class 1		2012 IRC	2012 IBC	221,939
Cole	Class 1		2000 IRC	2000 IBC	75,990
Jackson	Class 1	2009 IECC	2009 IRC	2009 IBC	674,158
Jefferson	Class 1	2003 IECC	2003 IRC	2003 IBC	218,733
Platte	Class 1	2012 IECC	2012 IRC	2012 IBC	89,322
St. Louis (City)	N/A	2009 IECC	2009 IRC	2009 IBC	319,294
St. Charles	Class 1		2009 IRC	2009 IBC	360,485
St. Louis (County)	Class 1	2009 IECC	2009 IRC	2009 IBC	998,954

The Division of Energy is engaged in building code efforts. For example, as part of requirements associated with receiving funds through the American Recovery and Reinvestment Act of 2009, Section 410, Missouri is required to demonstrate 90 percent compliance with IECC 2009 and ASHRAE-90.1-2007 by 2017, and the Division of Energy has undertaken several efforts to meet the requirement. In recent years building code efforts have also included research on the current status of code adoption in Missouri, research on the costs and benefits of the codes, outreach to municipalities, efforts to increase knowledge and adoption of the codes, and coordination with DOE and the regional code networks such as Midwest Energy Efficiency Alliance.

In the past, Missouri has considered adopting a statewide energy code. In 2010, the Building Codes Assistance Project drafted Senate Bill 745, which would have adopted the 2009 IECC and ASHRAE Standard 90.1-2007 statewide.[143] It also would have directed Missouri's Department of Natural Resources to establish an automatic review cycle, either every three years or within nine months of the publication of a new model code version. In addition, House Bill 938 (2011) would have established a modified version of the 2006 IECC series as minimum statewide construction standards.[144] Both bills, however, failed to advance beyond legislative committees.

4. Summary of Key Points

- Implementing cost-effective energy efficiency processes and technologies is a proven method of reducing wasteful spending and operating costs.Since the building sector is the largest energy-consuming sector in Missouri, investments made to reduce energy use within residential, commercial, and state-owned buildings, yield a significant return and result in added benefits for building occupants such as increased comfort and productivity. Ample opportunities exist for Missouri to improve energy standards for building, to adopt leading-by-example programs, and to consider more aggressive energy efficiency goals and targets deriving from policies such as the Missouri Energy Efficiency Investment Act.
- In a given building, most of the energy consumed is used for space heating and cooling. Missouri has significant potential to reduce dependence on fossil fuels for these uses by increasing the use of ground source heat pumps, currently underutilized in the state.
- Multifamily housing has a number of characteristics that should make energy efficiency improvements an appealing investment, but only a fraction of the potential energy savings in the multifamily sector has been realized due to split-incentive issues. Improving the energy efficiency of multifamily housing also improves the stability of vulnerable households, most of which are renters whose annual income is typically lower than that of homeowners and therefore spend a higher percentage of their income on energy.
- Benchmarking the energy performance of buildings represents a key first step to understanding how energy is used. There is opportunity for the state to encourage the private sector to participate in benchmarking programs and also to institute policies that require state-owned buildings to be benchmarked for energy and sustainability metrics.
- As electricity prices continue to rise, some states are placing more emphasis on energy efficiency as the least-cost resource. The Missouri Energy Efficiency Investment Act sets a platform for the state to achieve

energy efficiency reductions through demand-side management programs implemented by the state's investor-owned electric utilities. While MEEIA serves as a good first step, there are opportunities for policy modifications that would encourage more aggressive, and mandatory, targets. Other benefits could be derived from allowing natural gas IOUs to voluntarily participate in MEEIA and exploring opportunities for better accounting for social and environmental benefits into cost-effectiveness tests that are used to screen technologies.

- Energy education and consumer awareness programs can help residents and businesses understand the multiple benefits of energy efficiency and building practices that support these principles. In addition, programs can also focus on developing behavior-based energy conservation, such as turning lights off or setting thermostats at appropriate levels. An informed, energy-literate public is better equipped to make thoughtful and responsible energy-related decisions in everyday life.

- Building energy codes ensure a base level of energy efficiency in all newly built or substantially renovated commercial and residential buildings. Missouri is one of nine states in the country that do not currently have enacted building codes, and therefore there are large efficiencies in the building sector that remain untapped.[145] While Missouri does require that all new or renovated state-managed buildings meet currentenergy codes and achieve annual reductions in energy consumption, the lack of a statewide code for commercial and residential buildings leaves the majority of the buildings in the state uncovered. There are opportunities to improve code adoption including development of training programs, allowing utilities to claim credits for code improvements under MEEIA, and encouraging local governments to adopt codes in the most populated areas of the state.

- Significant amounts of energy are used in the treatment of water and wastewater and its delivery and distribution. Increasing efficiency at water treatment facilities through the installation of more efficient pumps, motors, and other equipment, can help reduce the burden of energy cost. In addition infrastructure improvements to the distribution system could prevent the loss of purified drinking water as well as the energy resources associated with its treatment and distribution.

II. Transportation

The transportation sector in Missouri is responsible for a large portion of energy consumption. Of the 1,813 trillion BTU that were consumed in the state in 2012, the transportation sector was responsible for 30.4 percent of that amount.[146]

The transportation sector includes all modes of transportation, from personal vehicles to public transportation, airplanes, freight trains, barges, and pipelines. Of these, personal vehicles consume more than 60 percent of the energy used[147] and therefore represent a prime area where efficiencies and improvements can make an impact. Over the past century, dependence on vehicles burning petroleum-based fuels has become a defining component of American life, bringing countless benefits to personal lifestyles and the economy. In more recent years, numerous efforts have been undertaken to identify more efficient fuel alternatives and increase the efficiency of motorized vehicles.

The content that follows characterizes energy use in Missouri's transportation sector and provides background information on transportation fuels and modes of transport.

1. Missouri Transportation Facts

Missouri's central location provides a significant advantage due to its extensive transportation network, which includes some of the country's least congested highways, two of the largest rail terminals, and over a thousand miles of navigable waterways. This combination of location and infrastructure helps lower the cost of travel and freight transportation to businesses located in Missouri, while providing accessibility to major markets.[148]

Other Missouri transportation facts include:

- **Roadways –** There are a total of 33,884 miles of roadway within the state of Missouri, making it the nation's seventh largest state highway system, with more miles than Iowa, Nebraska, and Kansas' systems combined. Major routes make up about 20 percent of Missouri's roadways but handle nearly 80 percent of the traffic.[149]
- **Aviation –** Missouri has 128 public-use airports and 35 business-capable airports. Two of our airports support international traffic: Lambert-St. Louis International and Kansas City International. Most cities in the U.S. and

Comprehensive Bicycle Infrastructure and Promotion
Mid-Missouri, 2000-Present

Columbia is home to 108,500 residents, more than 30,000 of whom are students at the University of Missouri-Columbia. In July of 2005, the City of Columbia became one of four cities nationwide to receive a $25 million grant from the federal government under the Non-motorized Transportation Pilot Program. The funding created the GetAbout Columbia program to promote an increase in walking and biking while providing the infrastructure to support it. Most notably, funds supported projects that created 13.2 miles of off-road shared use paths, 44.4 road miles of streets with shared-lane markings, and bicycle skills and safety classes in which there were 4,000 participants. Bicycling has increased since the early years of the GetAbout Columbia and the program recorded an increase in walking of 22 percent and an increase in bicycling of 44 percent between 2009 and 2013.

Canada can be reached from Missouri in less than three hours by air.

- **Railroads** – Missouri has 4,822 miles of mainline railroad track. Kansas City and St. Louis are the nation's second- and third-largest freight rail hubs. In 2012, 438 million tons of freight traveled by rail in Missouri, the 4th most in the nation.

- **Waterways** – Missouri has 14 public river ports, including St. Louis, which is the third largest inland port in the U.S. Barge traffic in Missouri moves more than 30 million tons of freight or $4.1 billion in cargo through public ports and terminals each year[150]. Missouri is ranked 10th for inland waterway mileage and is the northern-most ice-free point on the Mississippi river. Barges traveling from St. Louis can reach twenty-nine industrial centers, which combined have a total population of 90 million.

- **Public Transit** – More than 70 million public transit trips are made by Missourians per year and some form of public transportation exists in all 114 Missouri counties and the City of St. Louis.

- **Bicycle & Pedestrian** – Missouri has approximately 600 miles of shared-use paths on the state system, including 232 miles of the Katy Trail.[151]

In Missouri, the agency that is in charge of transportation infrastructure is the Missouri Department of Transportation (MoDOT). MoDOT works with the public, transportation partners, state and federal legislators, and other state and local agencies to provide a safe and efficient transportation system to Missourians.

At the federal level, revenue for transportation infrastructure and projects is derived from Missouri's share of the nation's 18.4 cent per gallon tax on gasoline and 24.4 cent per gallon tax on diesel fuel. It also includes various highway user fees and other grants. In terms of local revenue, Missouri's primary funding source is taxes levied on fuels, which are currently among the lowest in the country at a value of 17 cents per gallon for gasoline.[152] In addition MoDOT receives a share of vehicle and driver licensing fees, as well as sales and use taxes on motor vehicle purchases and leases.

U.S. DOE Clean Cities
Kansas City

The U.S. Department of Energy (DOE) Clean Cities, a network of nearly 100 cities, is a program that advances the nation's economic, environmental, and energy security by convening stakeholders in the public and private sectors to deploy alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies. Their activities stimulate local economies, facilitate the adoption of new transportation technologies, and make communities cleaner, healthier places to live.

Member cities benefit from networking opportunities with fleets and industry partners technical training, workshops, and webinars and funding opportunities from DOE.

The Kansas City Regional Clean Cities Coalition is a public/private partnership for clean transportation and has participated in the Clean Cities program since 1998. The Metropolitan Energy Center and project partners fund the staff and project administration

2. Transportation Fuels

2.1 Traditional Transportation Fuels

Nearly 100 percent of Missouri's transportation system is currently powered by fossil fuels - primarily gasoline for personal transportation vehicles and diesel for heavy-duty vehicles. As explained in Chapter 2, Missouri is not a major oil producer or refiner and therefore all gasoline used for transportation purposes is imported to the state.

From 1970 to 2012, Missouri's nominal expenditures on transportation fuels increased from $878 million to $15.0 billion in 2012[153], representing a sixteen-fold increase. The growth in expenditures was mainly driven by the price of oil, which increased from $2.9 dollars per barrel in 1970 to $101.1 dollars per barrel in 2012.[154] While prices of gasoline and diesel are lower in Missouri than the national average, on a per capita basis, Missourians spend approximately 13.6 percent more on gasoline per year than the national average due to greater distances traveled.[155]

2.2 Alternative Transportation Fuels

Alternative transportation fuels can play a significant role in diversifying fuel supplies, limiting Missouri's reliance on imported fuels, and reducing environmental emissions. Furthermore, some alternative fuels, such as biodiesel, can be produced within the state in dedicated refineries, therefore adding to overall domestic capacity and economic productivity.

Using alternative transportation fuels requires careful consideration of options available, as well as the benefits and costs to the vehicle owner and to society. Some of these considerations include the cost of the fuel on an equivalent basis with other petroleum-based transportation fuels, availability of fueling stations and fuel supply, benefits to the engine in terms of operations and maintenance, and the incremental cost of either purchasing or converting a motorized vehicle to operate on the fuel. Although prices for alternative vehicles and alternative transportation fuels are at present higher than traditional fuels and vehicles, prices are likely to decrease in the future as production volumes and demand increase.

Prices of alternative transportation fuels relative to conventional fuels vary. At the national level some alternative fuels (B20, B99-B100) have higher costs relative to gasoline, while compressed natural gas, E85 and propane have lower prices on a per gallon basis. Figure 37 shows the retail prices for gasoline, diesel ethanol blend (E85) and biodiesel blend (B20) in the state for the past five years. Although the figure does not include every transportation fuel covered in this section, it shows that E85 is less expensive than gasoline and B20 is slightly more expensive than pure diesel.

for its members. The St. Louis Regional Clean Cities Program is the recognized Clean Cities administrator in St Louis and it provides tools and resources for voluntary, community based programs to reduce consumption of petroleum-based fuels and increase the utilization of alternative fuels, stations, and vehicles.

Historic Prices of Transportation Fuels in Missouri

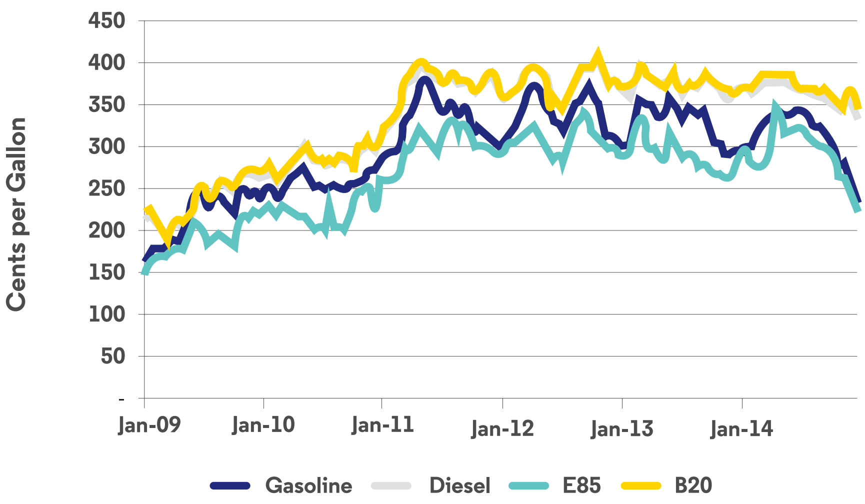


Figure 37. Historic Retail Prices of Transportation Fuels in Missouri, 2009-2014.

Source: Missouri Department of Economic Development: Division of Energy, "Missouri Energy Bulletin."

Note: prices are shown per gallon of fuel, which is the traditional payment for users at the pump. When normalized to a price per gallon equivalent, alternative fuel prices tend to be higher than gasoline and diesel because of their lower energy content per gallon. However, consumer interest in alternative fuels generally increases when the alternative fuel price is less than the conventional fuel price, even if that does not directly translate to savings on an energy-equivalent basis.

The sections that follow provide a brief overview of the most common alternative transportation fuels. It should be noted that other types of fuels, such as methanol and mixtures of natural gas liquids with ethanol and other solvents, are being explored at the national level; however, they are not yet available at a commercial level.

a) Biofuels

A variety of policies in the state incentivize the production of biofuels. For example, the Fuel Conservation for State Vehicles Program establishes targets for reduction in state fuel consumption by requiring state purchase of flex fuel vehicles that use fuel consisting of 85 percent ethanol. In addition, the Missouri Department of Agriculture's Ethanol Production Incentive Fund and Qualified Biodiesel Producer Incentive Fund have provided support for research, marketing, and commercialization of biofuels in our state. Additional information on the availability and production of biofuels is presented in Chapter 2: Energy Supply, Section I. Availability of In-State Resources.

i. Ethanol

Ethanol use is widespread and almost all gasoline in the U.S. contains some grade of ethanol, typically E10 (10% ethanol, 90% gasoline), to oxygenate the fuel and reduce air pollution. Ethanol is also available as E85, a high-level ethanol blend containing 51 to 83 percent ethanol[156] depending on season and geography, for use in flexible fuel vehicles. Ethanol has a higher octane number than gasoline, providing premium-blending properties; however, it contains anywhere from 20 to 30 percent less energy per gallon than gasoline, depending on the volume percentage of ethanol in the blend.[157]

By state law, all gasoline sold in Missouri must include a mix of 10 percent ethanol. This law, called the Renewable Fuel Standard Act, is intended to strengthen the agricultural economy, improve air quality, and reduce oil imports.

ii. Biodiesel

For transportation purposes, biodiesel can be used in its pure form (B100) or blended with petroleum diesel. Common blends include B2 (2% biodiesel), B5, and B20. Most vehicle manufacturers approve blends up to B5 and some approve blends up to B20.

iii. Other Biofuels

In addition to ethanol and biodiesel, a variety of aviation biofuel blends have recently passed certification by the Federal Aviation Agency for use in commercial and military jet engines. However, at present fuel production costs exceed the cost of petroleum-based jet fuel. Basic biological research and pilot-plant studies continue, in an effort to produce commercially viable aviation biofuels from renewable non-food crop sources.

As a producer of biodiesel and ethanol, Missouri is well positioned to benefit from biofuels. Relying on these resources as alternative transportation fuels helps diversify the state's reliance on imported oil, hedge against increasing oil prices, reduce environmental impacts, and promote domestic industries and the creation of jobs.

b) Electricity

Electricity can be used to power all-electric vehicles and plug-in hybrid electric vehicles, which draw electricity directly from the grid and other off-board electrical power sources and store it in batteries. Hybrid electric vehicles use electricity to boost fuel efficiency. Using electricity to power vehicles can have significant energy security and emissions benefits.

Though not yet widely available, fuel cell vehicles can use hydrogen to generate electricity onboard the vehicle. Hydrogen is an alternative that is of interest due to its ability to power fuel cells in zero-emission electric vehicles. Government

Electrify Heartland
Kansas City

Electrify Heartland was an electric vehicle planning project managed by Metropolitan Energy Center. It was a product of the Greater Kansas City Plug-In Readiness Initiative, co-chaired by Kansas City Regional Clean Cities Coalition. The goal was to produce a regional plan to prepare public resources and secure the economic and environmental benefits of plug-in vehicles within targeted metro areas with a total estimated population of 2.7 million.

The targeted metro areas included Kansas City, MO & KS; Jefferson City, MO, Wichita, KS; Salina, KS; Lawrence, KS; and Topeka, KS. The 14 concerned counties were: Cass, Clay, Cole, Douglas, Jackson, Johnson, Leavenworth, Miami, Platte, Ray, Saline, Sedgwick, Shawnee, and Wyandotte.

The work was developed in response to the federal funding opportunity announcement titled Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure (FOA: DE-FOA-0000451).

and industry are working towards clean, economical, and safe hydrogen production and distribution for use in fuel cell vehicles. Fuel cell vehicles are beginning to enter the consumer market in localized regions domestically and around the world. The market is also developing for buses, material handling equipment, ground support equipment, medium and heavy-duty vehicles, and stationary applications.

c) Natural Gas

Two forms of natural gas are used in vehicles: compressed natural gas (CNG) and liquefied natural gas (LNG). Both are clean burning, domestically produced, and relatively low priced. CNG is typically used in light-, medium-, and heavy-duty applications, while LNG is typically used in medium- and heavy-duty vehicles.

d) Propane

Also known as liquefied petroleum gas or propane autogas, propane is a clean burning, high-energy alternative fuel that has been used for decades to power light-, medium-, and heavy-duty propane vehicles. Propane has a high octane rating, making it an excellent choice for spark-ignited internal combustion engines. The Missouri Propane Gas Association, headquartered in Jefferson City, is actively involved in supporting propane, including its use as a transportation fuel.

The Laclede Group First CNG Station
St. Louis, 2014

In the summer of 2014, the Laclede Group opened its first public compressed natural gas (CNG) fueling station near Lambert-St. Louis International Airport. The station serves trucking fleets, school buses, and passenger vehicles that run on CNG. The airport already has two operating CNG stations for its airport vehicles and parking shuttles, allowing more than 50% of the airport fleet to run on CNG and other alternative fuels.

Compressed natural gas is less expensive and more environmentally friendly than gasoline, making it a desirable alternative for some customers. By using CNG as a transportation fuel, carbon monoxide emissions are reduced by 90% and smog is virtually eliminated. The station has exceeded expectations since opening, and Laclede plans to open more stations in the future.

3. Modes and Infrastructure

a) Personal Motor Vehicles

Based on Missouri Department of Revenue motor vehicle data from fiscal year 2013, there were approximately 3.5 million passenger vehicles registered in our state, or an equivalent of approximately 0.6 vehicles per capita. The second category of most registered vehicles belongs to trucks, which collectively add to 1.4 million vehicles registered in the state.[158] According to the U.S. Department of Transportation Federal Highway Administration (FHWA), in 2013 Missouri motor vehicles traveled approximately 69,458 million miles, 28.7 percent of which were traveled during interstate trips.[159] With 5.1 million vehicles registered in the state,[160] this means that on average each vehicle traveled 13,642 miles in a year, compared to a national average of 11,679 miles per motor vehicle (all vehicles).[161] As an important and relevant national trend, the latest forecast from the FHWA recognizes a nine percent decrease in the amount of miles driven by the average American between 2004 and 2014.[162] The FHWA believes that this trend will continue.

With regard to the fuel economy of personal motor vehicles, miles per gallon (MPG) provides a quick and easy comparison across vehicles.

In 1975 the U.S. Congress enacted legislation to improve the average fuel economy of cars and light trucks produced for sale in the country. Called the Corporate Average Fuel Economy (CAFE), these regulations establish standards separately for passenger cars and non-passenger vehicles at the maximum feasible levels in each model year. According to the CAFE standards, the average fuel economy for cars must improve from 27.5 MPG, where it has been since 1990, to a projected average combined fleet-wide fuel economy of 40.3 to 41.0 MPG in model year 2021 and 48.7 to 49.7 MPG in model year 2025.[163]

b) Alternative Fuel Vehicles

Alternative fuel vehicles (AFVs) are those vehicles that can run on non-traditional fuels such as propane, biofuel blends, electricity and natural gas. The numbers and types of alternative fuel vehicles currently available from manufacturers are steadily increasing, and all major U.S. vehicle manufacturers are producing alternative fuel vehicles. According to a review performed by MoDOT, alternative fuel new vehicle sales in the West North Central division were approximately 1,000 in 2011 and are projected to be 4,000 in 2025, with an average annual growth of nine percent. In addition, in 2011 hybrid, flex-fueled, and bi-fueled new vehicle sales in this region were 17,000 and are projected to grow at a 10 percent annual rate through 2025.

c) Alternative Fuel Vehicle Infrastructure

The infrastructure needed to power AFVs is slowly but steadily increasing. Since the

AT&T Fleet Reaches Milestone of 8,000 CNG Vehicles
St. Louis, 2014

St. Louis is the home of fleet operations for AT&T. In 2009, AT&T pledged to add 15,000 alternative fuel vehicles within ten years, and by March of 2014, a milestone was reached when the 8,000th compressed natural gas vehicle arrived.

AT&T's CNG fleet ranges from fuel transfer trucks to service tech vans. Most fueling is done at public access CNG stations to support the industry and encourage use. AT&T now operates 10,000 various alt-fuel vehicles, including gasoline-electric hybrids, extended-range electrics, and pure electric vehicles. As a National Clean Fleets partner, AT&T works closely with the St. Louis Clean Cities coalition, setting a great example of a global company committed to alternative fuels.

A brief discussion follows on the types of AFV that are currently commercially available:

Table 18. Types of Alternative Fuel Vehicles

Type of Vehicles	Advantages	Challenges
Electric Vehicles: Information indicates that electric vehicles use is growing and that there are currently approximately 1,600 electric vehicles in Missouri. In plug-in electric vehicles, onboard rechargeable batteries store energy to power electric motors.	Produce no tailpipe emissions, but there are emissions associated with the production of electricity. Fueling plug-in vehicles with electricity is currently cost effective compared to gasoline, especially if drivers take advantage of off-peak utility rates offered by many utilities.	Currently have a shorter range per charge than most conventional vehicles per tank of gas – typically about 100 miles on a fully charged battery. Limited infrastructure for charging outside of an individual's home.
Hybrid Electric Vehicles: powered by an internal combustion engine that runs on conventional or alternative fuel and an electric motor that uses energy stored in a battery. The battery is charged through regenerative braking and by the internal combustion engine and is not plugged in to charge. Some Hybrid Electric Vehicles can also be pluged-in to feed on electricity from the grid.	Typically achieve better fuel economy and have lower fuel costs than similar conventional vehicles. Plug-in vehicles can also take advantage of off-peak utility rates offered by many utilities.	Higher incremental cost at time of purchase.
Flexible Fuel Vehicles: Most vehicles can use biofuel blends with no change to their engines. Biofuels have chemical characteristics similar to petroleum-based fuels, so they can be used as a direct substitute for transportation fuel, or in blends with petroleum-based fuels in any percentage without losing fuel economy.	Available nationwide as standard equipment with no incremental cost. Fueling stations offering E85 are predominately located in the Midwest.	
Natural Gas Vehicles: Running on either CNG or LNG, natural gas vehicles are similar to gasoline or diesel vehicles with regard to power, acceleration, and cruising speed.	Produce lower levels of some emissions. Fuel cost is typically lower than conventional gasoline or diesel.	The driving range of is generally less than that of comparable gasoline and diesel vehicles. Currenlty available light-duty natural gas vehicles from original equipment manufacturers is limited, however the choices are steadily growing. Vehicle fueling infrastructure is limited. Therefore, fleets may need to install their own natural gas infrastructure, which can be costly.
Propane: A variety of light-, medium-, and heavy-duty propane vehicle models are available through original equipment manufacturers and select dealerships.	The cost of propane is typically lower than gasoline, so the return on investment can be quick. Propane at primary infrastructure sites costs less than gasoline and offers a comparable driving range. Lower maintenance costs. Produces lower amounts of some harmful air pollutants and greenhouse gases, depending on vehicle type, drive cycle, and engine calibration. Infrastructure for fueling exists statewide.	Initial cost of vehicle is higher than conventional gasoline vehicles.

mid-90s Missouri has seen a significant increase in the number of E85 fueling stations. Other alternative fuels, including electricity and CNG, have also experienced increases in the number of available refueling locations. As of April 2015, there are a total of 351 public AFV charging stations and an additional 54 private stations in the state.[164]

Specific to electric vehicles, connection of electric vehicle charging stations will impact the design, operation, and cost of the grid as penetration of these vehicles in our state increases. Due to this interrelation, electric utilities are uniquely positioned to help support electric vehicle infrastructure and charging station networks. Although not commonly used in Missouri currently, time-of-use policies that charge customers a cost for electricity at different times of day may incent electric vehicle owners to charge their vehicles at off-peak hours, thereby reducing stress on the grid. In addition, lower electricity prices charged at off-peak hours may further reduce the lifecycle cost of operating electric vehicles and provide an added incentive for customers to purchase these vehicles.

The Alternative Fuel Infrastructure Tax Credit program was established in 2008 to increase availability of alternative fuels and refueling facilities in Missouri. From 2009 through 2013, the Division of Energy authorized and the Department of Revenue issued tax credits in the amount of $179,290 for thirteen projects: one CNG, one propane, and 11 E85 facilities. A total of $6 million was authorized for tax years 2009, 2010, and 2011. In 2014, the program was reauthorized by the General Assembly from January 1, 2015 through December 31, 2017 and expanded to include electric vehicle recharging stations. The reauthorization includes an annual cap of $1 million, but the law states it is subject to annual appropriations, which provides uncertainty regarding its implementation.

Due to increasing markets for low-cost natural gas and the availability of the tax credit to individuals who want to install electric vehicle recharging stations, it is likely the program will be very popular, fully utilized, and will play an important role in advancing alternative fuel infrastructure in the state if appropriations are made available.

KCP&L Clean Charge Network
Greater Kansas City
region, 2015

In January 2015, KCP&L announced that it will install and operate over 1,000 electric vehicle charging stations, which will comprise the largest electric vehicle charging station network offered by any utility in the United States, and will be able to support more than 10,000 electric vehicles.

The Clean Charge Network, as the project is called, will largely be located in the Kansas City area, where the bulk of KCP&L's customers live. However, the utility is planning to make charging stations available to customers in all portions of their service territory, which primarily spans across western Missouri and northeastern Kansas. Prior to the installations, only 40 charging stations were available in the area.

Kansas City is the largest auto-manufacturing center in the United States outside of Detroit, making this location well suited for new transportation technologies. The Network should alleviate range anxiety, the fear of running out of power before reaching the next charging station, and therefore enable people to purchase electric vehicles. This will ultimately attract new businesses and talent, and create new jobs. KCP&L plans to have the stations completed by summer 2015.

In Missouri, in lieu of related taxes, the owner of a motor vehicle that operates on LPG, CNG, LNG, or electricity must annually purchase a special fuel decal and pay a fee. Hybrid vehicles and motor vehicles with historic registration, however, are exempt from these special fuel decals. Starting in 2016, CNG used as a vehicle fuel will be taxed on a gasoline gallon equivalent basis and LNG used as vehicle fuel will be taxed on a diesel gallon equivalent basis, unless the owners or operators of the vehicles have installed fueling stations as of December 31, 2015 that are used solely for their own vehicles.

d) Public Transit

With some exceptions such as passenger rail networks, public transportation services are typically deployed at the municipal level rather than at the state level. Public transportation programs offer many benefits to Missourians including enhanced personal mobility and access to traveling options, economic savings associated with reduced fuel use, reduced air emissions, and reduced traffic congestion, particularly in urban areas.

In Missouri, the two largest public transportation networks are located in Kansas City and St. Louis. The Kansas City Area Transportation Authority operates local and express routes, demand-response, bus rapid transit, and vanpool services connecting the metropolitan area, suburbs, and other communities. The city of St. Louis has the largest light rail system in the Midwest[165], MetroLink, which consists of two lines that feature 37 stations and carry an average of 53,123 people each weekday.[166] Columbia, Jefferson City, St. Joseph, and Springfield have public transportation agencies in charge of operating intra-city routes. In addition, the state also has several independently owned rural transportation providers that operate bus routes connecting rural areas in 87 counties.

Missouri has three passenger rail routes operated by Amtrak: the Missouri River Runner traveling daily between St. Louis and Kansas City; the Illinois Service and Lincoln service extension connecting Chicago, Illinois with St. Louis; and the Texas Eagle which starts in Chicago and passes through St. Louis on its way to Texas and ultimately Los Angeles, California. During fiscal year 2013 Amtrak Missouri River Runner ridership grew to 196,661 passengers, representing the sixth consecutive year of ridership growth. Increased reliability is the primary reason behind this growth. Twice a day the Missouri River Runner serves Kansas City, St. Louis, and eight points in between - Kirkwood, Washington, Hermann, Jefferson City, Sedalia, Warrensburg, Lee's Summit, and Independence.[167] Use of this intercity passenger train reduces emissions and removes approximately 600 cars per day from the St. Louis to Kansas City corridor.[168]

In addition to public modes of transportation, riders have the option of participating in regional ridesharing programs such as those available in the regions of Kansas City, St. Louis, Springfield, and Mid-Missouri, and others supported by the private sector. Ridesharing not only helps alleviate traffic congestion, but also helps save money and reduce environmental pollution. The Missouri Division of Energy has worked with MoDOT and rideshare programs around the state to sponsor promotional campaigns such as "Share the Ride Statewide". To promote ridesharing in Missouri, MoDOT maintains the iCarpool program database, accessible at http://www.modot.org/services/carpools/. Similar rideshare programs are offered by private entities.

e) State Fleet

In 1991 the Missouri General Assembly set standards for economically and environmentally responsible state fleet management. The intent of the Fuel Conservation for State Vehicles Program, administered by the Division of Energy, was to increase the average fuel efficiency of the state fleet and to encourage the use of cleaner alternative transportation fuels in state vehicles. All Missouri state agencies are required to comply with the statute and are subject to one or both of the fleet efficiency and alternative fuel requirements.

The Fuel Conservation for State Vehicles Program requires state agencies to meet minimum guidelines for efficient vehicle fleet management. In addition, agencies are to operate vehicles on alternative fuels, which are defined to be consistent with DOE's designations and includes 85 percent ethanol, propane, compressed natural gas or others as designated by U.S. DOE, if the fuels are within the incremental lifecycle cost caps designated in the statute.

Effective January 1, 2008, a new statutory provision requires the Commissioner of the Office of Administration to ensure that no less than 70 percent of new state fleet vehicle purchases be flexible fuel vehicles that can operate with E85. Prior to 2008, state agencies were required to meet a 50 percent standard using any eligible alternative fuel vehicles. This fuel-specific procurement policy restricts Missouri government's full access to all alternative fuels and limits its ability to respond to market and technological changes.

In addition, auto manufacturers generally do not use E85 technology on smaller, more fuel-efficient vehicles as they receive significantly more credit toward CAFE standards when E85 is employed on larger vehicles. As a result of this statutory provision, the state fleet is beginning to be made up of larger, less fuel-efficient vehicles than are necessary to meet state government travel needs. Removing the 70 percent prescriptive requirement would allow agencies to purchase vehicles using other emerging alternative fuels and technologies while also increasing the efficiency of the fleet.

f) Freight

Missouri's multimodal freight system supports the movement of trucks, planes, barges, and trains; in 2011, the system transported more than one billion tons of freight valued at over $1.2 trillion per year.[169] The freight system is an important factor in sustaining and enhancing Missouri companies' position in the market place. By far, the largest percentage of freight in Missouri travels either by truck or by rail. As shown in Figure 38 trucks accounted for approximately 49.2 percent of the freight tonnage and 59.0 percent of the freight value in Missouri in 2011, while rail lines moved 45.1 percent of tonnage and 38.6 percent of the freight value. Waterways transported 4.9 percent of the freight tonnage and 1.0 percent of the freight value, and air cargo and pipelines transported the remaining tonnage.[170]

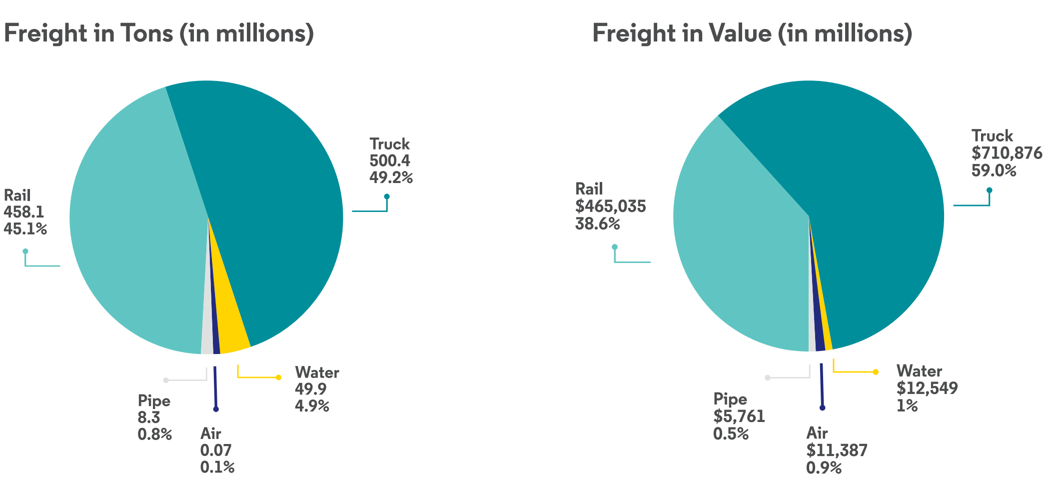


Figure 38. Freight Movement by Tonnage and Value per Mode, 2011.

Source: Missouri Department of Transportation, "Missouri State Freight Plan," accessed March 2015. http://www.mofreightplan.org/wp-content/uploads/2015/02/Missouri-Freight-Plan-Executive-Summary-FINAL-small-version.pdf

Missouri waterways provide low-cost transportation and move an average of $12.5 billion in cargo per year through a system of 1,000 miles of navigable rivers, 14 public port authorities, and more than 200 private ports.[171] The Mississippi-Missouri River System is used primarily for industrial transportation, carrying agricultural and manufactured goods, iron, steel, and mine products over a great area of the country. The Mississippi and Missouri rivers carry 460 million short tons and 3.3 million short tons, respectively, of freight every year.

MoDOT estimates that every resident in the state spends approximately $4,500 per year either directly or indirectly on the transportation of the goods they purchase. Improving freight transportation can lead to job creation as well as decreased transportation costs, which in turn lowers the cost of goods and results in consumers having more disposable income.[172]

Currently, approximately 94 percent of goods in Missouri are shipped by either rail or truck. It is projected that this percentage will stay the same through 2030, although a shift of approximately six percent from rail to truck is expected to occur within that total.[173] Trains can transport four times more ton-miles per gallon than trucks, typically at a lower cost. The Rocky Mountain Institute estimates that the expansion of rail intermodal systems, in which trains transport goods over medium to long distances and trucks transport goods to the final destinations, could save up to 25 percent of heavy truck fuel by 2050 on a nation-wide basis.[174] The National Renewable Energy Laboratory also notes that shifting from truck to rail offers the greatest potential for energy reduction, but states that major mode shifts are unlikely to occur without considerable changes in costs or strong regulatory measures. This is owing to the fact that, currently, each freight mode offers distinct advantages and disadvantages in relation to price, speed, reliability, accessibility, visibility, security, and safety. Truck and air modes are typically used for time-sensitive, higher-value, and lower weight freight, while rail and water often handle less time-sensitive, lower-value, and heavier weight goods.[175]

In a report prepared for Missouri's Strategic Initiative for Economic Growth, several opportunities for the development of Missouri's transportation and logistics sectors are identified. Those opportunities include: stimulating foreign trade opportunities via development of air cargo and multi-modal distribution hubs; expanding foreign trade zone designations in Missouri metros; developing low-cost land sites in rural areas to provide transportation and logistics growth opportunities in non-metro jurisdictions; and increasing transportation and logistics capacity in order to improve the state's prospects for growth in manufacturing and other target sectors.[176]

Many companies that provide shipping services in Missouri are currently realizing increases in freight efficiency. Notably, the shipping company UPS operates a fleet that includes more than 3,150 alternative fuel and advanced technology low-emissions vehicles, including all-electrics, electric hybrids, hydraulic hybrids, propane, compressed natural gas, liquefied natural gas, and biomethane. In 2013, UPS reached a milestone of logging 55 million miles using these alternative fuels and advanced technology vehicles, and by 2017, UPS believes that number will reach 1 billion miles. UPS insists that its alternative fuel and advanced technology vehicles be economically viable in terms of initial purchase price, maintenance costs and reliability.[177]

A critical component of Missouri's transportation and logistics strategy will be a continued focus on linking current and future railways with airports, highways, and riverports in order to increase multi-modal distribution access for our companies and customers.[178]

4. Summary of Key Points

- Ranked behind the buildings sector in terms of energy consumption, the transportation sector is responsible for 30.4 percent of energy consumed in the state, mostly in the form of fossil fuels . Opportunities to diversify the state's fuel portfolio and infrastructure can bring significant value to Missouri's transportation infrastructure and economy.

- Transportation infrastructure and projects require significant amounts of dollars to develop and maintain. The Missouri Department of Transportation's revenue is derived from federal taxes on gasoline and diesel, highway user fees and grants, state fuel taxes, and use taxes on motor vehicle purchases and leases. Missouri ranks 46th nationally in terms of revenue per mile of highway, primarily because the state's large system is funded with one of the lowest fuel taxes in the country.[180] Policy modifications should carefully consider the state's ability to collect revenue for infrastructure projects and expansions.

- As a producer of biodiesel and ethanol, Missouri is well positioned to benefit from biofuels. Relying on these resources as alternative transportation fuels promotes domestic industries and the creation of jobs and helps reduce the state's reliance on imported oil, hedge against increasing oil prices, and reduce environmental impacts. By state law, all gasoline sold in Missouri should include a 10 percent ethanol mix. This and other policies such as the Fuel Conservation for State Vehicles Program, an executive order which requires state purchase of flex fuel vehicles that use fuel consisting of eighty-five percent ethanol, and the Missouri Department of Agriculture's Ethanol Production Incentive Fund and Qualified Biodiesel Producer Incentive Fund, which provide support to the research, marketing, and commercialization of biofuels, are critical and should continue to be endorsed and supported.

- The numbers and types of alternative fuel vehicles currently available from manufacturers are steadily increasing, and the infrastructure needed to power these vehicles is also increasing, albeit slowly. Since the mid 1990s the state has seen a significant growth in alternative fuel infrastructure. The state has the Alternative Fuel Infrastructure Tax Credit, which provides tax credits for installing and operating alternative refueling stations using ethanol, some forms of natural gas, biodiesel, or hydrogen, and electric charging stations. The fiscal year 2016 approved budget includes an appropriation of $100,000, the first since the appropriation requirement was added to the statute in 2014.

- Electric vehicle charging stations need access to the electric grid and will likely impact the design, operation and cost of the grid. Due to this interrelation, electric utilities are uniquely positioned to help support electric vehicle infrastructure and charging station networks. In addition, time-of-use policies that charge customers a cost for electricity at different times of day may incent electric vehicle owners to charge their vehicles at off-peak hours and may further reduce the lifecycle cost of operating electric vehicles.

- Public transportation ridership in Missouri continues to grow and is supported by MoDOT, Division of Energy, and local city agencies.

- Public transportation programs offer many benefits to Missourians, including enhanced personal mobility and access to traveling options, economic savings associated with reduced fuel use, reduced air emissions, and reduced traffic congestion.

- Programs by both the private and public sector that support ridesharing and telecommuting practices can positively affect the quality of life of individuals while also resulting in reduced traffic congestion, lowered use of fuels, and lower environmental emissions. Opportunities to encourage these programs and educate the public and businesses on their benefits should be explored further.

- Alternative fuels can play an important role in reducing Missouri's reliance on energy imports derived from oil-based products. Ethanol and biodiesel are produced in geographically diverse areas of the state and have particular significance to Missouri's economy. The state currently provides tax credits for installing and operating alternative refueling stations using ethanol, some forms of natural gas, biodiesel, and hydrogen, and electric charging stations, subject to appropriations. Additionally, Missouri's current Renewable Fuel Standard Act could be evaluated to highlight potential modifications to improve its effectiveness in increasing the penetration of different fuel blends.

III. Energy Assurance and Reliability

Energy Assurance can be defined as a set of policies, actions and projects that are undertaken to ensure key assets will function and deliver energy services in the event of an emergency.[181] Over the last three decades, the focus of energy assurance has evolved significantly as our nation has been impacted by varying energy risks resulting from global and local issues: from natural disasters to system and infrastructure failures, pandemics, deliberate physical and cyber-attacks, and energy supply and price instability.

In recent times, one of the most significant events that changed the nation's perspective on energy infrastructure and national security was the terrorist attacks in New York on September 11, 2001. As a result of recent natural disasters, such as Hurricanes Katrina and Rita in the fall of 2005 and Hurricane Sandy in October 2012, there is a greater focus on making communities stronger and more resilient.

Natural disasters account for over 95 percent of all energy emergencies nationwide and have an immediate and long-lasting impact on the energy supply infrastructure, including billions of dollars in damage and lost economic activity. Destroyed or damaged power lines, pipelines, and distribution centers have resulted from severe thunderstorms, large-scale flooding, winter ice and snowstorms, and tornadoes. Additionally, disruptions caused by storms that damage transmission and distribution lines are the most frequent source of power outages.

Specific to our state, on May 22, 2011 the city of Joplin was hit by a mile-wide tornado that was one of the deadliest tornados in nearly 60 years, with the death toll reaching 161.[182] Other recent examples close to home include the severe storms, tornados, straight-line winds, and flooding that took place in Missouri during the period of September 9-10, 2014, resulting

Green Town Joplin
Joplin, 2011

Following the tornado on May 22, 2011 that devastated Joplin, various individuals, companies, and civic entities decided to rebuild Joplin with a focus on energy efficiency and sustainability. A citizen advisory group was formed in order to identify priorities for recovery.

The Citizens Advisory Recovery Team, as this group is called, gathered input from local residents and submitted ideas to the City to serve as a guide for decision-making based on identified priorities. Some successful rebuilds include:

- The East Middle School/ Soaring Heights Elementary complex was built to be approximately 20-25 percent more efficient than required by code. This efficiency was achieved through a creative use of space, energy consumption, and natural daylight.
- The new Mercy Hospital has a new wall system, roof, and windows, built to be "storm hardened" and resist high wind speeds.
- Habitat for Humanity built 84 homes to ENERGY STAR standards.
- Several businesses and homes utilized Insulating Concrete Forms for their wall systems, which provide improved insulation and therefore savings on utility bills. Additionally, these walls are safer in the event of a future storm.

in a Presidential disaster declaration. This declaration made federal funding available to eligible local governments and the state on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged during the disaster in Adair, Andrew, Atchison, Daviess, Gentry, Grundy, Harrison, Holt, Knox, Lewis, Linn, Livingston, Macon, Mercer, Nodaway, Putnam, Ralls, Shelby, Sullivan, and Worth counties.

Since 1990, Missouri has received more than 30 federal major disaster declarations. These events have elevated Missouri's need to enhance and maintain its emergency energy supply planning and response efforts including energy assurance.

1. Role of Government

In 2013, the Department of Economic Development – Division of Energy prepared the Missouri Energy Assurance Plan (MEAP)[x]. The purpose of the MEAP is to provide for timely and coordinated notification to state and local government agencies, businesses, institutions, the media, and residents in the event of energy deficiencies, and to recommend appropriate actions that may be taken.

MEAP establishes the policies and procedures to be used by Missouri's Department of Economic Development - Division of Energy, support agencies, and other organizations when responding to and recovering from shortages and disruptions in the supply and delivery of electricity, natural gas, and other forms of energy and fuels. In the event of an energy emergency the Division of Energy works closely with the appropriate state, local, and federal emergency response agencies and Missouri's energy suppliers to help guide response activities.

In addition to the Division of Energy three other agencies that are heavily involved in energy assurance planning and support in the event of emergencies are the Federal Emergency Management Agency (FEMA), the State Emergency Management Agency (SEMA), and the Missouri Public Service Commission.

Mid-America Regional Council is a "Climate Action Champion"
Kansas City, 2014

The White House and DOE announced 16 communities, including the Kansas City region, which earned the first "Climate Action Champion" award in 2014. The recipients are selected for considering their climate vulnerabilities and for taking "decisive action to cut carbon pollution and build resilience".

The Mid-America Regional Council, a nonprofit association that does metropolitan planning for the Kansas City region, is recognized for proposing the creation of a regional Resilience Working Group. The Council promotes regional cooperation and innovative solutions, and seeks to reduce greenhouse gas emissions by two percent per year.

[x]The MEAP update was completed with assistance from the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability and the National Association of Energy Officials. Due to the sensitivity of information in the MEAP, the Department of Economic Development is withholding the document from full public disclosure and treats it as a confidential document. However, to the extent possible, the MEAP has informed much of the content in this section.

At the federal level FEMA is the agency charged with supporting states and local agencies to build, sustain, and improve the nation's capability to prepare for, protect against, respond to, recover from, and mitigate all hazards. FEMA Region VII administers FEMA programs and coordinates federal disaster response in Iowa, Kansas, Missouri, and Nebraska. The office is located in Kansas City, Missouri, at the geographic center of the four-state region.

SEMA's mission is to protect the lives and property of all Missourians when major natural or man-caused disasters threaten public safety. SEMA is responsible for developing a State Emergency Operations Plan which details the actions of Missouri state government departments and agencies in the event of any emergency requiring the use of state resources and personnel. SEMA also serves as the statewide coordinator for activities associated with the National Flood Insurance Program.

2. Vulnerability Assessments

A threat or vulnerability assessment is the first and perhaps the most critical step in preparing a comprehensive energy assurance policy. Vulnerability assessments identify critical gaps and risks to public and private energy-related systems and facilities and help determine which vulnerabilities to mitigate and in which priority. They allow critical infrastructure community leaders to understand the most likely and severe incidents that could affect their operations and communities and use this information to support planning and resource allocation. As a first step, critical infrastructure must be identified and then risks can be assessed in terms of:[184]

- **Threat:** natural or manmade occurrence, individual, entity, or action that has the potential to harm life, information, operations, the environment, and/or property;
- **Vulnerability:** physical feature or operational attribute that renders an entity open to exploitation or susceptible to a given hazard; and
- **Consequence:** effect of an event, incident, or occurrence.

Missouri actively participates in the Threat and Hazard Identification and Risk Assessment (THIRA) process under the guidance of the Office of Homeland Security and the Federal Emergency Management Agency. THIRA is a common risk assessment process that helps Missouri communities, including individuals, businesses, nonprofit groups, and all levels of government to better identify and understand the various types of risks to the community and determine actions that could be employed to avoid, divert, lessen, or eliminate a threat or hazard. In past years risk assessment for energy infrastructure was limited.

Working with the U.S. Department of Energy (DOE) and the National Association of Energy Officials (NASEO), Missouri is addressing fundamental risk assessment strategies to identify and implement a series of "best practices" to threat and vulnerability assessment.

3. Disaster Planning

Energy assurance planning is an all-hazards approach including man-made and natural disruptions such as terrorism attacks, cyber attacks, infrastructure failures, hurricanes, earthquakes, flooding, and other natural disasters.[185] When planning for a disaster, the U.S. Department of Homeland Security's (DHS) National Infrastructure Protection Plan recommends the following:[186]

- Build security and resilience into the design and operation of assets, systems, and networks;
- Employ siting considerations when locating new infrastructure, such as avoiding floodplains, seismic zones, and other risk-prone locations;

- Develop and conduct training and exercise programs to enhance awareness and understanding of common vulnerabilities and possible mitigation strategies;
- Leverage lessons learned and apply corrective actions from incidents and exercises to enhance protective measures;
- Establish and execute business and government emergency action and continuity plans at the local and regional levels to facilitate the continued performance of critical functions during an emergency;
- Address cyber vulnerabilities through continuous diagnostics and prioritization of high-risk vulnerabilities; and
- Undertake research and development efforts to reduce known cyber and physical vulnerabilities that have proved difficult or expensive to address.

a) Collaboration

The stakeholders involved in managing risks to critical infrastructure include partnerships among owners and operators; federal, state, local, tribal, and territorial governments; regional entities; non-profit organizations; and academia. An integrated approach across this diverse community is required in order to identify and prepare for threats and hazards to critical infrastructure, reduce vulnerabilities, and mitigate the potential consequences of adverse events that do occur.[187]

In Missouri, an example of state agency collaboration involves the Missouri Department of Transportation's (MoDOT) critical role in keeping the transportation system open and operational for the public and emergency response personnel in the event of an emergency. For example, MoDOT is charged with removing debris during ice storms to allow access and mobility for other emergency responders. Other responsibilities include removing snow during winter to improve the safety and mobility of the traveling public and emergency responders, working with energy suppliers during flooding events to provide access to their systems along and near highway rights of way, and operating traffic control systems that allow for the safe and efficient movement of traffic within urban areas.

Another example of collaboration at the federal and state level includes the support provided by the DOE's Office of Electricity Delivery - Infrastructure Security and Energy Restoration Division. Through this office, technical expertise is offered to state and local governments to ensure the security, resilience, and survivability of key energy assets and critical energy infrastructure at home and abroad.

Yet another example comes from the NASEO, a non-profit organization whose membership includes senior energy officials from the state and territory energy offices. NASEO provides assistance, education, and outreach to support states' energy assurance planning, response, and smart grid resiliency efforts. NASEO's Energy Security Committee serves as the focal point of the program, and committee members participate in planning and implementation activities aimed at facilitating peer exchange, offering expert input into state activities, and facilitating regional coordination. During an energy emergency NASEO may:[188]

- Assist in the coordination of regional energy emergency response by state energy offices;
- Work with FEMA and DOE by serving as a central energy information clearinghouse and providing timely and accurate information provided by individual state energy offices;
- Stimulate interactive communication between state energy offices by

receiving and transmitting up-to-date situation reports from state energy offices and other sources; and

- Serve as the states' liaison to appropriate federal agencies and the U.S. Congress.

Local governments are engaged in Missouri's homeland security program through the establishment of regional advisory groups, called Regional Homeland Security Oversight Committees that fall under the governance structure of the Homeland Security Advisory Council.

Overall, Missouri's collaborative energy assurance planning process engages public and private energy stakeholders to assure the availability of affordable vital energy resources during and following an emergency event. However, there is a need to enhance private energy supplier participation in the energy emergency planning process. Since the majority of energy supplies are owned or operated by private business, it is important that energy emergency planning be expanded to include private energy sector input. This includes an understanding from all fronts of key assets and infrastructure, the emergency planning and response efforts, and strategies that these private energy businesses design and implement. Having a better understanding of the private energy business emergency planning and response processes, and incorporating these elements into a public energy assurance initiative, could greatly enhance overall energy emergency planning and response.

This public-private partnership approach to energy assurance planning has been underscored by lessons learned from large-scale weather events such as Hurricane Katrina, Superstorm Sandy, and the winter 2013-2014 Polar Vortex, in response to which private energy suppliers and public sector emergency response systems worked together to address emergency response and recovery efforts in multiple states over prolonged periods of time.

Since Superstorm Sandy utilities have continued to expand and improve processes and procedures to maintain energy security, business continuity, and assurance during extreme weather events, natural disasters, and even terrorism. This work has positioned Missouri's Investor Owned Utilities well in regards to storm management and using the National Response Event process. Ameren Missouri, Empire Electric, and KCP&L are part of the Midwest Mutual Assistance Group as well as the Edison Electric Institute (EEI), through which each utility has signed a Mutual Assistance Agreement. These agreements allow utilities to request help and support each other in the event of an emergency and efficiently move extra resources into an area to help restore power to affected areas.

b) Training

Training is essential in responding effectively to energy emergencies, and industry best practices recommend that training be planned at the intra-state and inter-state level. The intra-state exercise should include key state agencies, local governments, industry, and federal partners. The inter-state or regional exercise should consider and include neighboring states, local governments, industry, and federal partners.

The MEAP recommends that regular and ongoing energy assurance training be conducted with representatives from state government agencies, local governments, and energy suppliers to identify the roles and responsibilities of each in responding to an energy shortage. Periodic tests should be conducted throughout the year, under simulated emergency conditions, to reinforce the training process of staff as well as offer other entities an opportunity to test their own plans.

In 2011, Missouri participated in the Midwestern Regional Energy Assurance Exercise. The following are lessons learned from the exercise:[189]

- Communications: know who the key points of contact are and establish relationships in advance of emergencies; have robust communication technologies and protocols in place; and develop plans for communicating with the public.
- Interdependencies: state and local governments need to understand energy industry interdependencies and prepare for them; this will improve recovery time.
- Roles and Responsibilities: plans should clearly define roles and responsibilities.
- Collaboration and Coordination: federal, state, and local government and the private sector need to work together, share information, and communicate effectively in both preparation and response.
- Resource Allocation: identify and establish resource priorities and maintain strong situational awareness so allocations can be made effectively if and when they are needed.

4. Supply Assurance

As explained in previous chapters, Missouri relies on energy resources from outside the state, such as coal, petroleum, natural gas, transportation fuels and propane. Given this dependency, Missouri's Energy Assurance Plan addresses a variety of federal and state policies and procedures to help mitigate the potential impacts of energy supply disruptions. Missouri works closely with regional partners, including energy producing states, to assure adequate supplies of energy are available to Missouri's consumers during and following an emergency event. Generally speaking, a more diversified energy portfolio that includes energy efficiency, renewable energy, and alternative fuels can assist in reducing reliance on out-of-state resources and mitigate risk of shortages or disruptions in supply of source fuels that in turn could have significant impacts on our utilities and communities. As the state's energy mix changes and clean energy options are introduced, the MEAP should be reviewed and updated.

The sections that follow shed some light on policies and procedures that are relevant to assuring the availability of energy resources for Missourians.

a) Coal

Missouri's dependence on coal makes coal-fired generating units vulnerable to interruptions in coal supplies. A large coal plant under full load may require at least one coal delivery per day containing over 15,000 tons of coal in order to remain in operation. Since coal is delivered to Missouri by rail, we are vulnerable to disruptions in the rail system from weather or congestion.

Under the Power Plant and Industrial Fuel Use Act, Section 404(a), the President has authority to allocate coal, and require its transportation, for the use of any power plant or major fuel burning installation during an energy emergency.

a) Coal

Missouri is part of the Central Region Natural Gas Pipeline Network, which is composed of twenty-two interstate and thirteen intrastate natural gas pipeline companies across 10 states.[190] Natural gas storage within the Midwest and adjacent regions provides a critical cushion for supply during peak usage, the winter season, although it remains exposed to the potential for supply disruptions.

c) Oil and Transportation Fuels

Missouri receives the majority of its petroleum products from several pipelines that originate in the Gulf Coast region. This dependency makes the state vulnerable in the event of emergencies that may occur out of state. For example, in 2005, Hurricane Katrina severely damaged several Gulf Coast refineries, and this resulted in a shortfall of transportation fuel deliveries into Missouri and a significant increase in fuel prices.

Crude and Rail Transport

The significant rise in crude production from the Bakken formation extending from Montana to North Dakota has prompted the need for additional transportation modes to carry crude to destination points for refining and shipping. As greater volumes of crude are transported by rail, the probability of safety and security concerns has increased as well.

Railroads are a viable alternative to pipeline transportation largely because they offer greater flexibility. The nation's railroad network is more geographically extensive than the oil pipeline network and better able to ship crude oil from new areas of production to North American refineries. While there are about 61,000 miles of crude oil pipeline in the United States, there are nearly 140,000 miles of railroad.[191]

Following a series of significant oil train derailments in the United States and Canada that occurred between March 2013 and May 2014, a series of recommendations addressing crude oil rail safety were offered,[192] including those addressing local and state government that highlight the need for cumulative risk analysis of crude oil rail infrastructure and increased rail traffic.

According to data for the period 1980 to 2014 from the Pipeline and Hazardous Materials Safety Administration,[193] there have been four crude oil rail transport accidents in Missouri, all within the Kansas City, Missouri area, involving Bakken formation crude destined to Gulf Coast refineries. As many as 10 crude oil trains move through Missouri counties each week along the Kansas/Missouri border and the Illinois/Missouri border.[194]

Regulatory Authority

The Federal Railroad Administration (FRA) has jurisdiction over railroad safety. State inspectors predominantly enforce federal requirements because federal rail safety law preempts state law, and federal law is pervasive. FRA regulations cover the safety of track, grade crossings, rail equipment, operating practices, and movement of hazardous materials.

The Pipeline and Hazardous Materials Safety Administration within US Department of Transportation (PHMSA) issues requirements for the safe transport of hazardous materials by all modes of transportation, which the FRA enforces with respect to railroads.

Rail incidents are investigated by the National Transportation Safety Board (NTSB), an independent federal agency. The NTSB makes recommendations toward preventing future incidents based on its findings. While the FRA has largely agreed with NTSB's recommendations, its rulemaking process involves consultation with industry advisory committees, and it must determine which of the many rail safety measures under evaluation deserve priority. Implementing a change in FRA regulations can take years.

d) Propane

Particularly for liquid fuels and propane, a just-in-time delivery market serves Missouri, which makes the state highly dependent on the ability of suppliers to meet demand. Issues affecting liquid petroleum non-transportation fuels are basically the same as those for transportation fuels. Transportation of propane into the state takes place either by pipeline to bulk terminals, or by rail or truck to storage facilities, and any disruption to the transportation system creates a vulnerability to the delivery of propane. However, the major impact of a shortfall of propane availability in the state would likely be an increase in price. In the event of a fuel shortage, the governor, or the governor's designee, has the authority to establish a state set-aside system for propane, middle distillates, motor gasoline, residual fuel oil, and aviation fuels.

Propane is a significant source of energy for rural home heating and agricultural processes, and the state has a robust propane gas industry. The "Polar Vortex" event, a prolonged period of sub-freezing temperatures during the 2013-2014 winter heating season, impacted several Midwest states, including Missouri. The high demand for propane crop drying, coupled with this weather phenomenon, resulted in high and sustained demand for propane from November 2013 through March 2014. Record-setting consumer demand throughout the Midwest depleted propane supplies at bulk distribution terminals resulting in long wait times by propane transporters. These constraints resulted in propane supply shortages and even curtailments in other states, although the effects in Missouri were largely limited to delays.

Enhanced storage capacity at bulk terminals would help ease long wait times to fill transports. And greater use of tertiary storage in customer tanks could be encouraged through aggressive summer fill or pre-buy contracts or by offering credit finance or metered service arrangement between propane companies and consumers.

To help ease the seasonal rise and fall of propane demand, Missouri marketers should continue to examine and implement enhancements in propane use through landscaping as well as a dedicated or dual-fueled transportation fuel resource in rural fleet application.

5. Microgrids, Smart Grids and Distributed Generation

Microgrids, which are localized grids that can disconnect from the traditional grid to operate autonomously, can play an important role in reducing impacts of emergency events. Microgrids can strengthen grid resilience and help mitigate grid disturbances because they are able to continue operating while the main grid is down, and they can function as a grid resource for faster system response and recovery. Microgrids also support a flexible and efficient grid by enabling the integration of growing deployments of distributed generation including renewable sources, combined heat and power, and energy storage. In addition, the use of local sources of energy to serve local loads helps reduce energy losses in transmission and distribution, further increasing efficiency of the electric delivery system.[195]

Depending on how utilities and regulators define microgrids, they can fall under the purview of smart grid initiatives. Smart grid technologies, including Advanced Metering Infrastructure, are an important component of a resilient grid and should be considered to enhance energy emergency response in the short term and reduce vulnerability and risk in the long term. Smart grid characteristics such as outage detection and self-healing capabilities improve electricity grid system response to energy emergencies. As an example, smart meters can provide timely and accurate power outage information, improving emergency responses and even preventing some outages altogether.

Although there are many benefits of smart grids, the increase in connectivity across traditionally segmented operations can increase system vulnerabilities, and with digital technologies such as smart grid components and remote monitoring and control equipment, there can be an increased risk of cyber-attacks.[196]

Finally, despite the increased global focus on smart grids, including the role of smart grids in resiliency planning and smart technology, smart grids remain largely in the pilot stage. There is, however, an opportunity for Missouri to review the costs and benefits of smart grids and microgrids, including their role in resiliency planning.

6. Transportation and Transmission

Transportation is the largest energy-consuming sector in Missouri and special attention must be paid to ensure that extreme weather conditions, natural disasters, strikes or international embargoes do not lead to interruptions in the supply of transportation fuels. The inability to supply fuel to the transportation system not only impacts the mobility of people but may also affect the transportation of resources and lead to the interruption of deliveries needed for electricity generation, causing a potential for power outages. As a means of mitigating this risk, Missouri works to promote alternative fuels including propane, biofuel blends, electricity, and natural gas, with the intent of reducing dependence on a single fuel source such as gasoline or diesel.

In terms of electricity, many miles of electricity transmission lines deliver power to substations and later to customers. Issues that may impact reliability include transmission congestion in certain areas of the system and the need for redundancy. In addition, disruptions caused by storms that damage transmission and distribution lines are the most frequent source of power outages, but an accident or unusual event at a power plant could also cause an extended plant shutdown. Through bilateral agreements utilities work together to aid one another in the event of an emergency, during power plant shut downs, and in case of transmission outages.

7. Physical and Cyber Security

7.1 Critical Facilities

Critical facilities are considered those that provide essential customer services and that should be considered a priority in the instance of an energy emergency.

Missouri University S&T Microgrid
Rolla, 2014

A small-scale microgrid was unveiled at the Missouri University of Science and Technology's Solar Village in July 2014. This is an opportunity for researchers to analyze a new system of energy management.

The microgrid, which manages and stores renewable energy among the four homes in the village located on 10th Street in Rolla, serves as a research instrument for Missouri S&T professors and students with the goal of analyzing the abilities of small-scale microgrids. Students living in the four solar houses monitor the results and demonstrate how people interact with a new system of energy management.

Missouri S&T's Solar Village allows for the development of research ranging from Building Science, to Electrical Distribution, to Material Science.

Some examples of critical facilities include hospitals, law enforcement, fire protection, generating stations, and associated transmission and distribution infrastructure.

The Public Technology Institute provides critical facility guidelines that help establish energy infrastructure priorities. First, it is important to identify essential customer services and ensure that recipients of these services are considered priority customers by the utility during a brownout or emergency event.

In 2006, the North American Electric Reliability Corporation adopted Critical Infrastructure Protection Standards that establish minimum requirements needed to ensure the security of electronic information exchange to support the reliability of the bulk power system. On February 12, 2013, the President issued an Executive Order improving critical infrastructure cybersecurity.[197]

7.2 Cybersecurity

A cyber-attack can be any type of offensive maneuver that targets information systems, infrastructures, or computer networks in order to steal information, destroy infrastructure, or produce some other type of vulnerability. It is particularly important to protect the energy industry from cyber-attacks because when electricity or fuel supplies are low the impact to the economy and to other industries can be significant.

Combating cyber threats is a shared responsibility. The public, private, and non-profit sectors, and every level of government all have an important role to play. At the federal level, the DHS plays a key role in securing the federal government's civilian cyber networks and helping to secure the broader cyber system through:

- Partnerships with owners and operators of critical infrastructure such as financial systems, chemical plants, and water and electric utilities;
- The release of actionable cyber alerts;
- Investigations and arrests of cyber criminals, and
- Education about how the public can stay safe online.

While utilities are responsible for building a strong cybersecurity capacity for critical infrastructure, it is becoming increasingly important that regulators be able to recognize underlying concepts of robust cybersecurity when it comes before them in a proceeding. A few of the concepts that should inform a regulator's assessment of a utility's cybersecurity proposal should include the following: prioritizing systems and networks over components, ensuring that human factors are considered, deploying defense-in-depth, and promoting system resilience.[198]

To address concerns about effective cybersecurity practices for protecting essential electric utility infrastructure, the Missouri Public Service Commission (PSC) opened a working case, File No. EW-2013-0011, in July 2012. Working with several stakeholders, participants in that case agreed that the review of security practices should be expanded to include all Missouri regulated utilities and to include physical security threats as well as cybersecurity threats. To that end, the PSC closed the electric utility working case and opened a new expanded working case, File No. AW-2015-0206, to include all utilities, not just electric utilities. The goal of this working case is to review and consider the physical and cybersecurity practices of all Missouri utilities.

In our state, the Missouri Office of Cyber Security (OCS) is responsible for managing all information security-related events within the enterprise and ensuring proper administrative and technical controls are implemented to safeguard the state of Missouri's information systems. In addition, the OCS promotes and provides expertise in information security management for all state agencies and supports national and local homeland information security efforts.

Due to the increased awareness of information security-related events and insight into the network and endpoints as the result of expanding its capabilities, OCS has created a Security Operations Center (SOC). The SOC is responsible for managing all information security related incidents for the enterprise, ensuring they are properly identified, analyzed, communicated, remediated, and reported. The core mission of the SOC is to ensure that citizens' data remains private and secure. The SOC also mitigates the potential liability caused by data breaches.

7.3 Training

The Emergency Management Training program delivered by SEMA offers an extensive array of training opportunities for state and local emergency managers, public officials, members of volunteer relief organizations, and professionals in related fields. The program has proven itself to be a comprehensive and effective vehicle to train state and local officials in disaster mitigation, preparedness, response, and recovery. Jurisdictions across Missouri can and do cope with disaster by preparing in advance through training activities and by using the skills learned to build local teams and coalitions that respond to emergencies.

Specific to cybersecurity, the National Association of Regulatory Utility Commissioners (NARUC) recommends that regulators invest in training staff on cybersecurity standards and provide regular updates to training as information changes and technology advances. In addition, NARUC provides cybersecurity training free of charge through grant-funded programs once or twice per year and convenes cybersecurity experts at its meetings. In partnership with the National Electricity Sector Cybersecurity Organization, NARUC also hosts regular threat assessment teleconferences.

8. Summary of Key Points

- The Missouri Energy Assurance Plan establishes the policies and procedures to be used by Missouri's Department of Economic Development - Division of Energy, support agencies, and other organizations when responding to and recovering from shortages and disruptions in the supply and delivery of electricity, natural gas, and other forms of energy and fuels. The MEAP is a critical document that should be reviewed and updated frequently.

- Energy infrastructure provides essential fuel to other sectors and in turn depends on the nation's transportation, communications, and government infrastructures. There are also interdependencies within the energy infrastructure itself, particularly the dependence of petroleum refineries and pipeline pumping stations on a reliable electricity supply, while backup generators and utility maintenance vehicles depend on diesel and gasoline fuel. Energy assurance exercises should include system interdependencies and should continue to be reviewed as part of the Missouri Energy Assurance Plan.

- Inter- and Intra-state collaboration at all levels of government and with the private sector is critical for energy assurance. Missouri's government should continue to work with private institutions to identify resources and invest in technologies and other measures that make the electricity sector more resilient while helping to curb further climate change.

- Microgrids and smart grids can provide several benefits in terms of grid resiliency. Microgrids can strengthen grid resilience and help mitigate grid disturbances because they are able to continue operating while the main grid is down, and the can function as a grid resource for faster system response and recovery. Smart grid characteristics such as outage detection and self-healing capabilities improve electricity grid system response to energy emergencies. Smart grids remain largely in the pilot stage and there is an opportunity for Missouri to review the costs and benefits of smart grid and microgrids, including their role in resiliency planning.

- A more diversified energy portfolio that includes clean energy and alternative fuels can assist in reducing reliance on out-of-state resources and mitigate risk of shortages or disruptions in supply of source fuels that in turn could have significant impacts on our utilities and communities. As the state's energy mix changes and clean energy options are introduced, the MEAP should be reviewed and updated.

- Ameren Missouri, Empire Electric, and KCP&L are part of the Midwest Mutual Assistance Group as well as the Edison Electric Institute. Each utility has signed a Mutual Assistance Agreement through EEI. At this time, municipals and cooperatives are not part of the Regional Mutual Assistance Group.

- Missouri relies heavily on propane for home heating and agricultural processes and, as a result, the state has a robust propane gas industry While the state largely avoided prop ane supply disruptions and curtailments during the 2013-2014 winter heating season, supply assurance could be enhanced by several policy changes. These changes include enhancements to current propane storage practices, switching to a metered service arrangement between propane companies and consumers, and offering credit finance opportunities.

- Although Missouri actively participates in the Threat and Hazard Identification and Risk Assessment process under the guidance of the Office of Homeland Security and the Federal Emergency Management Agency, there is a need to complete a statewide risk assessment of critical energy infrastructure and key energy assets.

- Enhanced storage capacity at bulk terminals would help ease long wait times to fill transports. Greater use of tertiary storage (customer tanks) could be encouraged through aggressive summer fill or pre-buy contracts or by offering credit finance or metered service arrangement between propane companies and consumers.

- To help ease the seasonal rise and fall of propane demand, Missouri marketers should continue to examine and implement enhancements in propane use through landscaping as well as a dedicated or dual-fueled transportation fuel resource in rural fleet application.

Chapter 4:
Energy Infrastructure Modernization

Missouri utilities are investing in grid modernization, primarily targeted at improving reliability, resilience, and operating efficiencies in centralized generation and delivery infrastructure. Accelerating modernization by promoting greater automation and decentralization would yield a smarter and stronger electrical grid capable of meeting our evolving need for diversity and clean energy. Grid modernization in which information communication is two-way would not only benefit customers by empowering them to make cost savings decisions, but also benefit utilities and industry stakeholders and generate economic growth.

This chapter identifies opportunities for system enhancements and recommends mechanisms to promote further investment in grid modernization. These metrics should be designed in order to provide assurance that grid modernization is not a costly transition to a novel technology but rather a replacement of outmoded equipment with cost-effective technology that empowers consumers to exercise more choice over their energy use while allowing utilities to better respond to the evolving needs of their customers. In addition, the need to address security and consumer privacy is essential while developing a smarter and stronger power grid that will be more dependent on two-way communication and information technologies.

I. The Modern Electric Grid

1. The Current Status of the Grid

The fundamental design of the electric power grid has remained largely the same for a century. It is built around large centralized power plants that are connected to consumers via miles of transmission and distribution lines. Historically, Missouri's electric utilities have focused investments in energy infrastructure on ensuring adequate and reliable service and on leveraging economies of scale in supply-side generation and delivery infrastructure to achieve cost savings. These investments have resulted in highly reliable service at relatively low rates. The frequency and duration of outages are generally lower than the rates experienced in other states, and when outages do occur, they are primarily associated with weather events such as severe thunderstorms or ice storms rather than congestion or antiquated equipment.

The current grid and corresponding systems have been designed with some level of flexibility and resilience to accommodate variability and uncertainty in overall load as well as contingencies related to network and conventional power plant outages. Flexibility is the ability of a resource, whether it is a component or a collection of components of the power system, to respond to the scheduled or unscheduled changes of power system conditions at various operational timescales. Resilience refers to the ability of the energy infrastructure, including individual grid components or entire systems, to resist failure and rapidly recover from a breakdown.

Grid operators at the regional and local levels must respond to trends that affect load patterns, such as decreased demand growth, the changing demand patterns across the day, increased variable renewable generating resources, power plant retirements, and extreme weather events. Many recent analyses lay out options for flexible electric systems that can come from a portfolio of supply- and demand-side initiatives, including grid storage, more responsive loads, changes in power system operations, larger balancing areas, flexible conventional generation, and new transmission.

Over the last decade, technological improvements and innovation have resulted in significant opportunities for grid modernization and placed new emphasis on demand-side resources as a beneficial and cost-effective alternative to supply-side resources.

Much of Missouri's electric grid, especially in large metropolitan areas, was constructed to serve dramatic increases in electric demand in the 1950s, 1960s, and early 1970s. This demand was driven by air conditioning, industrial load growth, population growth, and urban sprawl. At the Missouri Public Service Commission's (PSC) recent Aging Infrastructure and Environmental Regulations Discussion, Ameren Missouri discussed the current need for increased investment in the electric system, but stated that investment becomes difficult to recover with declining growth. The company emphasized that it was important to make long-term decisions for future generations and to continue to provide safe and reliable power to customers as their expectations continue to increase.[199]

Missouri utilities are investing in grid modernization, primarily targeted at improving reliability, resilience, and operating efficiencies in centralized generation and delivery infrastructure. Accelerating modernization by promoting greater automation and decentralization would yield a smarter and stronger electrical grid capable of meeting our evolving need for diversity and clean energy. Grid modernization in which information communication is two-way would not only benefit customers by empowering them to make cost savings decisions, but also benefit utilities and industry stakeholders and generate economic growth.

2. Grid Reliability

Between 2008 and 2012 the estimated costs of weather-related power outages ranged nationally from $107 billion to $202 billion.[200] Weather-related disturbances have a greater impact on grid reliability than component failures, direct physical attacks on infrastructure, and cyber incidents combined[201] – see Figure 39.

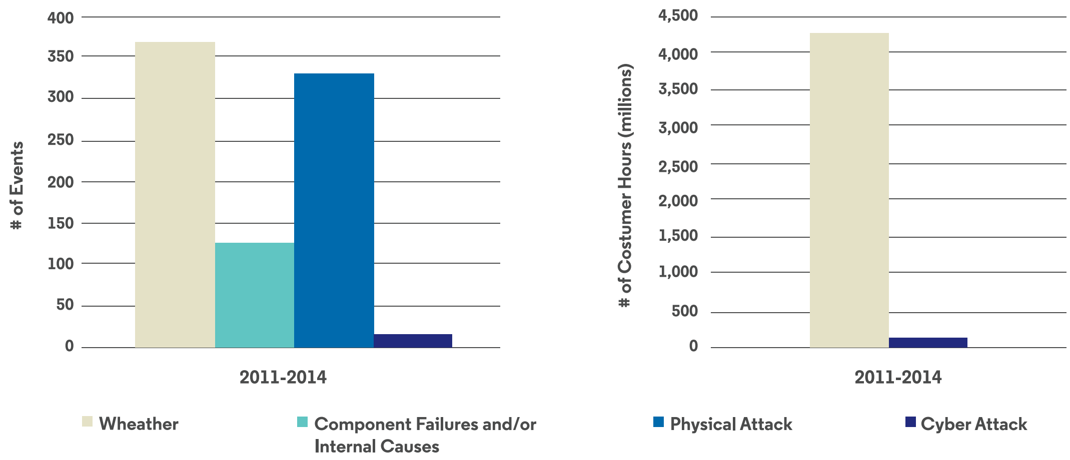


Figure 39. Left Figure: Electric Disturbance Events, January 2011- August 2014; Right Figure: Customer Hours Affected by Electric Disturbance Events, 2001 – August 2014.

Source: Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure. U.S. Department of Energy. April 2015.
http://energy.gov/sites/prod/files/2015/07/f24/QER%20Full%20Report_TS%26D%20April%202015_0.pdf

Note: While weather was responsible for less than half of all reported incidents, weather accounted for the vast majority of customer interruption hours from 2011 to 2014. Not all reported events (shown on the left), such as voltage reductions and public appeals, result in actual customer outages (shown on the right).

Extreme weather events, including extreme heat waves, droughts, and wildfires, that can damage electricity infrastructure or reduce transmission efficiency are projected to increase with climate change. Temperatures in the U.S. are likely to continue to rise in the coming decades resulting in electricity transmission and distribution systems that carry less current and operate less efficiently due to higher ambient air temperatures.[202] According to documented case studies, sudden, extreme heat can cause transformers to malfunction or stop working.[203] In addition, as temperatures increase, electricity demand for cooling during peak demand periods will likely also rise, thereby increasing the utilization of transmission and distribution systems in those periods. Finally, reduced power plant cooling efficiency is anticipated from increasing air and water temperatures, which increases the risk of partial or full shutdowns of generation assets and the services they provide.[204]

Beyond procedural barriers, there are problems with inadequate information and tools with which to manage for resilience. Quantitative measures of adequacy of resilience investments, or even a commonly accepted method for determining the appropriate level of resilience at either the transmission or distribution level, do not exist. For example, while the North American Electric Reliability Corporation develops and enforces mandatory reliability standards applicable to the bulk electric system (subject to Federal Energy Regulatory Commission review, approval, and independent enforcement authority) and, more recently, physical security and geomagnetic disturbance standards, there are no mandatory standards in place that speak directly to grid resilience against natural disasters. In addition, there is no common, generally accepted analytical method of determining whether it is prudent to implement alternative resilience projects.[205]

Missouri utilities' investment in grid modernization has been primarily targeted at improving reliability, resilience, and operating efficiencies in centralized generation and delivery infrastructure. These investments include numerous smart grid infrastructure components ranging from smart line capacitors and microprocessor relays to Supervisory Control and Data Acquisition (SCADA) systems and Automated Metering Infrastructure (AMI).

Missouri's electric utilities have historically provided adequate and reliable service to its customers. The System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI) are two metrics commonly used to judge the reliability of the electric system. SAIDI measures the total duration (in minutes) of interruptions for the average customer during a given time period. SAIFI measures the average number of times that a customer experiences an outage during the year. Table 19 illustrates 2013 SAIFI and SAIDI data adapted from the U.S. Energy Information Administration (EIA) for Missouri's IOUs and includes national averages and the averages of five companies operating in comparison states. SAIDI and SAIFI are presented with and without Major Event Days (MED). MED is calculated individually for each company and, generally speaking, represents an outage that surpasses a certain threshold of duration specific to each company. In other words, if the minutes of interruption on a given day are outside the normal range for a company, that day is classified as a MED. For each category, three out of four of Missouri's IOUs performed better than the regional and national averages.

Table 19. SAIFI and SAIDI Data for Missouri, 2013.

Source: Adapted from U.S. Energy Information Administration (EIA). "Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files." Accessed July 2015. http://www.eia.gov/electricity/data/eia861/index.html

Missouri Regulared Utility	SAIDI with MED	SAIDI without MED	SAIFI with MED	SAIFI without MED	Number of Customers
Empire District Electric	146	146	1.27	1.17	160,799
Kansas City Power & Light	208	70	1.18	0.82	276,535
KCP&L Greater Missouri Operations	219	103	1.50	1.08	308,938
Union Electric dba Ameren Missouri	371	8	0.99	0.7	1,206,122
Missouri Averages	236	102	1.17	0.90	488,099
Illinois, Iowa, and Kansas Average	270	108	1.44	1.12	334,143
National Average	331	131	1.37	1.06	599,199

Note: The national average comprises 62 vertically integrated electric utilities.

The Missouri Energy Risk Profile, prepared by the U.S. Department of Energy (DOE), reports that for the period 2008-2013 weather and falling trees were the primary cause of electrical outages in Missouri - see Figure 40. Over that same period 214,763 customers were affected annually by electrical outages with a total duration of outages of 45.3 hours – see Figure 41.

Causes of Electric-Utillity Reported Outages (2008-2013)

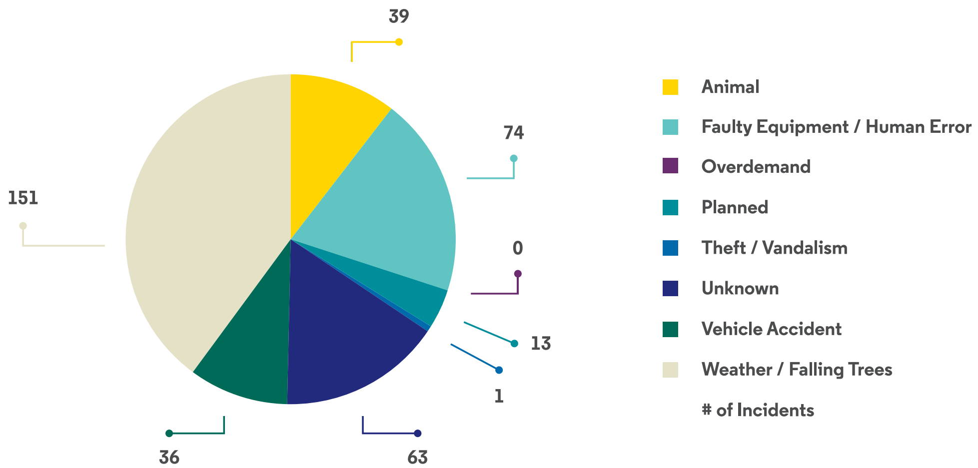
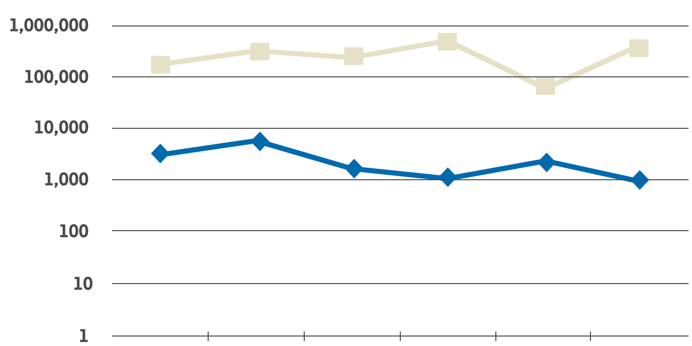


Figure 40. Causes of Electric-Utility Reported Outages, 2008-2013.

Source: U.S. Department of Energy (DOE). "State of Missouri Energy Sector Risk Profile." 2015. http://www.energy.gov/sites/prod/files/2015/05/f22/MO-Energy%20Sector%20Risk%20Profile.pdf

Utility Outage Data for 2008-2013



	2008	2009	2010	2011	2012	2013
Total number of people affected by outages	3,840	6,350	2,060	1,030	2,140	900
Total duration of autages (minutes)	175,430	244,520	198,280	322,990	56,080	291,400

Figure 41. Utility Outage Data for 2008-2013.

Source: U.S. DOE. "State of Missouri Energy Sector Risk Profile." 2015.

3. The Vision for a Modern Grid

While there is no common definition for what a "modern grid" should consist of, there is general consensus from stakeholders involved in modernization efforts that a modern grid will be more sophisticated than the current grid, with two-way communication between systems. These communication systems will allow the grid components, consumers, and operators to make more informed and timely decisions. In addition, the modernized grid should be more distributed and decentralized, flexible, reliable, efficient, and should utilize cleaner sources of electricity. Finally, a modern grid should be a stronger grid that promotes greater resilience, safety, and security.[206] As a modern grid is developed there will certainly be impacts to generation, grid operations, markets, customers, utilities, and regulatory models.

With regard to generation, a modern grid should include both central and distributed generation sources with a mix of both dispatchable and non-dispatchable resources. Combined with both central and distributed generation sources, the storage of energy with new technologies is likely to become a critical component to future system design. Energy storage technologies are anticipated to increase the development of distributed, non-dispatchable resources such as small-scale solar photovoltaic systems. Finally, as microgrids continue to be developed they are anticipated to compliment future grid operations.

With additional generation sources as well as stored energy resources, grid operators will need the ability to predict conditions in close to real time through the use of two-way communications from system components as well as sophisticated modeling and estimation capabilities. In addition, in some jurisdictions the distribution grid could become a platform that will enable changes to the retail electric marketplace with wholesale-to-retail transactions and retail-to-wholesale transactions. In all likelihood, there will be a mix of both regulated and competitive electric services.

A modern grid should leverage two-way communication technologies to provide for higher levels of customer information, interaction, and control. Real-time communications to end-use devices and equipment will allow for increased automation and greater levels of energy efficiency, conservation, and peak demand reductions. Clear and accurate price signals would allow customers and devices to respond appropriately and make informed decisions.

A modern grid will require significant levels of investment and utility business models must continue to account for infrastructure development costs while also providing an incentive for entities to build and maintain infrastructure in the future. In addition, the compensation structure for transmission and distribution utilities will require revisions to account for the services that they provide and also the ancillary services that consumers and/or third parties may also provide back to the grid at the retail level. As the development of non-regulated distributed generation assets becomes more prevalent, the planning process for regulated assets is also likely to become more challenging.

Changes to current regulatory models may be required in order to appropriately balance the public good with the needs and desires of individuals. Smart grids should benefit both customers and energy providers. A modern grid is likely to add complexity to regulation as the increasing interdependencies of transmission and distribution operations create jurisdictional uncertainty that will need to be refined and clarified with better coordination between federal and state regulatory bodies.

Safeguards to mitigate and protect against cyber, physical, and other threats will be critical.[207]

Grid modernization cost-recovery mechanisms must be designed in a manner that demonstrates adequate consumer protection. In Missouri, consumer protection measures considered in the past include prudence reviews, which stipulate the refund of any imprudently incurred costs, and caps on rate adjustments, which help insure that costs remain reasonable. In addition, metrics determined applicable to Missouri could be used to evaluate effectiveness of grid modernization investments.

A number of consumer protection issues should be addressed in the overall construct of smart grid design and deployment planning, such as consumer education and bill protection programs, ownership of data, privacy, security, the risk of remote disconnection, and social safety nets for vulnerable consumers (e.g. financial assistance or optional dynamic pricing options or hybrid flat-rate/time-of-use rate structures). Effective educational outreach about smart grid and smart meter technology and its benefits is needed, especially among low-income households. Concerns about rising costs from smart grid-enabled programs or technology should be proactively and effectively addressed. Consumer advocates are concerned that customers who are unable to modify their consumption habits should not have to bear the extra costs of smart grids or be subject to dynamic or time-based pricing. Planning should include identifying opportunities for less technology-savvy consumers to have access to user-friendly devices that help them better manage household energy costs. Participation rates in energy efficiency programs for renters and low-income consumers should be improved and smart grid investments should be integrated with utility energy efficiency and renewable energy programs and targets.

II. The Benefits of a Smart and Modern Grid

Modernization of Missouri's electric grid can support important public policy priorities including improving the reliability and resilience of electric service, enhancing safety and security, and containing energy costs. The modern grid that is envisioned has numerous benefits. The grid will become more reliable and resilient, more efficient, and will empower customers to manage and reduce their energy costs. Upgrading our electric transmission and distribution system infrastructures will provide direct, measurable benefits to customers provided the investments are verifiable and transparent, adhere to cost estimates, and deliver on promised outcomes.

1. Improved Resilience

Increased automation will help protect, communicate with, and control the elements of the grid while quickly identifying problems and then resolving them. For example, information obtained from grid components through real-time communications can allow for automatic adjustments or redirections of power. Automated controls can also identify stressed equipment so that it can be repaired or replaced before a failure occurs.[208] By diversifying generation sources there will be increased levels of redundancy if an asset were to unexpectedly go offline. A smart grid would be able to identify and correct power quality issues that can impact customers, particularly large industrial facilities that often have sensitive equipment.

There is evidence that hardening of critical energy infrastructures, before a disaster occurs, could help save lives and reduce economic losses to individuals, businesses, insurers, states, and the federal government. For example, while not specific to energy, a statistical study of 5,500 Federal Emergency Management Agency mitigation grants awarded between 1993 and 2003 found that the benefit-cost ratio for mitigation investments was about 4:1.[209] According to the April 2015 Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure, produced by DOE, it is essential to focus on modernizing transmission, storage, and distribution infrastructure assets at the same time that they are being hardened. The report describes four categories of transmission, storage, and distribution infrastructure that are particularly vulnerable to hazards and ranks the vulnerabilities from low to high:[210]

- Electricity Transmission: high vulnerability to physical attacks and wind, medium-high vulnerability to earthquakes, wildfires, snow and ice, extreme heat, and geomagnetic storms.
- Electricity Substations: medium-high vulnerability to cyber and physical attacks and geomagnetic storms - large power transformers in such substations are a particular concern. A common vulnerability for substations is flooding, and flood vulnerability has a relatively high probability.
- Aboveground Electricity Distribution: high vulnerability to wind, medium-high vulnerability to earthquakes, physical attacks, wildfires, and snow and ice.
- Control Centers: Medium-high vulnerability to cyber and physical attacks.

In terms of resilience and reliability, a report recently published by DOE shares the results of several American Recovery and Reinvestment Act (ARRA) grants that were provided to states to determine how smart grid technologies could speed outage restoration following major storm events, reduce the total number of affected customers, and improve overall service reliability to reduce customer losses from power disruptions. According to the report, the utilities that used smart grid technologies for outage management were able to accelerate service restoration and limit the number of affected customers during major storm events. In addition, the utilities were able to use repair crews more efficiently, while reducing costs and outage time. The utilities deployed two modern grid approaches: (1) the use of distribution automation including automated feeder switching and fault location, isolation, and service restoration, and (2) the integration of AMI capabilities with outage management systems.

2. Energy Storage

The design of the current grid requires that electricity generation meet customer demand in real time. Since customer demand is volatile and unforeseen, load swings do occur and generators must maintain reserve capacity to deliver energy when it is needed. Energy storage technologies, however, can provide a buffer between generation and the volatility of customer demand. Storage technologies are unique because they can take energy or power from the grid, add energy or power to the grid, and supply a wide range of grid services on short (sub-second) and long (hours) timescales.

Energy storage technologies, including those described in Chapter 2: Energy Supply, will be critical to a modern grid as a means of providing flexibility to operators. Some storage technologies such as batteries, flywheels, and supercapacitors, have fast response rates (seconds to minutes) and can delivery energy over a short time frame. Other storage technologies, such as compressed air energy storage and pumped hydro storage, have more limited flexibility in response time as the response time of those technologies is on a timescale of hours to days.[211] The modern grid will likely incorporate multiple energy storage technologies so that supply and demand are matched more efficiently over an entire 24-hour time period.

3. Reduced Costs

A modern grid can reduce costs for consumers by encouraging energy efficiency, reducing peak demand, providing new rate options, and better integrating with distributed generation resources. Through modernization efforts at the grid level, continual optimization of distribution voltage will directly reduce energy consumption by minimizing line losses and optimizing energy flows. A modern grid can also complement existing energy efficiency and demand response programs, including those currently available in Missouri, while also allowing for new program models that are dependent upon customer data integration. Grid modernization technologies can help consumers use energy efficiently by conveniently providing usage and cost information in near real-time and encouraging consumer behavior to use energy during off-peak hours, reducing peak demand so that less power generation is needed to meet overall demand.[212] In turn, these efforts also result in reduced environmental emissions associated with the generation of electricity and reduced utility bills for the customer.

Greater reductions in peak demand result from a modern grid by enabling consumers to use demand side management information and tools to reduce their electricity use during periods of peak demand. Time-differentiated rates, as described in Chapter 2: Energy Supply, could encourage customers to impact peak demand. By shifting loads when electricity is most expensive, customers benefit from reduced costs, grid asset utilization is improved, and the need to build more generating capacity is avoided.

A modern grid can also provide opportunities for utilities to offer consumers more rate options and more control over their utility bills. Dynamic pricing structures can empower consumers to pursue cost-saving measures that both reduce peak demand and help utilities to cost-effectively manage fluctuations in demand. Utilities will be able to manage costs by contracting with consumers to allow the shift of electricity use away from peak hours.[213]

With the onset of modern grid technologies, distributed generation resources can provide more than localized demand resources, thereby further diversifying the overall generation mix and increasing reliability and resilience benefits. The two-way communication technologies associated with the modern grid can complement net metering offerings and policies while also assisting in better renewable energy tracking for compliance purposes. In addition, modern grid technologies can provide customer-specific load profiles that help consumers become more efficient with distributed generation systems and shift loads to off-peak periods.[214]

4. Demand Response

With time-of-use pricing combined with access to real-time energy usage information from a modern grid, consumers will be better able to take control of their electricity use when prices rise during peak demand periods. Consumers could pre-program smart appliances to operate within selected price and performance levels. In turn, some electricity consumption could be shifted from times when the price is most expensive to periods when the price is cheaper, for example at night.[215] Demand response is applicable to both residential and commercial customers; for example, commercial buildings could turn air conditioning down, or stop operation of certain functions.

Demand response and curtailment programs offered by utilities would be enhanced by the implementation of time-based rates including time-of-use (TOU) rates, critical peak pricing, critical peak rebates, and variable peak pricing. The use of time-based rates is growing – the Federal Energy Regulatory Commission estimates 2.1 million residential customers participated in 2012, nearly double the 2010 amount - but time-based rates are still used by only a small fraction of total customers.[216]

Missouri has offered time-differentiated and curtailable load rates since at least the early 1980s. TOU rates reflect relatively higher prices, which customers pay during summer peak periods, and relatively lower prices which customers pay in winter and off-peak hours. However, subscription to TOU programs has been limited. In its most recent rate case, Ameren Missouri proposed adjustments to better target rate differentials between peak and off-peak hours. Currently, all of Missouri's investor-owned electric utilities also offer curtailment or interruptible load programs to commercial and industrial customers. While curtailment events are rarely called, these programs can be effective in reducing load during peak periods.

In 1994 Ameren Missouri offered a curtailment pilot program[217] to explore demand-side potential at levels of at least 1,000 kW. In 2004, the company conducted a residential pricing pilot program study that offered variations of TOU rates and critical peak pricing elements, including the use of thermostats designed to reduce load during critical peak periods. Conclusions from the study indicated that demand was responsive to critical peak pricing; however, the amount of load shifted was not found to be significant. More recently, KCP&L tested a home area network pilot project that included a programmable thermostat and other load control devices as part of the company's smart grid demonstration project.

Modernization of Missouri's electric grid infrastructure can work to overcome past barriers to implementation by facilitating greater control of energy consumption and demand through two-way interaction between the utility and the customer. This can increase customer participation in demand-side programs, subsequently increasing their cost-effectiveness and achieving greater energy and demand savings.

5. Grid Communication

As previously described, the fundamental design of the electric power grid has remained largely the same for a century. From a customer perspective, this includes electromechanical meters and other analog technologies that do not provide for modern, digital capabilities. As a result of the lack of effective two-way communication between customers and utilities, the current electric system in the U.S. has very little feedback between energy producers and energy consumers.[218] This poses difficulties for a utility when forecasting electricity production requirements. It is important for utilities to maintain reserve capacity to meet potential peak demand. However, maintaining reserve capacity is both inefficient and very costly.[219]

6. Empowering Customers

Smart grid technologies allow for more effective interactions between power producers and power consumers. For example, smart meters typically collect 15-minute interval data on energy usage allowing utilities to institute practices such as dynamic pricing, in which the cost of electricity varies with the state of the grid, and demand management, in which customers can save money by having devices dynamically respond to signals from the utility.[220] Price differentials should be sufficient to increase consumer participation in dynamic pricing and demand response programs.

6.1 In-Home Energy Displays

Energy information displays, or in-home energy displays, have the potential to help customers save energy and money. Energy information displays provide feedback to a consumer on how much energy is being consumed in a real or near-real time basis. In most cases these displays receive data from the home's main circuit panel and convert it into cost and energy usage for the consumer. Some devices that are more sophisticated can provide information at the individual appliance level and generate statistics and trends. In addition these displays may be capable of setting alerts.

With the use of these devices the consumer receives immediate, appliance-specific feedback that allows him or her to learn about energy use and make decisions around it. To save energy, the consumer would have to act upon the information being provided, that is, the in-home displays do not save energy by themselves. It is important to mention that these displays are not exclusive for homes and can also be used by businesses.

Another approach to receiving energy information is the installation of gateways that communicate energy consumption information via a web portal, usually in conjunction with a smart meter. Multiple devices can be connected to a gateway so it can transmit data retrieved from the meter to each connected device.[221] Most in-home displays are currently being provided to homeowners through energy efficiency programs run by utilities.

6.2 Smart Thermostats and Appliances

Smart thermostats have all of the functionality of a programmable thermostat but provide a greater convenience to the user. They are connected via Wi-Fi and therefore can report information to the user via a computer or a mobile phone application. This provides the user with additional flexibility to program the thermostat, even when the user is away from the home or the office, and to react to potential changes in outside temperature. Smart thermostats come with monitoring systems that track energy use and offer visual reports and charts to the user so that he or she can understand energy use patterns. With this information the user should be able to identify areas where energy is being used inefficiently and adjust accordingly. Some devices are also able to "learn" a user's behavior and lifestyle through motion sensors, ambient light and humidity monitors by remembering manual adjustments. Some rely on a virtual perimeter or geofence to detect when a user is out of range.[222] In this manner the thermostat detects when a person is or is not in their home and can adjust settings accordingly.

Similar to smart thermostats, smart appliances are considered to be the next wave of technology products for a home. These appliances can be connected to a home network and controlled by the user even when the user is at a different location via a computer or mobile phone application. These appliances can provide direct, real-time feedback and allow for automation. In addition, with a time-of-use pricing structure, these smart appliances are able to receive pricing signals and follow programmed decisions regarding when they should run or when they should turn off. Smart appliances currently available in the marketplace include light bulbs, ovens, dishwashers, washers and driers, and water heaters.

6.3 Home Networks

A future complete home energy management system may include a network of wireless and wired sensors, display, and feedback devices, including automation functions that may communicate with the utility and would incorporate the proper safety, security, and privacy protocols. The home energy management network may result in a system that optimizes household performance based on supply conditions and market prices, as well as consumer comfort and environmental preferences.

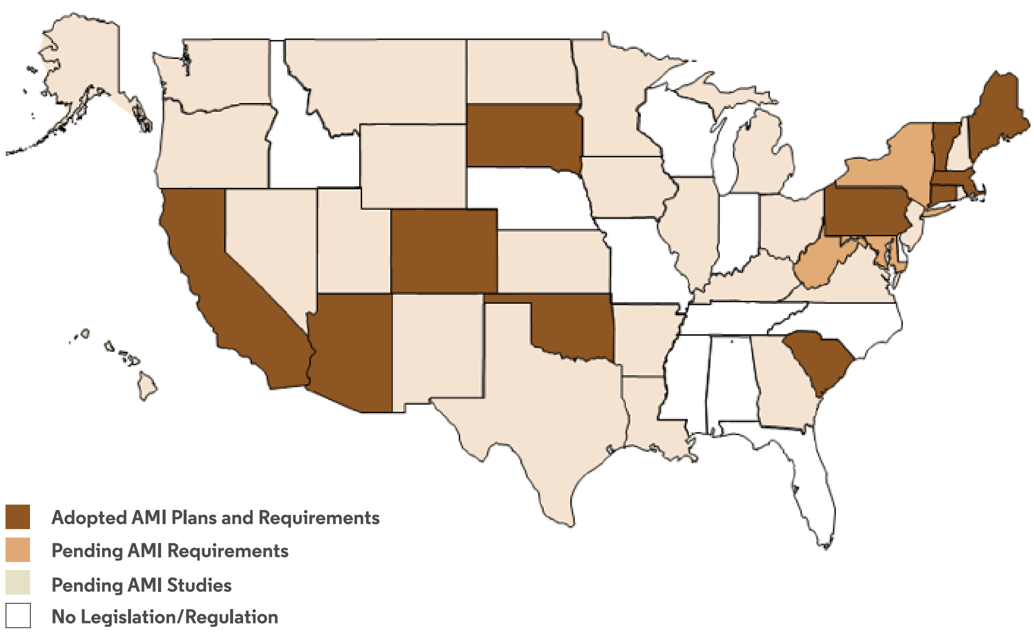
A complete home automation network may include several components. Among these are in-home smart devices and appliances with embedded networking or communication technologies that allow for wireless and/or wired automation. Advanced network systems and software that provide measurement and feedback of appliance-specific data could also be included as well as interface tools that provide two-way communication with a utility and can analyze and display data on various devices including in-home energy displays, smart thermostats, televisions, and mobile phones. A complete home automation network may, for example, provide monitoring and automation of appliances, lighting, space conditioning, and/or specific electrical plug-load and natural gas devices. It likely would also include some form of consumer interface for direct, real-time feedback.

III. Grid Operations and Current Modernization Efforts

The following section describes current grid modernization efforts regarding operations and the technologies associated with those efforts that are currently being deployed around the country.

Federal mandates promote smart grid projects and Title XIII of the Energy Independence and Security Act of 2007 established a national policy for grid modernization and provides incentives for smart grid investments.[223] In addition, the number of smart grid pilot projects increased significantly through approximately $4.5 billion of ARRA funding.[224] To date, state activities for grid modernization tend to focus on smart meters, data privacy issues, and opt out policies. The map shown in Figure 42 depicts how advanced metering legislation and regulation activities were progressing across the country as of 2011.

Advanced Metering Legislation and Regulation



Notes:
Adopted AMI Requirements: In addition to direct orders to deploy AMI, this includes orders from the state public utility commissions directing utilities to file deployment plans. Does not include regulation or laws that serve only to authorize or simply promote AMI deployment. The state of maine also has pending legislation to place a temporary moratorium on deployment.
Pending AMI Studies: Includes states in which the legislature or public utility commission is studing the effects of pilot programs and large scale deployments. This also includes the public utility commission decisions to study the effectiveness of requiring implementation of PURPA Standar 14 (Time-Based Metering and Communications) of EPAct 2005 on a utility-by-utility basis.
Source: SAIC

Figure 42. Advance Metering Legislation & Regulation, 2011.

Source: : U.S. Energy Information Administration (EIA). “Smart Grid Legislative and Regulatory Policies and Case Studies.” December 12, 2011. http://www.eia.gov/analysis/studies/electricity/

Annual smart grid spending nationwide hit a high of $5.2 billion in 2011, coinciding with peak deployment spending from cost-shared ARRA projects, and has declined to an annual level of $2.5 billion, as shown in Figure 43.[225] This decline is primarily a result of reduced advanced metering infrastructure (AMI) spending, which was significantly influenced by ARRA funding in the period 2010-2012. Industry analysts, however, do anticipate annual spending on distribution system smart grid technologies to gradually increase from $1.2 billion in 2011 to $1.9 billion in 2017, with decreased spending ($3.6 billion in 2011 down to $1.2 billion in 2017) for AMI.[226] In comparison, total capital investments by investor-owned utilities (in 2012 dollars) in electricity delivery systems averaged $8.5 billion annually for transmission system upgrades and $17 billion annually for distribution system upgrades from 2003-2012.[227]

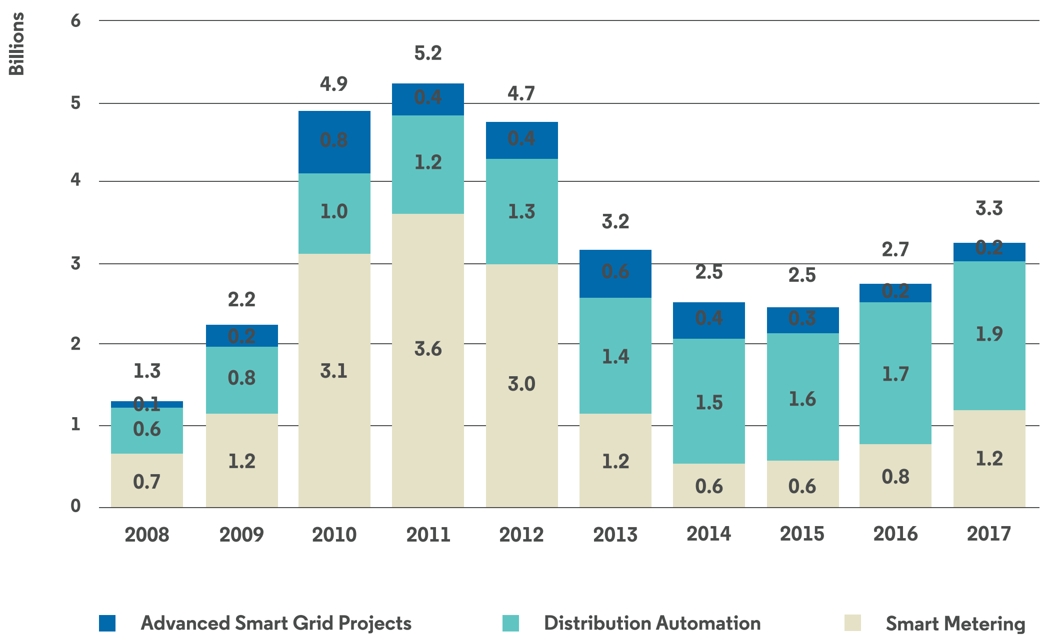


Figure 43. Baseline U.S. Smart Grid Spending 2008-2017 (Historical and Forecast)

Source: Bloomberg New Energy Finance. "U.S. Smart Grid Spend Report." March 6, 2014. Prepared for the U.S. Department of Energy by Brian Warshay and Colin McKerracher.

As of March 2013, joint federal and private expenditures under ARRA totaled $6.3 billion from the 99 Smart Grid Investment Grants (SGIG), which represent the largest portion of ARRA investments. Between 2009 and 2015, DOE and the electricity industry were expected to jointly invest more than $7.9 billion in the SGIG projects, which involved more than 200 electric utilities and other organizations to modernize the electric grid, strengthen cybersecurity, improve interoperability, and collect an unprecedented level of data on smart grid operations, benefits, and utility impacts. In the same time frame, an additional $1.6 billion in cost-shared funding was planned to support energy storage demonstrations and regional demonstrations to assess emerging smart grid concepts[228].

Estimates of overall spending required to fully implement the smart grid vary.

The Electric Power Research Institute estimates that spending of $338-$476 billion over a 20-year period is required to fully implement the smart grid, including preliminary estimates of $82-$90 billion for transmission systems and substations, $232-$339 billion for distribution systems, and $24-$46 billion for consumer systems.[229] The Brattle Group estimates that total transmission and distribution investment may need to reach nearly $900 billion (nominal) by 2030 to meet forecast electricity demand.[230]

1. Transmission System Upgrades

At the national level transmission development and planning activity has been steadily increasing since the early 2000s, reversing a decades-long decline following the historic build-out of the transmission system in the mid-20th century. As an asset class, transmission attracts significant investment from utilities, financial investors, and project developers. Investor-owned utilities spent a record high of $16.9 billion on transmission in 2013, up from $5.8 billion in 2001.[231] Looking forward, a high level of transmission investment is expected to replace aging infrastructure, maintain system reliability, facilitate competitive wholesale power markets, and assist regions in meeting public policy objectives, such as renewable energy goals. For example, in Missouri Ameren's most recent integrated resource plan found "regional wind" resources to have the lowest levelized cost of energy of all renewable resources.[232] The development of this resource will spur investment in new transmission assets.

Transmission system modernization includes the application of digitally based equipment to monitor and control local operations within high-voltage substations and wide-area operations across the transmission grid. There are many opportunities to infuse advanced technologies into key operating elements of the grid. Some notable opportunities are shown in Table 20.

Table 20. Examples of Key Technologies for the Grid of the Future

Source: Quadrennial Energy Review Analysis: Taft, J.D. and A. Becker-Dippman. "Grid Architecture." Pacific Northwest National Laboratory. PNNL-24044. January 2015. http://energy.gov/epsa/qer-document-library.

Grid Component/Opportunity	Description
AC/DC power flow controllers/converters	Technologies that adjust power flow at a more detailed and granular level than simple switching.
Advanced multi-mode optimizing controls	Controls capable of integrating multiple objectives and operating over longer time horizons, to replace simple manual and turing controls, or controls that operate based only on conditions at single points in time.
Bilaterally fast storage	Energy storage in which charge and discharge rates are equally fast and thus more flexible.
Control frameworks	New hybrid centralized/distributed control elements and approaches.
Management of meta-data, including network models	New tools for obtaining, managing, and distributing gris meta-data, including electric network models.
Synchronized distribution sensing	Synchronization of measurements in order to provide more accurate snapshots of what happening on the grid.
Transactive buildings	Buildings with controls and interfaces that connect and coordinate with gris operations in whole-grid, coordination frameworks.
"X"-to-grid interface and integration	Interface technologies, tools, and standards for the general connection of energy devices to power grids; includes integrated mechanisms for coordinating those devices with gris opperations in whole-grid coordination frameworks.
Distribution System Operation	Structure for clear responsibility for distributed reliability.

2. Metering Infrastructure

Most of the electric meters in use today are electromechanical and are based on technology that first developed at the end of the 19th century. While these meters are reliable, they are being phased out and replaced by digital meters. Digital meters can measure usage information more frequently, record data, and in the case of AMI technology, include two-way communication technologies that provide information to both utilities and customers. The deployment of digital meters includes state-of-the art AMI systems that allow for two-way communications, either on request or based on predefined schedules, and automated meter reading (AMR) technology that automatically collects consumption, diagnostic, and status data and transfers it to a central database for billing and analysis.

Advanced metering technologies have a variety of benefits that can lead to improvements in operational efficiency, asset utilization, reliability, and lowered operations and maintenance costs for utilities and customers. These technologies can enhance the application of time-based rates and help better understand residential energy consumption.[233]

AMI technology is anticipated to be a critical component for full development and deployment of a modern grid. However, there are a number of issues that need to be addressed before increasing deployment of AMI including the lack of consistent specifications for AMI systems, the need to develop a consistent approach for integrating the communication backbone, and the need to develop standard interfaces between systems such as the AMI system, the data management system, and other utility systems.[234] In addition, there are cost issues associated with AMI as it is expensive to replace existing working meters and utilities need to demonstrate the cost-effectiveness of doing so.

The Federal Energy Regulatory Commission has conducted a survey every two years since 2008 to assess the uptake of AMI across the country. Recent survey results indicate significant growth in advanced metering deployment in the U.S. For example, in 2012 the number of advanced meters operating in the U.S. (38 million) as a percentage of total meters installed was estimated to be 23 percent, representing a 14 percentage point increase from 2010 levels.[235] The Institute for Energy Efficiency (IEE) projects that a total of 65 million advanced meters will be deployed by the end of 2015.[236]

As of July 2014, over 50 million AMI meters had been deployed in the U.S., covering over 43 percent of U.S. homes. Moreover, IEE finds that about 46 million smart meters have been installed in the U.S, with 31,773 of those meters installed in Missouri. In that same year there were 458,698 AMI meters installed in Illinois, 4,104 in Iowa, and 76,000 in Kansas.[237]

Utilities are now focused on integrating and optimizing information gathered by smart meters as well as other investments in the digital grid to provide benefits and new capabilities to customers and system operators. The IEE 2014 Smart Meter survey highlighted a few areas where utilities are leveraging smart meters.[238] First, AMI systems integration with outage management systems and distribution management systems provide enhanced outage management and restoration combined with improved monitoring of the distribution system. Second, smart meters position the grid as a platform for the integration of distributed energy resources such as distributed generation, community solar, electric vehicles, storage, and micro-grids. Third, smart meters result in operational savings such as reduced truck rolls, automated meter reading, and reduced energy theft. And fourth, smart meters can provide new customer services including automated budget assistance and bill management tools, energy use notifications, and smart pricing and advanced demand response programs.

3. Challenges to Deployment

The adoption of grid modernization technologies varies across the nation and depends on many factors including state policies, regulatory incentives, load growth, and the technology experience level within various utilities. States play a major role in how and at what pace this transition will occur in their respective jurisdictions. State regulators review and approve expenditures and set rates for investor-owned utilities (IOUs) in their states. Certain states may also regulate municipal utilities or rural electric cooperatives. State policy makers operate within a highly structured legal and regulatory framework, much of which was not designed to address the complex issues arising from the rapid grid modernization occurring today.[239]

Barriers to grid modernization investments tend to arise from unfavorable market fundamentals or regulatory challenges, rather than from constraints related to access or cost of capital, although, this may change if interest rates rise or risk spreads change. These barriers include lack of full market valuation for ancillary grid services, including storage, as well as a lack of information available for decision makers to inform an appropriate level of resilience upgrades.[240] Additionally, market externalities that may impact the cost-benefit metrics of grid modernization, such as climate change impacts due to greenhouse gas emissions, are not addressed under current regulatory frameworks. In other words, while the up-front costs of grid modernization investments are easy to calculate, the back-end benefits can be difficult to monetize and may not be as clear to regulators since the benefits may be spread over multiple customer classes and may not be fully realized for years. The concern, and sometimes the result, is that state regulators may not approve cost-recovery or even the implementation of grid modernization technologies without specific guarantees that benefits of the technologies will exceed the costs in the long-term. This has historically been a challenge for all utilities that are including grid modernization activities into future business planning efforts.[241]

In addition, the information technology and communications infrastructure that supports smart grid devices can create costs and integration challenges that are largely new to utilities. Predicting the effort and time needed to integrate new networks and systems as well as the useful life expectancy is difficult. Indeed, utilities do not yet know the extent to which information technology (IT) and communications infrastructure may need to be upgraded and maintained as technologies evolve. Many grid modernization demonstration projects were challenged by systems integration, though several utilities have also realized large operational savings.[242]

Smart meter implementation by some utilities has also resulted in some customer concerns regarding privacy protections and data usage. Data security and projecting customer information from unauthorized access is critical. In addition, concerns are often raised regarding data sharing. Utilities have long been able to track customer usage information and utilize that information for multiple functions including, but not limited to, customer billing grid-planning efforts. These efforts are carefully monitored by regulatory agencies in order to protect customers and their information. In addition, utilities are subject to local and state laws and regulations that restrict sharing of customer information without customer permission.[243]

Grid modernization information technology and communications infrastructure must have appropriate security foundations and models in place to ensure data security, grid safety, and advancement of smart grid technologies. Uncertainty in the security and privacy of data as well as information access is often a barrier to the adoption of smart grid solutions. Smart grid IT now includes systems that were previously outside of the grid. These systems generate beneficial data but also create new security issues.[244]

Determining the full costs and benefits of grid modernization efforts will take time, especially as many utilities begin to leverage new data and information technology applications that will generate additional value from deployed systems. Utilities and state and local regulators all have widely varying experience with smart grid technologies and differing views on costs and benefits. As a result, investment decisions and deployment rates have thus far been determined at the local level and have been shaped by individual state energy goals, regulator views on appropriate and allowable investments, and the level of smart grid experience at individual utilities.[245] Thus, updating the regulatory paradigm is a continuing challenge, particularly in terms of customer value, consumer protections, and utility risk and cost-recovery, for innovative grid modernization investments.

4. Recent Policy Changes

In recent years a number of states have adopted or are considering grid modernization and smart grid related laws, regulations, and requirements, both voluntary and mandatory, in an effort to overcome deployment challenges. Common trends are beginning to emerge on the cost-recovery methodologies that utilities and public utility commissions are adopting to facilitate grid modernization. Nearly every cost-recovery strategy employed to date appears to fall within one of the following categories:

- Trackers: A method that may be tied to specific projects or broader measures and involves tracking of unpredictable costs by utilities and recovery over a certain period of time.
- Balancing Accounts / Rate Base: An accounting methodology employed by regulatory agencies that allows utilities to identify and recover reasonable and prudent costs through future rate structures when costs are unrecovered due to rate freezes or ceilings. In some instances, utilities have also been allowed to build cost recovery into the rate base.
- Customer Surcharge: A charge allowed by regulatory agencies so that utilities can recover specific cost items.
- State Funding: Direct funding from state governments for grid modernization projects.
- Formula rates: A method for setting rates based on verified revenues and costs that may include requirements for performance to particular metrics to assure customers are receiving benefits and may be tied to earnings caps, infrastructure investment commitments, and job commitments over specified timeframes.

Trackers are the most common cost recovery methodology being employed as they allow for focused cost-recovery without going through the full rate case process. This approach can be deployed quickly while limiting a utility's risk exposure. The second most common approach is applying recovery through rate base adjustments, a cost approach estimating the marginal costs to serve a customer class and equitably distributing those costs to customers.[246] Finally, some regulatory agencies are expanding the valuation models used by utilities to support business cases to include societal benefits, wider service offerings, increased system-wide benefits, greenhouse gas and carbon footprint reductions, customer satisfaction, and increased energy efficiency.[247]

Under traditional cost based regulation, utilities do not begin recovering the investment costs until the associated facilities are in use and the costs have been reviewed by regulators. To address immediate needs and targeted policy objectives, the Missouri Legislature has authorized the Missouri Public Service Commission (PSC) to approve non-traditional cost-recovery mechanisms which allow for the recovery of capital costs and expenses either as they are incurred between rate cases or on an expedited basis. Such mechanisms, when properly implemented, can serve to encourage desired investments in infrastructure.

As described in Chapter 2: Energy Supply, the Infrastructure System Replacement Surcharge is available to investor owned natural gas utilities and one metropolitan water utility as a mechanism to replace worn or deteriorated distribution mains; it allows for rate adjustments between rate cases in order to align cost recovery with the time period in which costs are incurred. Accounting Authority Orders (AAOs) and expense trackers ordered by the PSC allow utilities to record depreciation, taxes, interest or other expenses incurred between rate cases in a deferral account for potential recovery in future rates. AAOs or trackers have been authorized for recording costs associated with infrastructure safety inspections and replacing infrastructure damaged by ice storms. These types of mechanisms were also used after the Joplin tornado.

Historically, the PSC has considered alternative funding and accounting mechanisms, such as a surcharge, to fund certain improvements for water or sewer systems before the additional plant is fully operational and used for service. Specifically, the PSC has considered and approved such mechanisms for small water and sewer companies in limited and unique circumstances to aid in construction or modifications of infrastructure (pumps, controls, and other equipment). Additionally, the Missouri Energy Efficiency Investment Act (MEEIA) assigns the PSC broad authority to advance Missouri's policy goal of achieving all cost-effective energy and demand savings by employing accelerated depreciation, capitalization of investments, rate design modifications and performance incentives. This authority is granted in order to encourage investor-owned utilities to assist customers in using energy more efficiently, offsetting the need for investments in supply-side resources by valuing them equally to demand-side resources.

5. State Infrastructure Policies

Illinois

The state of Illinois has already made significant progress towards the development of a modern grid with the anticipated deployment of over five million new AMI meters and more than $2 billion of modern grid investments that will be installed through 2018. These investments for customers of Commonwealth Edison (ComEd) and Ameren Illinois, the state's two largest investor-owned utilities, are the result of years of discussion regarding grid modernization and culminated in the Illinois Energy Infrastructure Modernization Act, a law implementing formula rates that supports smart grid deployment and funds programs to support electricity system innovation. In a recent news article Ameren stated that the Act has led to hundreds of millions of dollars of investments to modernize Illinois' electric grid, which has created jobs, benefitted customers, and fixed aging infrastructure. The company believes that grid modernization coupled with appropriate consumer protections could bring similar benefits to Missouri.[248]

The Illinois Energy Infrastructure Modernization Act supports grid modernization through a number of components. First, both ComEd and Ameren Illinois are required to create real-time, on-the grid opportunities for energy entrepreneurs to test new technologies through test beds for new hardware and software solutions. In addition, roughly $24 million in utility funds were deployed to establish the Energy Foundry, a private, nonprofit impact venture capital fund that invests in early-stage smart grid companies and provides funding opportunities for companies engaged in the aforementioned test beds and grid modernization activities. The Act also mandates significant funding for consumer education from third parties, such as municipalities and nonprofits, with the majority of funding anticipated to support energy efficiency, demand response, and dynamic pricing programs. Finally, and most importantly, the Act includes performance metrics to measure the performance of the AMI smart grid rollout, including measures for voltage optimization, distributed generation, and greenhouse gas emission reductions.

As a result of the law, utilities have the option to recover the costs associated with grid modernization under a new rate structure provided that they meet specific performance and investment mandates, with penalties for non-performance.[249]

Arkansas

The state of Arkansas recently passed the Regulatory Reform Act of 2015 that provides mechanisms for cost recovery of infrastructure investments. The Act's stated intent is to establish a regulatory framework that implements rate reforms to provide just and reasonable rates to consumers and enables public utilities to provide reliable service while maintaining stable rates.[250] The Act authorizes utilities to elect to implement a formula rate review mechanism using a forward test year, sets policies for determining a reasonable return on equity, recovery of the allowance for funds used during construction and cost allocation and rate design. An annual review provides for revenue adjustments with a cap of four percent. Revenues are not adjusted if the earned return on equity is within plus or minus 0.5 percent of the authorized return rate. In April 2015 Entergy Arkansas Inc. announced a $62 million transmission grid investment and filed a rate case electing to use some of the mechanisms authorized in the Act.[251]

New York

The state of New York's largest utility, Consolidated Edison (ConEd), is challenged by continuing to supply power while not investing too heavily in new infrastructure. The utility has a service territory that includes New York City and serves approximately three million customers. In 2013, during a hot summer day in July, ConEd's load peaked at 13,322 MW and was forecasted to reach 13,675 MW in the summer of 2015. Each year since 2005, ConEd has invested at least $1 billion on infrastructure upgrades and expansions. In addition, the utility is in the middle of a four-year, $1 billion storm improvement program to strengthen the grid to prepare for severe weather events like Hurricane Sandy. This plan for New York City and Westchester County includes advancing smart grid designs to help reduce customer outages, building and installing protective barriers around critical equipment, and redesigning two underground electrical networks in lower Manhattan and one in Brooklyn.[252]

ConEd is also taking steps to reduce the need for large infrastructure investments by deploying additional energy efficiency and demand management programs. For example, in 2014 state regulators approved a unique demand management program proposed by ConEd for the Brooklyn and Queens boroughs. Facing the need for a $1.1 billion substation to handle growth in those areas, the utility will spend up to $150 million on energy efficiency initiatives and distributed resources with a goal of obtaining approximately 20 MW of energy savings or capacity. If these new programs are successful ConEd will delay having to build the substation until 2024 and customers may realize approximately $500 million in savings on their electricity bills. Since 2009, ConEd has provided $190 million in incentives to 221,000 customers through energy efficiency programs and its customers have installed 4,000 solar projects with a capacity of 60 MW.[253]

Maryland

Between 2010 and 2013 the Maryland Public Service Commission approved utility installation of AMI technologies as part of larger grid modernization efforts. As of December 2013 there were approximately 1.6 million new electric and gas meters installed and three out of four utilities planned on completing meter installations by the end of 2014.[254] Cost recovery for these efforts was contingent upon successful deployment and demonstrated cost effectiveness. The Maryland Public Service Commission required that utilities develop customer education and cyber security plans associated with their AMI deployments and mandated metrics to monitor deployment, costs and benefits, and customer engagement.[255]

Concerns regarding the potential impact of climate change on regional weather patterns as well as prolonged power outages resulting from recent hurricanes, storms, and blizzards required transparent and informed discussions on the challenges facing the electric distribution system. In July of 2012, Maryland's Governor signed an Executive Order directing his energy advisor, in collaboration with multiple state agencies, to solicit input and recommendations from experts on how to improve the resilience and reliability of Maryland's electric distribution system. The Executive Order specifically charged the Task Force with evaluating the effectiveness and feasibility of placing supply and distribution lines underground, options for infrastructure investments that would improve the resilience of the grid, and options for financing and cost recovery of capital investments.

After Task Force discussions, a report was drafted with 11 recommendations.[256] One recommendation was that the Maryland Public Service Commission incorporate both incentives for meeting minimum reliability standards and penalties for falling short. The report suggested that the state's current grid reliability metrics be expanded to include safety and customer satisfaction. Finally, the report recommended that utilities consider new cost-benefit criteria that take into account the economic loss to the state and customers when measuring the cost-effectiveness of resilience measures.[257]

California

In California the need for more reliable grid operations became apparent in 2001 during the California electricity crisis and, in response, utilities and regulators redesigned programs with a strong business case for AMI that would enable new pricing structures and savings incentives for customers.[258] In 2003, the California Public Utility Commission adopted a policy that all electric customers should have advanced meters, and, for customers with greater than 200 kW maximum demand, advanced meters are now in place. California is now considered by many to be the nation's most active state with regard to grid modernization laws and regulations, and California was the first state to pass a statewide grid modernization policy, which, importantly, requires that unreasonable or unnecessary barriers to adoption of a modern grid must be identified and lowered.

In September of 2009, the California Public Utility Commission established an expedited review process for grid modernization funding and since then the state has aggressively sought federal funding to support modernization efforts.[259]

IV. Missouri's Progress Toward a Modern Grid

As a relatively cautious, vertically-integrated state, Missouri will most likely take a thoughtful approach to grid modernization, focusing initially on those aspects of grid modernization that are cost-effective today. According to the 2014 Grid Modernization Index, an annual benchmarking effort developed by the GridWise Alliance and the Smart Grid Policy Center[260], Missouri ranks 22nd in the country in terms of the degree to which the state has moved toward a modernized system by instituting grid modernization policies, facilitating investments, and deploying new infrastructure. Across the U.S. the report found that overall, higher penetration of distributed generation resources, particularly solar photovoltaic systems, is starting to drive an increasing urgency for grid modernization.

Several efforts are currently underway in Missouri to further advance the research and deployment of smart grid technologies. These efforts have been undertaken by utilities across the state as well as universities, cities, and private companies, under the support of the Missouri Public Service Commission (PSC) and in some cases with funding received through the American Recovery and Reinvestment Act of 2009.

1. Electric Grid Investments

Ameren Missouri, KCP&L, KCP&L-GMO, and Empire District Electric have focused new grid investments to improve service reliability, operating efficiency, and asset optimization to develop a robust energy delivery infrastructure. For example, Ameren Missouri has approximately 2,300 line capacitors that are automated via two-way radio communications and approximately 800 tap changing substation transformers that are automated to adjust system voltage from commands issued by Distribution Control Offices. In addition, system voltage reduction has proven to work and Ameren Missouri-documented cases over 15 years show 1.0-1.2 percent demand reductions after programmed calls for 2.5 percent voltage reductions.[261] KCP&L utilizes line capacitors that are automated via one-way radio communications, and tap-changing substation transformers that are automated to reduce system voltage from remote commands.[262] Empire District Electric has some substation relays that utilize digital communications and automated recloser controls. All power transformers have either automatic load tap changers or line voltage regulation in the substation.[263]

2. Advanced Metering

The top three advanced metering infrastructure (AMI) deployments in the state are Laclede Electric Cooperative with 36,000, Kansas City Power and Light with 14,000 and the City of Fulton with 5,000. In addition, Co-Mo Electric Cooperative has been fully deployed with AMI meters since 2002. The company uses multiple avenues to show customers their hourly and daily usage through the "Power By The Hour" program that utilizes a Two-Way Automatic Communications System using the MultiSpeak® specification.[264] MultiSpeak® is an industry-wide software standard that facilitates interoperability of diverse business and automation applications used in electric utilities. For example, it monitors the distribution system and allows for outage detection and management. It also facilitates customer billing and relationship management including meter reading, load profile creation and connect/disconnect functions. Black River Electric Cooperative has also installed AMI in its service territory and implementations started in 2008.[265]

The top automated meter reading (AMR) deployments in the state are Ameren Missouri with 1.2 million meters deployed since 2000 and KCP&L has approximately 410,000 AMI installations in place and expects to have 680,000 meters installed by September 2016. There are approximately 100 net metering applications to date, 18,000 meters are configured for time-of-use/demand reporting and 5,000 are configured for 15-minute interval reporting for industrial and large commercial customer use. The remaining meters report daily kWhs for residential and small commercial customer use.[266] White River Valley Electric Co-op also has a full deployment of AMR meters throughout its service area.

Several electric cooperatives in Missouri, including Boone Electric Cooperative, Co-Mo Electric Cooperative, Laclede Electric Cooperative, Platte-Clay Electric Cooperative, Southwest Electric Cooperative and White River Valley Electric Cooperative utilize the MultiSpeak® Initiative for efficient communication integration.[267]

MeterGenius
St. Louis

One St. Louis based firm is already capitalizing on the modern grid and providing advanced tools to benefit utility customers with smart meters. MeterGenius, founded in 2013, provides utility-branded customer web portals fully equipped with energy management tools, smart appliance connectivity, and a rewards program that provides incentives to users who hit monthly energy goals. The insight, analytics, tools, and motivations provided by MeterGenius have proven to be effective at engaging customers and reducing energy use.

3. Demonstration Projects

KCP&L was selected for a $24 million Smart Grid Demonstration Grant from the U.S. Department of Energy (DOE) in 2009. The project totaled approximately $58 million overall, which included the DOE grant, funding contributions from vendor partners, and KCP&L covering the remainder. The purpose of KCP&L's project was to demonstrate a wide variety of emerging smart grid technologies in a real-world setting to determine the "readiness" of each technology for possible further deployment. Another critical aspect of KCP&L's project was demonstrating the ability to take commercially available products and demonstrate the ability to integrate them for total interoperability using emerging DOE and National Institute of Standards and Technology standards.

KCP&L's demonstration was highly successful and a great deal was learned from the project. The major components that were found to be needed on the KCP&L system are currently ready for enterprise deployment. The project demonstrated nearly all things considered "smart grid" that are below the transmission: from the substation, through the distribution system and into customer's homes, businesses and their electric vehicles. KCP&L is proceeding with larger deployments of the following technologies from the demonstration including: AMI; meter data management; distribution automation deployed in areas in need of reliability improvement; Upgraded Outage Management System (OMS); Distribution SCADA-lite (integrating existing Distribution Automation platform into new OMS); Enterprise Service Bus IT communications infrastructure; electric vehicle charging infrastructure; end-use programs; demand response; solar distributed generation; and enhanced cyber security.[268]

KCP&L-GMO continues to invest in numerous reliability and system improvement programs across the entire service territory. This includes deployment of automated equipment on distribution circuits, such as reclosers, capacitor banks, fault indicators, AMI meters, and switches, in order to improve monitoring capability and reduce outage durations.

In November 2009, Boeing was selected to receive an $8.5 million grant from DOE to lead several projects for improving regional transmission system planning and operation. The projects have the goals of increasing grid reliability, reducing system demands and costs, increasing energy efficiencies, rapidly allocating energy when and where it is needed, and providing greater network security and flexibility to accommodate new energy technologies.

The City of Fulton Electric Utility was one of 100 recipients of the SMART GRID grant awards funded through the ARRA. The City received over $1.5 million in grant funding, which was matched by the city, to replace electric meters with an AMI smart meter network that includes a dynamic pricing program with in-home energy displays to reduce consumer energy use. A total of 5,505 AMI meters were deployed with 4,359 of these for residential, 916 for commercial and 50 for industrial customers. The Electric AMI meters are GE single phase residential with a remote disconnect feature. Customers do not have an "Opt Out" option for the new AMI meters and the city is looking at different rate structures to offer a new tiered-rate structure and time-of-use rate to customers.[270]

Columbia Water & Light Recognized as a Reliable Public Power Provider
City of Columbia

In May of 2015 Columbia Water & Light earned recognition from the American Public Power Association (APPA) as a Reliable Public Power ProviderTM (RP3). The award, given for providing consumers the highest degree of reliable and safe electric service, was only given to 191 of the nation's more than 2,000 public power utilities. APPA is the national organization representing more than 2,000 not-for-profit, community- and state-owned electric utilities and the RP3 designation lasts for three years.

The RP3 designation recognizes public power utilities that demonstrate proficiency in four key disciplines: reliability, safety, training and system improvement. Criteria within each category are based on sound business practices and represent a utility-wide commitment to safe and reliable delivery of electricity. This is Columbia's fifth time receiving the RP3 designation since 2007 and the tenth year that the recognition has been offered.

4. Workshops and Reports

In February 2014 the PSC staff updated the Missouri Smart Grid Report[271] in which various smart grid technologies are discussed and smart grid opportunities in Missouri are presented to the reader.[272] The report recommended additional and ongoing stakeholder engagement to develop a comprehensive plan around smart grid. The report also recommended opening a docket to address the cost recovery issue specifically, as it is one of the most important issues applicable to all stakeholders. Since publication of the report, the PSC has conducted several workshops and conferences around the state to discuss the future of the smart grid and promote dialogue and collaboration between numerous stakeholders. The PSC docket that contains information on smart grid is (EW-2011-0175).

5. Summary of Key Points

- The design of the electric power grid has remained largely the same for century and is built around large centralized power plants that are connected to consumers via miles of transmission and distribution lines.

- Missouri's electric utilities have historically focused investments in energy infrastructure on ensuring adequate and reliable service and on leveraging economies of scale in supply-side generation and delivery infrastructure to achieve cost savings. Missouri has low cost, highly reliable electricity with the frequency and duration of outages being generally lower than the rates experienced in other states.

- There is no common definition for what a "modern grid" should consist of; however, there is general consensus from stakeholders involved in modernization efforts that a moderngrid will be more sophisticated than the current grid, with two-way communication between systems. A mor sophisticated electricity grid that supports two-way communication between systems will allow for more informed and timely decision making while being more distributed and decentralized, flexible, reliable, and efficient.

- A modern grid will be stronger and promote greater resilience, safety, and security. Over the last decade, technological improvements and innovation have resulted in significant opportunities for grid modernization and placed new emphasis on demand -side resources as a beneficial and cost-effective alternative to supply-side resources.

- To date, state activities for grid modernization have focused on smart meters, data privacy issues, and opt-out policies. In recent years, a number of states have adopted or are considering grid modernization and smart grid related laws, regulations, and requirements, both voluntary and mandatory, in an effort to overcome deployment challenges.

- Smart grids should benefit both customers and energy providers. Consumer protection issues should be addressed in the overall construct of smart grid design and deployment planning such as consumer education and bill protection programs, ownership of data, privacy, security, the risk of remote disconnection, and social safety nets for vulnerable consumers. Participation rates in energy efficiency programs for renters and low-income consumers should be improved and smart grid investments should be integrated with utility energy efficiency and renewable energy programs and targets.

- Common trends are beginning to emerge on the cost recovery methodologies that utilities and public utility commissions are taking to facilitate grid modernization. Trackers are the most common cost recovery methodology being employed, however, recovery through rate base adjustments through a marginal cost approach is also being employed.

- Several efforts are currently underway in Missouri to further advance the research and deployment of smart grid technologies. These efforts have been undertaken by utilities across the state as well as universities, cities, and privately owned companies, under the support of the PSC and in some cases with funding received through the ARRA.

Chapter 5:
Energy and the Economy

This chapter examines the relationship between energy and Missouri's economy. The chapter begins with an exploration of energy use and expenditures for individuals, businesses, and governments, while discussing factors that influence this use and opportunities to reduce it. In addition, the chapter explores the job environment for Missouri's energy industry including an analysis of the existing workforce, economic development programs, and opportunities to create and retain additional jobs.

I. Energy and Economic Activity

1. Individuals and Energy

Understanding how Missourians spend money on energy resources is an important means of identifying opportunities for cost reductions and also prioritizing activities that provide the highest value per dollar invested. According to the most recent Residential Energy Consumption Survey (RECS) from the Energy Information Administration (EIA), in 2009 energy expenditures for a Missouri household were approximately $1,892. That same year, the average income for a Missouri household was $45,159, which suggests that on average Missourians spend 4.19 percent of their annual income on energy.[273]

Missouri households use about 12 percent more energy than the average U.S. household but spend about seven percent less on energy – see Table 21. The higher energy use in Missouri, as in other Midwest states, is attributed to the temperature extremes that lead to high-energy use required to heat homes in winter and cool them in summer. However, the lower than average energy expenditures can be attributed primarily to low residential electricity prices and the fact that electricity accounts for the majority of household energy use in our state.

Table 21. Summary of Residential Energy Consumption Survey, 2009.

Source: U.S. Energy Information Administration (EIA), "Residential Energy Consumption Survey 2009: Table CE1.3 Summary Household Site Consumption and Expenditures in Midwest Region, Divisions, and States - Totals and Intensities, 2009 and Table CE1.1 Summary Household Site Consumption and Expenditures in the U.S. - Totals and Intensities, 2009", Accessed April 2015. http://www.eia.gov/consumption/residential/data/2009/

	Average Household Energy Use (Million BTU/Year)	Energy Use Compared To U.S. Average	Average Household Energy Expenditure ($/Year)	Energy Expenditure Compared To U.S. Average
Missouri	100	11% higher	$1,892.00	7% lower
Midwest*	112	25% higher	$1,981.00	2% lower
U.S.	90	-	$2,024.00	-

**Note: Individual state survey results are not available for all states, including Iowa and Kansas. In their place we present the results for the entire Midwest region, which includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.*

According to the RECS survey, heating and cooling a home account for over 40 percent of the average Missouri household energy expenses, and about 60 percent each year is spent powering lights, electronics, home appliances, refrigerators, and water heaters – see Figure 44.

Share of 2009 Missouri Household Expenditures by End-Use ($1,892 dollars)

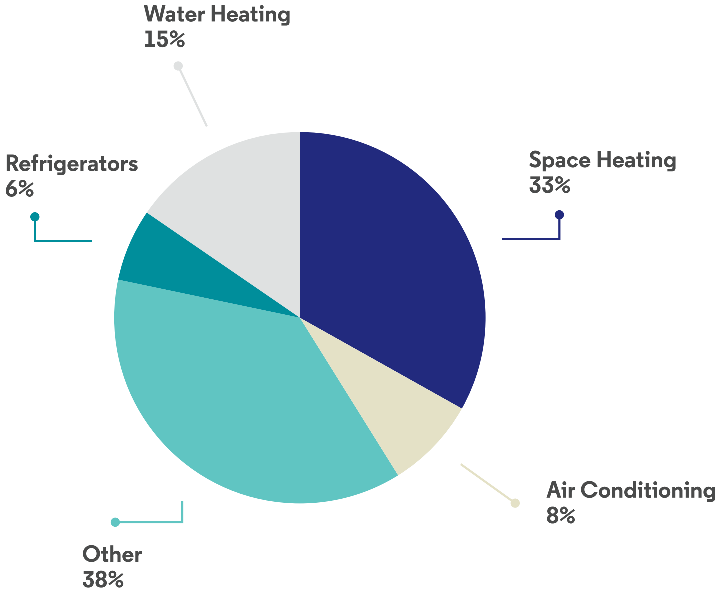


Figure 44. Missouri's Household Energy Expenditures, 2009.

Source: U.S. EIA. "Residential Energy Consumption Survey 2009: Table CE3.8 Household End-Use Expenditures in the Midwest Region, Totals and Averages, 2009." Accessed April 2015. http://www.eia.gov/consumption/residential/data/2009/

**Note: "Other" category encompasses all other energy uses in a residence, including lighting, appliances, electronics, and other household devices.*

In addition to the household energy uses summarized above, the residential sector tends to spend a significant amount on transportation fuels. While this data is not readily available at the individual state level, in 2009 the average U.S. household transportation expenditure for gasoline and motor oil was $1,986,[274] which is slightly higher than the $1,892 the average Missouri household spent on residential energy expenses.[275] These results indicate that total household energy expenditures in Missouri were around $3,878 in 2009.

As described in Chapter 3: Section I, national trends suggest that household energy use may have decreased slightly during the last fifteen years due primarily to energy efficiency improvements for space heating, air conditioning, and many major appliances.[276] However, during this same period of time, the expenditure on gasoline and motor fuels increased such that the average household expenditures have exceeded $2,500 every year since 2011 at the national level.

As described in previous chapters, the price of electricity for Missouri's residential sector tends to be lower than in other states due primarily to a reliance on coal, which has historically been a lower priced option than other fuels. Similarly, gasoline prices in Missouri are lower than most other states in the country, due in part to the fact that Missouri's state gasoline taxes are among the lowest in the nation. However, for the last fifteen years, natural gas prices in Missouri have been among the highest in the Midwest and slightly above the national average. For a snapshot of 2012 prices and how they compare to other states see Table 22.

Table 22. Average Retail Price In Dollars Per Million BTU, 2012.

Source: U.S. EIA, "State Energy Data System (SEDS): 2012," Updated May 30, 2014, http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

	Electricity Price In The Residential Sector	Natural Gas Price In The Residential Sector	Propane Price - Residential Sector	Motor Gasoline Average Price - All End-Use Sectors
Missouri	$29.80	$12.15	$22.58	$27.95
Illinois	$33.34	$8.17	$23.02	$29.30
Iowa	$31.71	$9.33	$22.97	$28.80
Kansas	$32.95	$9.90	$23.03	$28.60
United States	$34.82	$10.38	$28.18	$29.41

Additional information on how electricity, natural gas, propane, and gasoline prices have changed over the last fifteen years is available in Chapter 1: Missouri's Energy Outlook.

1.1 Home Energy Burden

It is also important to consider the impact of energy expenses on individual households. A monthly utility bill of $120 will seem reasonable to some families but overwhelming to others. A widely accepted metric for measuring the affordability of energy bills is the home energy burden, which is defined as the share of household income that is used to pay energy bills.[277] For example, a household with an annual utility bill of $2,000 and an annual income of $20,000 has an energy burden of 10 percent, but a household with the same $2,000 annual energy bill and an annual income of $50,000 has an energy burden of only 4 percent.

Energy burden can vary significantly among households based on a variety of factors that include the energy efficiency of the household, behavioral practices with respect to energy use, utility rates, eligibility and availability of utility assistance and efficiency programs, and number of family members. According to a study prepared by the U.S. Department of Health and Human Services, one tenth of households with incomes below $10,000 have a home energy burden less than 1.6 percent while one tenth have a home energy burden greater than 22.2 percent.[278] This shows that households with the same income level can have significantly different usage and expenditures based on age of the dwelling, quality of design and construction, ownership, and ability to make efficiency improvements. This same study also found that in general, lower income households experience higher energy burdens than higher income households. In addition, according to the U.S. Department of Energy (DOE), low-income households in the U.S. typically spend 17 percent of their total annual income on residential energy costs, compared to four percent for most other households.[279] Generally, a six percent energy burden is considered to be the threshold for affordability.[280]

Approximately 16 percent of Missourians fall below the poverty line and in rural Missouri the poverty rate is higher at approximately 18 percent. For these families energy prices as a proportion of income are heaviest and they are often forced to choose between paying their utility bills and affording other staples for modern life. In 2014, more than 600,000 households in Missouri had household incomes at or below 150 percent of the federal poverty level and faced an average energy burden greater than nine percent.[281] Table 23 summarizes the findings of a study that grouped household income by share of the federal poverty guideline, a measure of poverty that is calculated annually by the Department of Health and Human Services.

Table 23. Summary Of Home Energy Burden In Missouri, 2014.

Source: Fisher, Sheehan & Colton. "Home Energy Affordability Gap, 2014". Accessed April 2015. http://www.homeenergyaffordabilitygap.com/03a_affordabilityData.html;
U.S. Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation, "2014 Poverty Guidelines." January 24, 2014. http://aspe.hhs.gov/poverty/14poverty.cfm#guidelines

Income (As A Percent Of Federal Poverty Guideline)	Income Range For An Individual	Income Range For A Family Of Four	Number Of Households	Home Energy Burden
Below 50%	Less than $5,835	Less than $11,925	161,492	31%
50-100%	$5,835 - $11,670	$11,925 - $23,850	206,885	17%
100-125%	$11,670 – $14,588	$23,850 - $29,813	114,758	11%
125-150%	$14,588 - $17,505	$29,813- $35,775	119,679	9%
150-185%	$17,505 – $21,590	$35,775 - $44,123	166,426	8%
150-185%	$21,590 - $23,340	$44,123- $47,700	67,758	7%

Note: In 2014 the federal poverty level was $11,670 for an individual and $23,850 for a family of four.[282]

1.2 Factors that Influence Residential Energy Use

The 2009 RECS survey shows that while annual household energy expenditure increases with income, this increase is not proportional to the increase in wealth – see Table 24. EIA suggests that there are two primary reasons why household energy consumption does not increase proportionally to income. One reason relates to the economic principle of diminishing returns, which notes that as more and more units of a specific commodity are consumed, the benefit from the successive units decreases. As an example, the benefit of going from zero to one light bulb in a room is greater than the benefit of going from 10 to 11 light bulbs even though, in both instances, only one light bulb is added. Another reason that energy use does not increase proportionally to income is that wealthier Americans are better able to invest in higher quality construction and energy efficiency improvements to their homes, including better insulation and more efficient appliances.

Table 24. Average Annual Energy Expenditure Compared To Income, 2009.

Source: U.S. EIA. "Residential Energy Consumption Survey 2009." 2009. Accessed April 2015. http://www.eia.gov/consumption/residential/data/2009/

Annual Household Income	Energy Expenditure Per Household (Midwest)	Energy Expenditure Per Household Member (Midwest)	Energy Expenditure Per Household (U.S.)	Energy Expenditure Per Household Member (U.S.)
Less than $20,000	$1,657	$847	$1,571	$749
$20,000 to $39,999	$1,752	$758	$1,736	$718
$40,000 to $59,000	$1,935	$759	$1,976	$742
$60,000 to $79,999	$2,069	$745	$2,106	$782
$80,000 to $99,999	$2,274	$754	$2,340	$790
$100,000 to $119,999	$2,407	$786	$2,572	$856
$120,000 or More	$2,947	$988	$3,062	$1,004

In another study, the U.S. Environmental Protection Agency (EPA) examined the relationship between household energy consumption across three housing types and two community development patterns that vary primarily in terms of access to public transportation and density of population. The research findings, summarized in Figure 45, suggest that housing type and community development patterns have an impact on household energy use. In fact, homes, regardless of type, use less energy in transit-oriented developments that are focused on providing opportunities for walkable neighborhoods and public transportation than in typical suburban developments. Furthermore, multifamily homes use less energy than single-family homes regardless of community development patterns. The researchers also noted that choosing to live in an area with transportation options not only reduces energy consumption, but also can result in significant savings on home energy and transportation costs.[283]

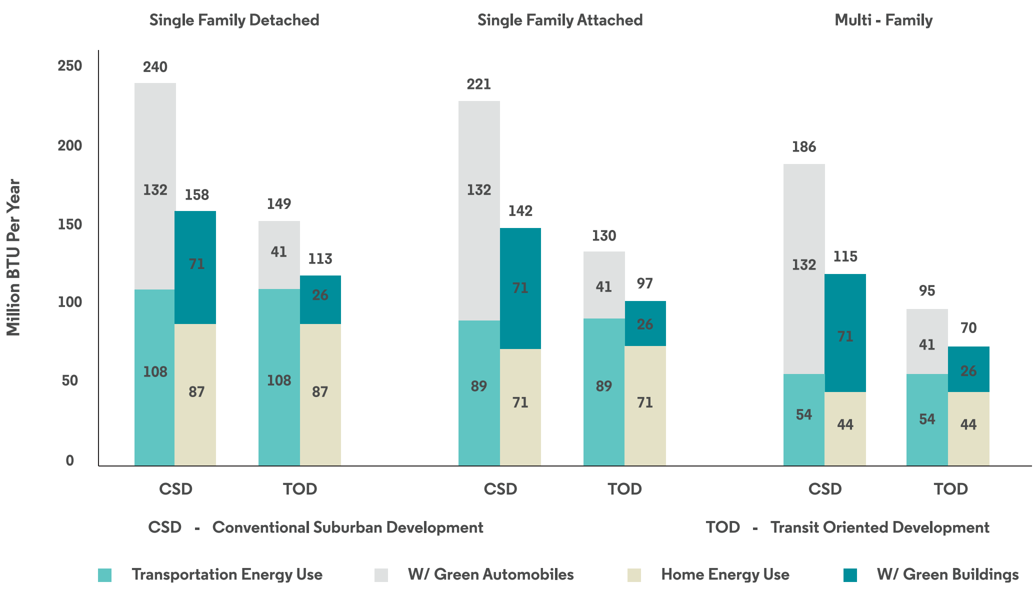


Figure 45. Household and Transportation Energy Use by Location.

Source: Jonathon Rose Companies, "Location Efficiency and Housing Types: Boiling it Down to BTUs," 2011, http://www.epa.gov/smartgrowth/pdf/location_efficiency_BTU.pdf

A research study conducted in 2013 noted that large homes, those that are approximately 6,400 ft^2 in size, use more than twice as much electricity as a typical home of about 1,600 ft^2. The study also found that electricity use among homes of the same size varies by as much as six times, indicating that home size is only a rough predictor of household energy use.[284] Other factors, such as income, climate, occupancy, construction features, and behavior are also important drivers of energy use. Behavioral change, prompted by attention to energy expense, includes adopting set-it-and-forget-it strategies such as installing programmable thermostats, faucet aerators, and efficient light bulbs; changing hot water heater settings; calibrating electronics; using smart power strips, motion sensors, and timers; and buying ENERGY STAR® appliances. Energy awareness can also drive other behavioral changes like taking shorter showers, cold-cycle washing and air-drying laundry, turning off lights, and driving at the speed limit. Additionally, when customers are informed about their own energy use in comparison to neighbors with similar homes, they may take action to reduce consumption by as much as one to three percent.[285]

Variation in electricity usage across homes of the same size

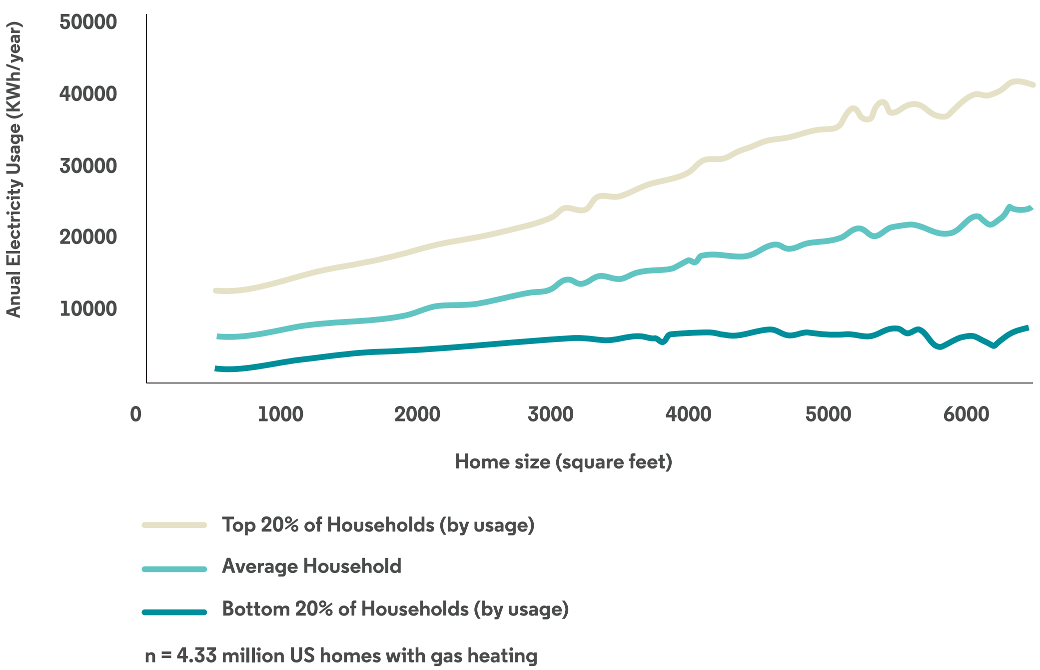


Figure 46. Variation In Electricity Usage Across Homes of the Same Size, 2013.

Source: Barry Fischer, "America's energy distribution: the top 1% of homes consume 4 times more electricity than average (and why it matters)," OPower, 2013. http://blog.opower.com/2013/03/americas-energy-distribution-the-top-1-of-homes-consume-4-times-more-electricity-than-average-and-why-it-matters/.

1.3 Low Income Energy Assistance Programs

The General Assembly's comments submitted to the EPA[286] express the widely held value of the importance of developing an energy infrastructure that allows Missourians across the socio-economic spectrum to afford the basic necessities of modern life, including their utility bills. Given that low-income customers typically have a higher energy burden than the average customer, and that there are greater energy efficiency opportunities for low-income households, a discussion of low-income customers and energy is relevant.

There are a number of programs available to Missouri residents designed to assist low-income customers in paying their energy bills. For example, every investor-owned utility (IOU) has budget billing and payment plans that allow customers to equalize monthly bills throughout the year. Further, some utilities have income-based bill credit programs designed to assist qualifying customers in paying their utility bills or overdue balances. Additionally some utilities allow customers to make voluntary contributions on their bill that are used to assist customers in need and, in certain instances, utilities make voluntary contributions themselves to assist these customers.

At the state government level, the Missouri Utilicare program provides financial support to eligible low-income, disabled, or elderly citizens through community action agencies who make payments for the eligible in need. Although the Utilicare program was created over 30 years ago, funding of the program has been inconsistent.

In addition, several programs exist at the federal level to provide services and support to low-income customers. These programs are administered by Missouri agencies at the state level. The sections that follow describe these programs.

a) Low-Income Home Energy Assistance Program

The Low Income Home Energy Assistance Program (LIHEAP) assists low-income households, particularly those that pay a high proportion of household income for home energy, in meeting their immediate home energy needs. The State of Missouri Department of Social Services Family Support Division applies for and receives LIHEAP funding from the federal government and then contracts with Missouri Community Action Agencies to conduct the eligibility determination for LIHEAP applications.

LIHEAP has two components: the Energy Assistance (EA) program and Energy Crisis Intervention Program (ECIP). The EA program is designed to provide financial assistance to help pay for primary fuel source heating bills for Missourians during the months of October through March. The EA benefit amount is based upon household size, income, and the type of fuel used for home heating.

The ECIP is designed to provide financial assistance to households in a verifiable energy crisis that is defined as: 1) receipt of a termination or disconnect notice indicating a specific disconnect date; 2) a final billing statement advising the account has been terminated; 3) a propane tank is filled at less than 20 percent capacity; 4) the customer is a cash on delivery customer; or 5) a pre-paid electric customer whose pre-paid usage is about to run out. Winter ECIP assistance is available from October through May, subject to availability of funds, and the maximum benefit amount is $800. Summer ECIP is primarily used to restore or prevent disconnection of services of a cooling energy source during June through September and the maximum benefit amount is $300.

For 2014, Missouri received a combined total of $71.1 million in LIHEAP block grant and re-allotment funding. The average benefit calculated across all LIHEAP programs was $430 per household for the

148,453 households receiving LIHEAP assistance. In comparison, 602,814 households had income at or below 150 percent of the Federal Poverty Level.[287]

Historically, a portion of the LIHEAP funds allocated to Missouri have sometimes been used to fund low-income weatherization under the LIWAP program. Low-income weatherization provides long-term benefits by reducing the energy burden for low-income families. In recognition of those benefits, the Missouri Energy Task Force created by Governor Matt Blunt in 2006 recommended that the Department of Social Services should transfer five percent in 2007 of the total LIHEAP funds to be used for weatherization and 10 percent in 2008 and 2009.[288] This 10 percent transfer was done again in fiscal year 2015, and at the time this Plan was finalized, it appeared likely to occur in fiscal year 2016. Continuing the stepped increases recommended by the Missouri Energy Task Force, the transfer should be increased to 15 percent.

Another recommendation of that Task Force was that the Department of Social Services should modify its rules to require that individuals living in owner-occupied dwellings who receive utility assistance will be referred to their local weatherization agency for weatherization of their residence. Implementing this recommendation would help low-income families who have had difficulty paying energy bills to improve the energy efficiency of their homes and lessen their energy burden.

b) Low-Income Housing Tax Credit

The Low-Income Housing Tax Credit (LIHTC) provides a transferable federal and state tax credit to owners of affordable housing developments, which can be sold to investors to generate equity for a proposed development. The tax credit is determined annually by the Internal Revenue Service, is dependent on the population of Missouri, and is administered by the Missouri Housing Development Commission (MHDC).

The LIHTC provides a state tax credit for ten years to qualified owners and investors in affordable rental housing developments equal to approximately nine percent of the eligible development costs.[289] In 2013 MHDC funded private developers via LIHTC to preserve 464 existing units and to build 879 new units of affordable housing. For residential new construction projects energy efficiency requirements are attached to these dollars as a way of ensuring that public funding is spent efficiently and effectively.[290]

Missouri law also provides an investment tax credit equal to 25 percent of approved costs associated with qualified rehabilitation of an historic building. The rehabilitation must be substantial, meaning that a threshold amount of 50 percent of the basis must be invested during the rehab.[291]

It should be noted that a taxpayer who has taken advantage of either the LIHTC and or the historic building tax credit programs (other than low-income customers) may not receive rebates through a utility energy efficiency program that is approved under the Missouri Energy Efficiency and Investment Act (MEEIA).

c) Low-Income Weatherization Assistance Program

The Low-Income Weatherization Assistance Program (LIWAP) is a federally funded program that is commonly supplemented with other state and utility funding. LIWAP provides home energy audits and cost-effective energy efficiency home improvements at no cost to Missouri's low-income households, especially the elderly, children, those with physical disadvantages, and others affected the most by high utility costs. The program aims to lower utility bills and improve comfort while ensuring health and safety and supporting local jobs.

To administer the LIWAP program in Missouri, the Division of Energy subcontracts with 18 Community Action Agencies and one not-for-profit agency. The Division of Energy provides technical and financial monitoring of these agencies to maintain federal compliance.

As mentioned previously, DOE estimates that low-income households in the U.S. typically spend 17 percent of their total annual income on residential energy costs, compared to four percent for most other households. A home that has been weatherized can reduce average annual fuel usage per dwelling by 35 percent for the typical low-income home. Because of this, LIWAP can be a long-lasting solution to the high energy burden problem that these customers face, and households that receive weatherization services are better able to pay their utility bills and purchase other necessities. Weatherization also allows for a reduced burden on utility assistance providers. Weatherization programs can be very cost-effective when considering the energy efficiency savings as well as other non-energy benefits. Weatherization has a benefit-cost ratio of about 1.4 for energy savings and when energy, health, and safety benefits are included, the benefit-cost ratio increases to four.[292] In addition to energy savings that help low-income households lower their energy bills, weatherization crews also address health and safety issues such as replacing faulty furnaces and water heaters.

1.4 Financing Energy Improvements

Several programs and opportunities exist around the nation to provide financing to homeowners who are interested in making energy efficiency improvements to their properties or installing renewable energy systems. Financing programs can be offered by utilities, financial institutions, third-party entities, and governments. A few examples of financing options available to residential customers include the Property Assessed Clean Energy (PACE) program, on-bill financing, and green banks.

PACE programs provide a simple and effective way to finance energy efficiency, renewable energy, and water conservation

PACE in Missouri
Various Locations, 2014

In January 2015 the Missouri Clean Energy District (MCED) completed its first PACE financing project at Kansas City's Wornall Plaza Condominiums for a total cost of $571,430 which included energy efficient lighting, building controls and heating ventilation and air conditioning upgrades. Its second financing project closed in April for the City of Otterville at a cost of $1,030,000 to upgrade its wastewater lagoon system to not only meet more stringent federal and state permit limits but also lower capital investment and operating costs. MCED plans to invest in more than a dozen projects in the coming months.

Funded by the St. Louis Clean Energy Development Board, as of April 2015, there were 10 projects completed for installation of energy efficient HVAC systems, photovoltaic systems, lighting and other energy efficiency measures at a total cost of over $555,600, with more projects under development. On July 14, 2015 the Missouri Athletic Club announced a $2.4 million energy efficiency retrofit of its St. Louis historic clubhouse using PACE financing to achieve energy savings of $200,000 per year. Energy Equity Funding, LLC administers the program on behalf of the St. Louis Clean Energy Development Board with project financing provided by PNC Bank. In less than a year, the St. Louis program has laid the foundation for a successful program that should continue to grow.

upgrades to both residential and non-residential buildings. Under PACE programs, municipalities and counties form special taxing districts to help property owners finance clean energy improvements by allowing a property owner to place an additional tax assessment on his or her property. Both residential and commercial property owners can utilize these loan programs to obtain financing for clean energy improvements that are repaid over a 20-year period.

In 2010 Missouri enacted a law allowing municipalities to create Clean Energy Development Boards, which can issue bonds and create and manage a local PACE program. In January 2011 Jefferson City formed the first local PACE clean energy development board in Missouri – now called the Missouri Clean Energy District. There are currently approximately 40 member communities that have joined this PACE board. In July 2013 the City of St. Louis launched its PACE St. Louis program that uses PACE financing for residential, single-family property owners who do not have an existing mortgage, and other building owners for energy efficiency, renewable energy, and water conservation projects. A third clean energy district, Show Me PACE, was launched in June of 2015. It is designed to serve the entire state using a system of on-demand financing in an effort to minimize the cost and time associated with financing. Its funding partner is PACE Equity. As of this report there were six municipalities participating in the Show Me PACE Clean Energy District.

PACE in Missouri is gaining momentum but there is great potential to finance more clean energy projects using this innovative model. Additional marketing, outreach, and technical assistance are needed and can play a key role in the program's success, initially by engaging local elected officials and administrators about joining a clean energy district. Then participating jurisdictions could publicize their PACE membership in the Missouri

In the summer of 2015, after only 45 days of formation, the Show Me PACE Clean Energy District (SMP), a statewide district, completed its first PACE financing project. The project, for Chesterfield's Cambridge Engineering, Inc. was for over $600,000 and among other things included lighting and HVAC improvements. With several other projects scheduled for completion in 2015, Show Me PACE is on track to demonstrate the value of PACE to Missouri economic development.

Sungevity - Third-Party-Owned Solar
Kansas City, MO

Sungevity, considered one of the top residential solar companies in the nation, selected Kansas City to open its new sales and service center in 2015, which will result in the creation of nearly 600 new jobs in clean energy over the next few years. The company also hires local solar experts to install solar systems. Because homeowners and businesses who want to employ rooftop solar energy often find it difficult to afford the upfront cost associated with installing and owning the system, Sungevity and other national companies offer solar leasing, power purchase agreements or ownership financing options to assist customers.

Besides amortizing the cost of the system over a period ranging

Clean Energy Board by using community groups to disseminate public information and by connecting with local community and neighborhood associations, small business groups and clubs, local nonprofit organizations, and others who can become effective advocates for PACE. It is also important to engage energy efficiency contractors and solar installers to help educate their customers about clean energy options and market PACE financing as a tool.

In addition to PACE, on-bill financing and repayment programs allow customers to receive upfront funding from utilities or third parties for energy efficiency improvements that is conveniently repaid to the lender on the customer's monthly utility bill. While customer creditworthiness can be a barrier to a broad extension of on-bill financing, some on-bill finance programs, noting that customers generally prioritize payments for maintaining utility service, have used a history of timely utility bill payment as a substitute for traditional means of credit evaluation. Programs that use this type of expanded underwriting criteria have maintained low loan default rates while increasing program participation rates. To date utilities in at least 23 states have implemented or are about to implement on-bill financing programs that lower or eliminate upfront installation costs and spread payments for efficiency improvements over time; however, Missouri is not one of them.[293]

Another recent financing tool to help homeowners make energy-efficient upgrades is called Warehouse for Energy Efficiency Loans (WHEEL). Sponsored by the National Association of State Energy Officials and modeled after Pennsylvania's Keystone Home Energy Loan Program, WHEEL is designed to provide low-cost capital to state and local energy loan programs. It buys unsecured residential energy efficiency loans, that originate in state or local government loan programs, and then bundles and holds them until the aggregate amount is large enough

from 10 to 20 years, the lease or power purchase agreements customer benefits from having the system installed, monitored, maintained and repaired by the company and is provided a warranty, performance guarantee, and insurance. Sungevity offers a number of financing and payment options, including zero money down, pre-paid, fixed or pay-as-you-go contracts.

to support a bond sale to institutional investors. Proceeds are used to recapitalize WHEEL so it can start the process again. The large-scale approach helps secure lower interest rates.[294] The partnership WHEEL builds with the contractor community is unique in that the assistance is delivered at the decision point and provides consumers lower interest rates to choose a more energy-efficient appliance, equipment, or measure.

Several states including Connecticut, New York, Vermont, and Hawaii are using green banks that are usually quasi-governmental, state-level financial institutions that offer low-cost financing for clean energy projects. Initially capitalized with state funding, green banks use a combination of loans and credit enhancements to leverage private investment in clean energy and energy efficiency. Other states, including California, Maryland, Illinois, Pennsylvania, Washington, and Rhode Island are considering similar legislation to establish green banks.[295]

2. Businesses and Energy

In 2013 Missouri was ranked 4th by the Economic Diversity Index for having one of the most diverse state economies in the nation.[296] In 2014 Missouri's Gross State Product (GSP) totaled over $284 billion, making it the 21st state in the country in terms of GSP.[297] Missouri has been featured on Pollina Corporation's list of top ten pro-business states for five years in a row.[298]

As shown in Figure 47, Missouri's private sector accounts for nearly 88 percent of the GSP with government activity accounting for the remaining amount. Of the private sector portion, manufacturing makes up the largest share of Missouri's GSP at 13 percent.

Missouri is home to 6,642 manufacturing firms, which collectively employ 252,724 workers. Manufacturing was recently ranked first among Missouri's top growth industries.[299] In terms of contributions to GSP, the largest manufacturing industries are food and beverage, tobacco, chemical products, and motor vehicles and components manufacturing.[300]

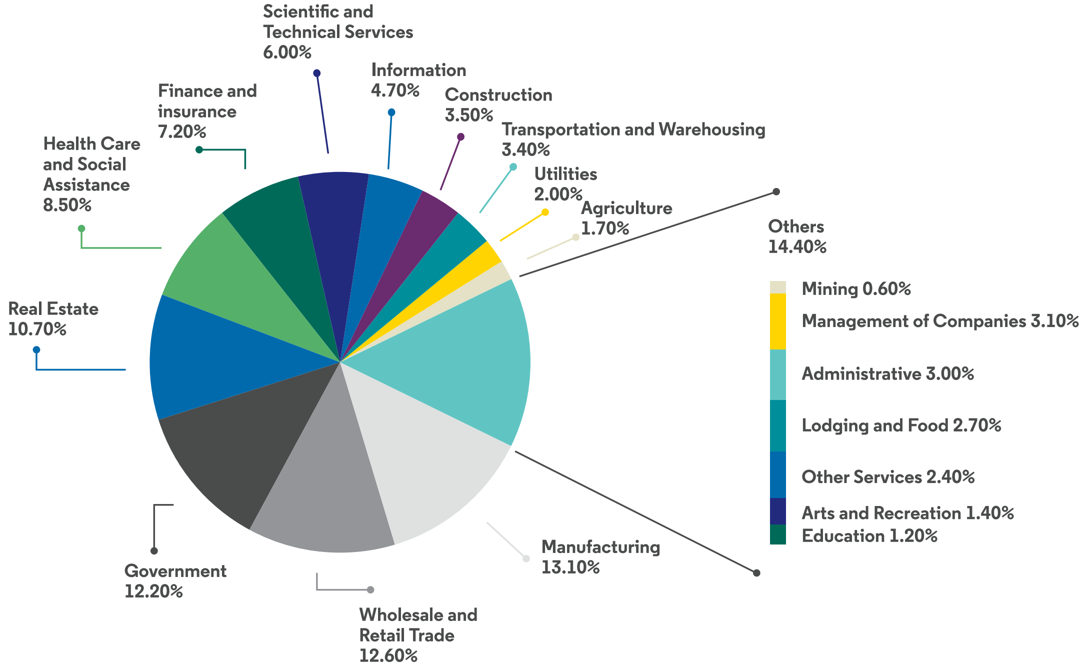


Figure 47. Breakdown of Missouri's Gross State Product by Industry, 2013.

Source: U.S. Bureau of Economic Analysis. "Real GDP by state (millions of chained 2009 dollars)." 2012.

According to the National Federation of Independent Business, energy expenditures, specifically those related to operating vehicles or heating and cooling buildings, are identified as a major cost by many small businesses. At the national level, approximately 10 percent of small-business owners state that energy is their single greatest cost. An additional 25 percent claim that energy is one of their top three business costs.[301]

While the low cost of energy in Missouri helps our businesses and economy by alleviating their energy burden, energy nonetheless makes up a large portion of operating costs for most small private sector employers in our state. Currently, manufacturing employers in Missouri pay 10 percent less per kilowatt-hour for their electricity than the national average. In comparison to states in our region, electricity prices for manufacturing in Missouri are roughly average.[302] Stakeholders have indicated that they can adapt to a gradual change in the cost of energy but that it is very difficult for businesses to weather unpredictability or substantial changes in cost.

Businesses can consume less energy and improve profitability by adopting cost-effective energy efficiency, demand response programs, and peak energy use management. Through on-site generation, businesses can lower costs by reducing or shifting load served by the utility while reducing the impact of disruptions and outages.

Opportunities also exist to increase the use of underutilized energy infrastructure. Linking new or expanding Missouri businesses to underutilized energy infrastructure benefits the business by reducing start-up costs, benefits the community by attracting capital expenditures and creating jobs, and benefits the utility by expanding its customer base and improving utilization efficiency of existing infrastructure.

2.1 Large Energy Consuming Sectors

The EPA estimates that energy comprises 30 percent of a typical office building's costs and is the single largest operating expense for a typical property.[303] As described in Chapter 3: Energy Use, commercial buildings have high energy demand and can put great strain on the power grid during peak periods. Implementing cost-effective energy efficiency processes and technologies, and making commercial buildings more efficient, could significantly lower operating costs and increase profitability for businesses.

One third of the country's total primary energy is used by the industrial sector with projected consumption to increase faster through 2040 than any other user. Due to the high energy use of industrial facilities as well as special commercial operations such as lodging and hospitals, energy efficiency projects at these facilities can have a favorable return on investment. This could result in significant ongoing operational savings and provides an attractive opportunity to stay globally competitive. It is estimated that businesses that implement energy efficiency projects in their facilities typically find rates of return as high as 25 percent.[304]

In Missouri industrial operations constitute a large portion of energy use and energy efficiency programs aimed at this sector can produce significant energy savings. However, the purpose of energy use at industrial facilities varies widely compared to the typical energy-intensive activities in residential or commercial buildings. For example, Missouri is highly ranked for data centers but given the sector's energy intensity and need for reliability, special consideration should be given for energy reduction and distributed energy opportunities. A particularly large energy-consuming sector in Missouri is the food and beverage sector. The state's E3 program, a collaboration of the EPA, DOE, U.S. Department of Commerce, U.S. Department of Agriculture, U.S. Department of Labor, and the Small Business Administration with representation from equivalent state agencies, has focused efforts to provide technical assistance to balance energy, economy, and environmental goals for communities, manufacturers, and manufacturing supply chains in the food and beverage industry. The program provides access to free energy-, water-, and emissions-savings audits for selected industrial facilities and offers training on lean management practices.

Not all energy efficiency contractors are equipped to address the specific needs of manufacturing facilities. To partially address this need, the Missouri Industrial Assessment Center at the University of Missouri-Columbia, funded by DOE, serves as a resource to qualified small- and medium-sized manufacturing companies. The Center promotes best practices in industrial energy efficiency, reusable energy, waste reduction, and increased productivity. In addition, it offers energy audits and productivity assessments to clients.

Utility or government sponsored energy programs may provide tailored solutions to increase end-user efficiency and identify and provide opportunities for cost-effective investments in energy efficiency measures. As described in Chapter 3: Energy Use, the current opt-out provision in MEEIA allows large industrial consumers to opt out of paying into the programs. Including combined heat and power or other self-directed efficiency programs as an option to fulfill energy efficiency targets in the MEEIA may result in increased participation from large energy users as it may provide a better operational fit as well as increased reliability.

3. Government and Energy

Similar to individual homeowners and businesses, state and local governments spend money to heat and cool buildings, power appliances, and operate vehicles while also powering traffic lights, treating water, and addressing other public service needs. According to the American Council for an Energy-Efficient Economy, state governments in the U.S. spend more than $11 billion annually on energy, which can account for as much as 10 percent of a typical government's annual operating budget.[305]

Specific to our state, during the fiscal year ending in June 2014, Missouri government spent more than $73 million on fuel and utilities, with over half those expenditures spent on the purchase of electricity – see Figure 48. The Office of Administration – Division of Facilities Management, Design and Construction estimates that in 2013, buildings they managed used more than two billion BTU of energy across all fuel types.

Expenditures of Fuel and Utilities, FY 2014

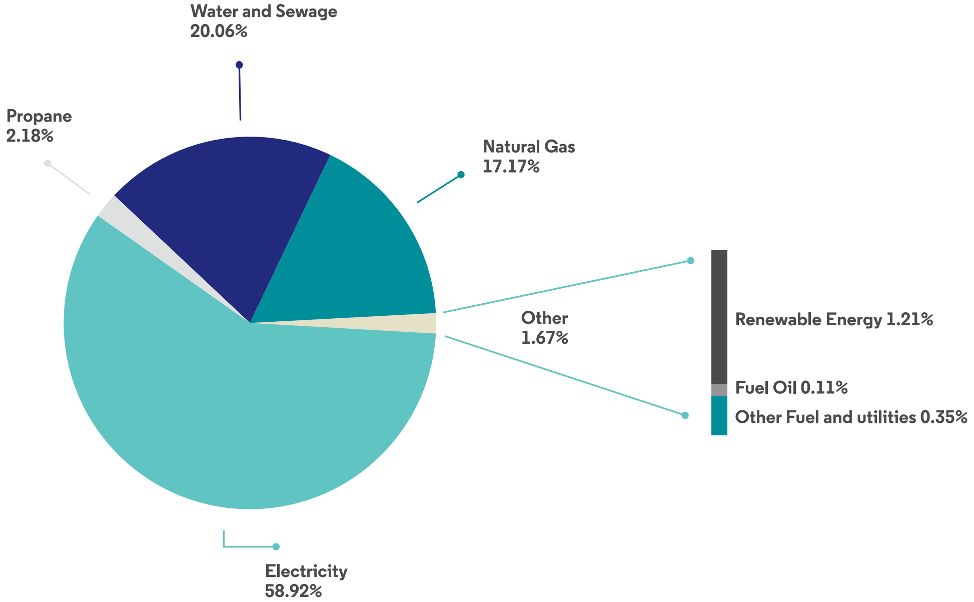


Figure 48. Breakdown of State Expenditures on Fuel and Utilities, FY 2014.

Source: Missouri Office of Administration: Division of Purchasing and Materials Management, "Payments by Category," 2015, http://mapyourtaxes.mo.gov/MAP/Expenditures/Categories/Default.aspx?year=2014

One challenge faced by nearly 400 cities and neighborhood organizations in Missouri is the fact that electricity usage for streetlights is typically charged at a flat rate and does not reflect actual energy usage. In 2014, several cities filed a formal complaint with the Missouri Public Service Commission (PSC), seeking to change this. Two smaller cities claim that if they paid for actual electricity used, rather than the flat fee, they could save residents more than $1.2 million a year. This kind of scenario has limited smaller local governments in Missouri from investing in upgrading lighting and reducing energy use while a bigger city such as St. Louis, which owns and maintains its own streetlights, can plan, invest, and see payback from energy reductions.[306] Although the PSC dismissed the complaint for failure to state a claim upon which relief could be granted, the cities appealed and the appeal is still pending.

3.1 Leading by Example

As noted in Chapter 3: Energy Use, local governments play a significant role in driving energy efficiency initiatives and have already put in place both ordinances and programs that focus on improving energy efficiency in their communities.

Missouri has long recognized communities' role in spurring innovation and for more than 25 years our state has supported energy efficiency and renewable energy technologies through the Missouri Energy Loan Program. Additionally, the Minimum Energy Efficiency Standards for state buildings, signed by the Governor in 2009, has led state agencies to decrease consumption by more than twenty percent since implementation.

Some local governments in Missouri have instituted policies to encourage Leadership in Energy and Environmental Design (LEED) certification for new government buildings. Local governments throughout the state have also been utilizing federal funds, including the Energy Efficiency and Conservation Block Grant, to finance initiatives to reduce energy expenses. For example, the City of Columbia utilized these funds to establish an Office of Sustainability. The City of St. Louis also used federal funds to install heating, ventilation and air conditioning (HVAC) retrofits, internal lighting upgrades, direct digital control upgrades and whole building lighting upgrades in its City Hall and saw savings of nearly 50 percent in 2013.[307]

Missouri Energy Loan Program

The Missouri Energy Loan Program, administered by the Missouri Department of Economic Development, is available for energy efficiency and renewable energy projects for public and governmental buildings and structures. Eligible recipients include public schools (K-12), public/private colleges and universities, city/county governments, public water and wastewater treatment facilities, and public/private non-profit hospitals. This program recently celebrated a milestone of 25 years.

Established in 1989, the program has awarded 560 loans to schools, local governments, colleges, universities and healthcare institutions for energy-saving investments, such as lighting upgrades, heating and cooling systems, insulation, windows and other measures affecting energy use. These projects have resulted in more than $175 million in estimated cumulative energy savings.

The energy conservation efforts cited in this chapter, and others occurring throughout the state, represent opportunities that other municipalities, businesses, and individuals in Missouri could imitate and build from. For example, opportunities exist to expand the scope of energy efficiency activities to target outside facilities, including landscaping, traffic signals, and exterior lights and signage.

4. Summary of Key Points

- Home energy burden can help measure the affordability of energy bills and is defined as the share of annual household income that is used to pay annual energy bills. Research indicates that in 2014, more than 600,000 households in Missouri had household incomes at or below 150 percent of the Federal Poverty Level and faced an average energy burden greater than nine percent. A six percent energy burden is generally considered to be the threshold for affordability. Opportunities to assist individuals who experience a high energy burden can be explored and can result in benefits that extend beyond cost reductions to improved comfort and better quality of living. Additional long-term benefits can be realized for residential occupants by utilizing a greater portion of LIHEAP funds for home energy weatherization efforts.

- Low-income customers typically have energy costs that are relatively high compared to their overall household income. The issue is typically exacerbated by poor housing quality and the lack of capital to make necessary improvements that would result in reduced energy bills. Programs that provide assistance to these customers and that prioritize improvements in old and inefficient buildings can result in significant amounts of energy savings and the added benefits of improved health, safety, and affordability for customers that may need it the most.

- With tight budgets, residents and businesses often do not pursue energy efficiency improvements due to the required upfront capital that is critical to move projects forward. Opportunities for leveraging private investment in energy efficiency and renewables, including on-bill financing, utility rebates or tax credits, PACE financing, credit enhancements, and loans, would alleviate this issue, particularly for those individuals and entities such as small businesses, not-for-profit organizations, hospitals, and water treatment facilities that may require assistance.

Government LEED Buildings

Some examples of LEED certified government buildings include Fire Station #7 in Columbia, Staley High School in Kansas City, Transportation Management Center in Springfield and Carondelet Recreation Center in St. Louis.

In addition the Missouri Department of Natural Resources' Lewis and Clark State Office Building in Jefferson City was the first state office building to be certified LEED platinum in the country. It incorporates numerous elements of sustainable design, which minimize its impact on the environment and provides employees with a more productive work environment. Almost 400 employees work in this 120,000-square-foot building.

- High energy-consuming sectors including commercial buildings, manufacturing facilities, and industrial operations that implement energy efficiency projects experience a high return on investment, significant operational savings, and increased profitability. Energy audits, assessments, and efficiency programs sponsored by utilities or government can provide tailored solutions for customers in these sectors and an opportunity for cost-effective investments.

- Linking new or expanding Missouri businesses to underutilized energy infrastructure benefits the business by reducing start-up costs, benefits the community by attracting capital expenditures and creating jobs, and benefits the utility by expanding its customer base and improving utilization efficiency of existing infrastructure.

- State agencies have reduced energy use by more than 20 percent since Governor Nixon signed Executive Order 09-18.[308] However, opportunities exist to expand the scope of their energy efficiency activities to target outside facilities, including landscaping, traffic signals, and exterior lights and signage.

II. Energy Jobs

Energy-related businesses currently operating in Missouri provide an array of energy products and services, with opportunities for expansion at different levels of the supply chain. Missouri is home to businesses focusing on extracting raw materials, producing manufactured parts such as electrical transformers, assembling products including wind turbines from component parts, and completing energy infrastructure projects. Jobs related to these businesses include those in manufacturing, wholesale trade, and professional, technical, and other services.

In terms of job potential, the Missouri 2011 Strategic Initiative for Economic Growth identified seven broad industry clusters, including Energy Solutions, as having a higher than normal potential for employment and economic growth. This cluster focuses on aggressive research, commercialization and technological advancements by Missouri industries to improve the extraction, delivery, and consumption of natural gas, wind, solar, biomass/biofuel, fossil fuels, and nuclear power.[309] Energy Solutions includes both energy efficiency and renewable energy jobs, as well as jobs in coal mining, power plant operations and maintenance, and others.

Currently the five largest employers in Missouri's energy industry are Emerson Electric Company, Black & Veatch, Application Engineering Group, Burns & McDonnell, and Accenture, all private-sector companies. However, the majority of private sector employers in Missouri are small businesses, with an average business size of 13 employees; 76 percent of Missouri businesses employ less than ten people.[310] There are many small businesses that provide energy services or related products such as Show Me Energy Cooperative in Centerview, GlenMartin/TWR Group in Boonville, Missouri Wind and Solar in Seymour, Microgrid Solar in Clayton, and Exergonix in Lee's Summit.

Small Modular Reactors (SMR) present potential for energy job growth in Missouri. SMRs are highly compact, safe, and reliable reactors that make nuclear power an attractive option for a variety of electric energy providers. In 2012, Westinghouse Electric Company, a global leader in nuclear energy technology, applied for federal cost-share investment funds from the U.S. Department of Energy (DOE) to design, license, manufacture and commercialize its Small Modular Reactor design. Westinghouse's application to the DOE, and its vision of developing SMR technology in Missouri, had strong support from an unprecedented collaboration of Missouri's electric power providers, including Ameren Missouri, the Missouri Association of Electric Cooperatives, the Missouri Public Utility Alliance, Associated Electric Cooperative Inc., Empire District Electric, and KCP&L.

In announcing the coalition supporting Westinghouse's application, Governor Nixon noted that designing, developing and commercializing next-generation nuclear technology will create good jobs for Missourians and expand global exports. Missouri is an ideal state to develop SMRs because of its outstanding workforce, powerhouse research institutions, strong support for nuclear power, and central location along two major rivers.

Although DOE did not award the cost-share funds to Westinghouse, Westinghouse recently announced that the U.S. Nuclear Regulatory Commission (NRC) approved the company's testing approach for the Westinghouse Small Modular Reactor design. The NRC approval is a significant step toward design certification and will reduce the time ultimately needed to license the Westinghouse SMR. In a letter dated February 27, 2015, the NRC told Westinghouse that it has granted a Safety Evaluation Report for the licensing topical report that the company submitted in April

2012 for agency review and approval. Westinghouse believes the NRC action confirms the technical maturity of the Westinghouse SMR concept design.[311]

In addition, a 2012 report developed by the Midwestern Governors Association found that Missouri is highly specialized in HVAC manufacturing within the Midwest. The concentration of HVAC manufacturing located in Missouri is larger than in other states, with an estimated 9,546 jobs in 2012.[312] The strength of the HVAC and commercial refrigeration-manufacturing sector in Missouri is related to co-locating production near related industries such as food production and consumer and industrial electronics. Food processors' reliance on commercial refrigeration accounts for half of the employment in this manufacturing category. The remaining businesses build HVAC units, compressors, and parts where demand is largely driven by construction trends. Skilled entrepreneurs, aided by the availabilities of key raw materials, such as iron and lead, helped build Missouri's historic strength in electrical equipment and components manufacturing at companies such as Emerson Electric, A.B. Chance (Hubbell), and Energizer. Local community colleges, technical schools, retraining programs and apprenticeships provide training and certification to maintain a steady supply of highly qualified workers.

1. Recognizing the Potential for Clean Energy Job Growth in Missouri

A 2009 study conducted by Missouri Economic Research and Information Center (MERIC) concluded that Missouri had over 130,000 "green jobs", which made up 4.8 percent of total employment in the state. MERIC defines green jobs as those that are directly involved in generating or supporting a firm's green-related products or services in the areas of energy, manufacturing, building, farming, government, and salvage and remediation. Though not all of the jobs identified by MERIC as green are related to energy, it is likely that those identified under the categories of green energy production, green manufacturing, and green buildings are. As shown in Figure 49, these three areas combined represent approximately 109,200 jobs in the state.

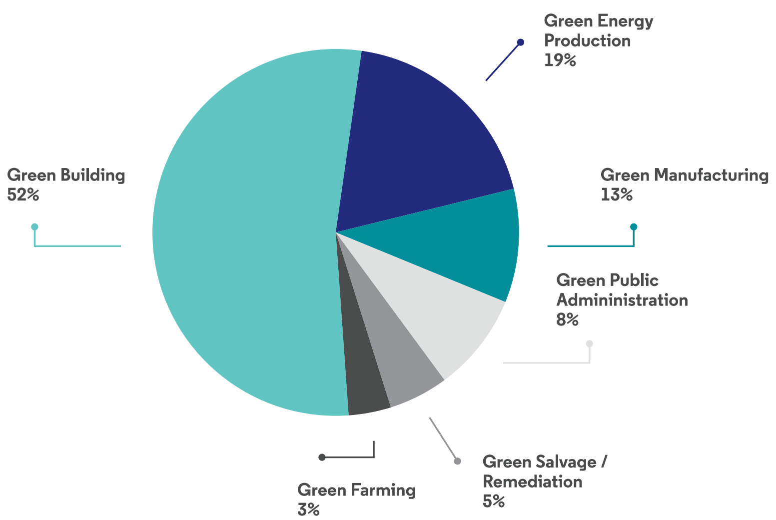


Figure 49. Missouri Green Economy Sectors and Jobs.

Source: Missouri Economic Research and Information Center, "The Missouri Green Jobs Report," Accessed March 2015. http://www.missourieconomy.org/pdfs/mo_green_jobs_report.pdf

As recognized under the Salvage and Remediation category above, there are opportunities to recover and recycle the materials from consumer and commercial electronics before disposal. As electronics become more sophisticated and consumers' upgrade and replacement cycles become shorter, the disposal in landfills or incinerators of electronic waste (e-waste), which often contains heavy metals such as lead, chromium, and cadmium, is a growing concern. Recycling e-waste avoids the improper handling and disposal of these often-toxic materials, which can cause health and environmental consequences. Missouri has deposits of rare earth metals and metallic minerals; however, quantities of these minerals are not well defined. The costs associated with mining and processing make it more economical to extract and possibly more attractive to recover. Some states have responded by enacting e-waste material recovery, management, and recycling laws. While Missouri enacted the Manufacturer Responsibility and Consumer Convenience Equipment Collection and Recovery Act in 2008, the program is limited to certain computer equipment, exempts televisions, cellular phones, and other consumer electronic devices.

Several studies conducted recently have attempted to qualify and quantify Missouri's potential for job growth from clean energy industries. For example, in 2013 Environmental Entrepreneurs identified Missouri as 10th in the nation for growth in clean energy and clean transportation jobs.[313] The Brookings-Battelle Clean Economy Database concluded that the largest segments of Missouri's clean economy in 2010 were public mass transit, waste management and treatment, energy-saving building materials, conservation, and regulation and compliance.[314] In addition, the fastest growing segments from 2003 to 2010 were electric vehicle technologies, smart grid, wind, solar thermal, and battery technologies - Figure 50. Energizer Battery Manufacturing, Ford Motor Company Kansas City Assembly, HNTB Corporation, Watts Radiant, Zoltek Companies and Brightergy are examples of clean energy companies in Missouri.

Largest Segments

of Missouri's clean economy, 2010

Segment	Jobs, 2010	Job Change, 2003-2010	Annual Average Job Change, 2003-2010 (%)
Public Mass Transit	6,111	+1,254	+3.3%
Waste Management and Treatment	5,421	+1,566	+5.0%
Energy - saving Building Materials	4,328	-472	-1.5%
Conservation	3,627	+495	+2.1%
Regulation and Compliance	3,522	+1,119	+5.6%

Fastest Growing Segments

of Missouri's clean economy, 2003-2010

Segment	Jobs, 2010	Job Change, 2003-2010	Annual Average Job Change, 2003-2010 (%)
Electric Vehicle Technologies	605	+602	+113.4%
Smart Grid	50	+43	+32.4%
Wind	244	+206	+30.4%
Solar Thermal	17	+12	+19.1%
Battery Technologies	406	+266	+16.4%

Figure 50. Largest and Fastest Growing Segments of Missouri's Clean Economy, 2003-2010.

Source: Brookings, "Sizing the Clean Economy: The Clean Economy in the State of Missouri," 2011, http://www.brookings.edu/~/media/series/clean-economy/29.pdf

Two sectors where the potential for job creation and growth is substantial are energy efficiency and renewable energy.

a) Energy Efficiency

Opportunities for economic development through energy efficiency may be particularly valuable to Missouri's economy. Energy efficiency also contributes to growth in the commercial sector through the delivery of energy efficiency technologies and services by manufacturers, contractors, and engineering and consulting firms.

The American Council for an Energy-Efficient Economy's (ACEEE) most recent report on energy efficiency jobs estimates that, as of 2010, the number of jobs related to energy and resource efficiency in the United States was around 830,000, with an annual increase of three percent. ACEEE also estimates that every $1 million investment in energy efficiency improvements supports around 20 jobs in the country, including direct, indirect, and induced jobs. This is larger than the economy-wide average of 17 jobs supported per $1 million of investment.[315] Specific to our state, a 2011 study estimated that Missouri could create 8,500 new jobs to design, install, and operate energy efficiency measures by 2025, which would be equivalent to opening 50 small manufacturing plants.[316]

b) Renewable Energy

Growth of jobs in the renewable energy sector is driven from policies and initiatives that the state has undertaken to develop this industry. As an example, the recent solar rebate offered as part of Missouri's RES was so popular among Missouri residents that the funds may already be exhausted.[317]

Overall, renewable energy industries have seen tremendous growth around the country and opportunities exist for further expansion in Missouri. In 2010 Missouri ranked 6th in the nation for photovoltaic jobs and 8th for jobs in biomass and biofuels. In addition, a 2012 report from MERIC noted that renewable energy exports make up a growing proportion of Missouri's total exports, suggesting the renewable energy industry could provide a valuable opportunity for increased exports.[318]

Missouri is home to a variety of successful companies working at different levels of renewable energy supply chains. For the wind industry, according to the American Wind Energy Association, there are 501 to 1000 direct and indirect wind jobs in the state supported at ten active manufacturing facilities - Figure 51.[319]

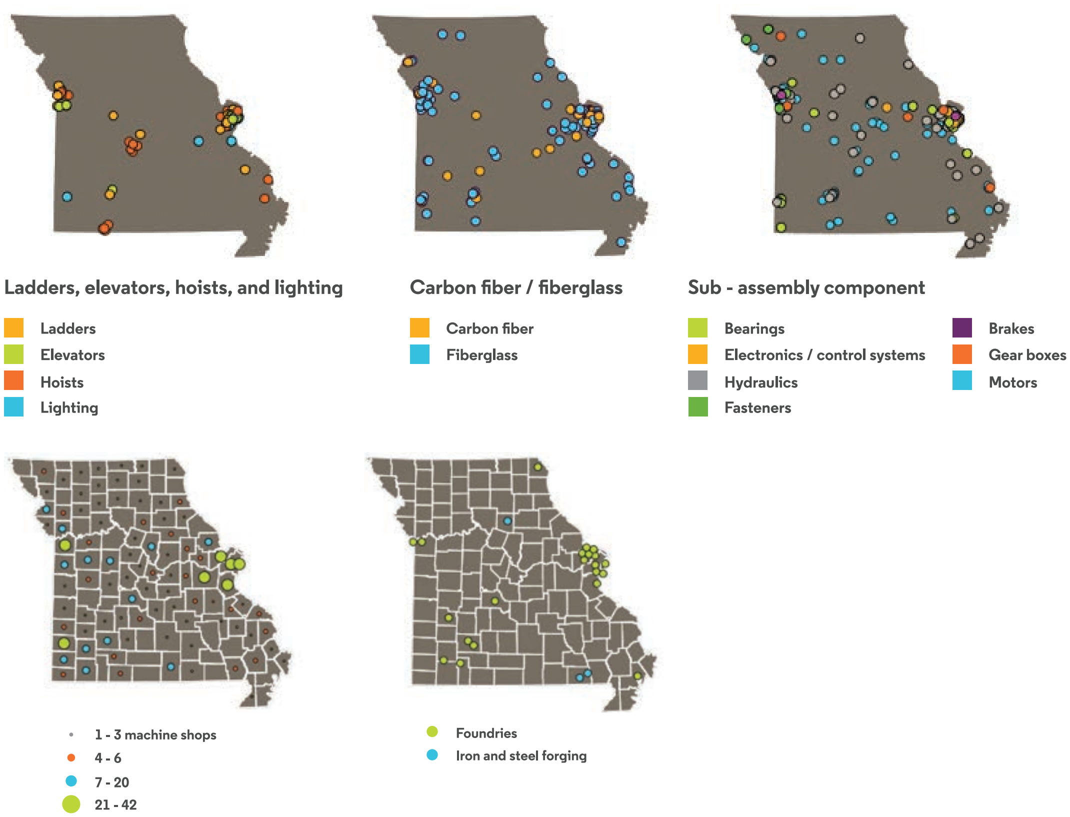


Figure 51. Missouri Companies Working In The Wind Energy Supply Chain.

Source: The Missouri Partnership, "5 Reasons Missouri is Right for Wind Energy," Accessed March 2015, http://missouripartnership.com/Portals/0/PDF/Wind%20Energy.pdf

The national solar industry has been creating jobs at a rate 20 times faster than the economy as a whole, with many of these jobs in solar installation.[320] Similarly, Missouri's solar industry has also been growing in recent years with $187 million invested in 2014 to install solar photovoltaic systems for residential, business and even utility use. This represents a 63 percent increase over the previous year with expectations for continued growth.[321]

According to the Solar Energy Industries Association, there are more than 97 solar companies at work throughout the supply chain in Missouri, employing 2,500 people. These companies provide a wide variety of solar products and services which can be broken down across the following categories: 14 manufacturers, six manufacturing facilities, 47 contractors and installers, two project developers, 10 distributors, and 24 engaged in other solar activities including financing, engineering, and legal support - Figure 52. These numbers are likely to increase due to the opening of a new sales and service center for Sungevity, one of the top solar service companies in the nation. The company has hired more than 100 employees and expects to create almost 600 jobs over the next five years.

Key:

- Manufacturer
- Installer
- Other

Figure 52. Missouri Solar Manufacturers and Installers.

Source: The Missouri Partnership, "5 Reasons Missouri is Right for Wind Energy," Accessed March 2015, http://missouripartnership.com/Portals/0/PDF/Wind%20Energy.pdf

2. Investment and Financing

Venture funding to support a clean economy requires capital sources with a tolerance for risk not often seen from traditional private sources. The national trend for venture capital investment currently demonstrates an aversion to early-stage risk and in Missouri venture capital demonstrates even stronger risk aversion at this stage. However, according to PricewaterhouseCoopers and the National Venture Capital Association, Missouri outperforms the national average in producing jobs from venture capital investment. Using 2010 data, the National Venture Capital Association ranked Missouri 12th in the number of new jobs created through venture capital investment with $770 million of venture capital invested in Missouri industrial and energy deals from 1995 to 2011.[322] These trends are likely the result of Missouri's competitive advantage of low cost utility service, low cost of doing business, history of innovation, and entrepreneurship. While the state currently has ways to mitigate barriers to investment in clean energy, clean energy financing is key to helping businesses reduce costs and meet customer demand for products derived from cleaner energy resources into the future.

The Missouri Treasurer's Office currently partners with lending institutions to spur economic development through low-interest loans via the Missouri Linked Deposit Program. Using the program allows lenders to lower their interest rates to borrowers by about two to three percent, thereby assisting qualified borrowers in financing their projects. Farming operations, multifamily housing, and consumers may use loan proceeds for energy efficiency measures and alternative energy projects, such as solar panels or wind turbines, among other things, provided they meet the lending institution's credit requirements.

Major companies have and will increasingly make location, expansion, investment, supply chain partnerships, and purchasing decisions based on meeting their own corporate responsibility and renewable purchasing requirements. The Department of Economic Development Advanced Manufacturing Industry Council recognizes that environmental and energy sustainability is becoming even more critical as customers demand social responsibility of their manufacturers.[323]

The U.S. Department of Defense recently improved its efforts to increase the productivity, efficiency, and effectiveness

Ikea
St. Louis

In July 2015, Ikea completed Missouri's largest rooftop solar installation for its St. Louis location. The 259,000-square-foot solar array is a 1.28 MW system composed of 4,085 panels.This comes only a few months after Ikea completed Kansas' largest rooftop solar installation. These projects bolster Ikea's goal of being energy independent by 2020. Working toward that goal, Ikea has installed over 700,000 solar panels on buildings throughout the world and owns roughly 157 wind turbines in Europe and Canada. Ikea is currently building 104 wind turbines in the U.S.

KCP&L Green Impact Zone
Kansas City Region 2010-2015

The Green Impact Zone consists of 150 inner-city blocks that suffer from high levels of unemployment, poverty, and crime. Within this zone, efforts are focused on training residents to participate in weatherization and energy efficiency programs to reduce utility bills, conserve energy, and create jobs.

Within the Green Impact Zone, KCP&L installed a 100-kilowatt solar system that is used as a demonstration for both teachers and students at a local school, Paseo Academy. Additional project initiatives include installing electric vehicle charging stations, connecting a large battery storage of the department's acquisitions, technologies, and logistics efforts. One area of emphasis is in Better Buying Power 3.0 which is incentivizing productivity in industry suppliers by rewarding contractors for successful supply chain and indirect expense management.

Investments in clean energy have come to be expected by mainstream institutional investors. Setting clean energy targets is now "business as usual" along with companies' reporting of progress in meeting the targets. Approximately 60% of the largest U.S. businesses have set public climate and energy goals to increase their use of renewable energy. Thirty-four of these businesses, including companies such as Facebook, eBay Inc., Walmart, Target, Bloomberg, GM, Ikea, Procter and Gamble, Intel, and Sprint, have signed the Corporate Renewable Energy Buyers' Principles: Increasing Access to Renewable Energy, which outlines principles that would help the signatory companies meet their needs for renewable energy. The principles include opportunities to work with utilities and regulators to expand businesses' access to long-term, fixed-price renewable energy that is cost competitive and that helps reduce energy emissions beyond the companies' business as usual.

When the Buyers' Principles were created in 2014, the original 12 signatories indicated that they required 8.4 million MWh (enough to power nearly 800,000 homes) of renewable energy per year through 2020. The number of signatories has since almost tripled. The large amount of renewable energy needed to meet these companies' goals shows that there is a clear demand and an investment opportunity for any provider that can meet their needs.[324] Missouri should work to remove barriers to clean energy investment.

Efforts to help Missouri utilities further diversify their portfolios and increase options for renewable power purchasing coupled with low energy prices will ensure our businesses are well positioned to meet future competition.

system, and substation automation. The zone also advanced a number of employment and training opportunities and helped build neighborhood leadership capacity.

Increased neighborhood capacity:

- 275 residents trained through Mid-America Regional Council Community Leadership Program.
- $271,226 in grants awarded to neighborhood associations to secure 501c3 designations, enhance websites and communications with residents, conduct strategic planning, purchase equipment, and host neighborhood cleanup events.
- New community meeting space available in three renovated structures in the zone.

Employment and Training:

- Eight Essential Employability Skills workshops with 133 graduates.
- A jobs pipeline offering regular updates on available jobs with 627 participants.
- Six interview fairs and 151 job replacements.
- 395 training certifications and 435 training referrals.

3. Workforce Development

All key energy sectors and their stakeholders, including the oil and gas industry, the electric power sector, and the renewable energy and energy efficiency industries, require a highly skilled, well-trained workforce to deliver clean, reliable, and affordable energy. Many sectors face significant workforce challenges due to a rapidly aging employee pool and high future demand for qualified workers. In 2013, the Center for Energy Workforce Development, which includes investor-owned electric and gas utilities, rural electric cooperatives, and the International Brotherhood of Electrical Workers, conducted a survey that found:[325]

- The size of the industry workforce decreased by approximately 8,000 jobs between 2010 and 2012;
- The average age of the workforce increased from 45.7 years in 2006 to 47.2 at the end of 2012; and,
- The percentage of workers ready to retire now increased from 8.9 percent in 2010 to 9.9 percent in 2012.

As the utility workforce ages there is a need to ensure there are sufficient replacement workers that have skills applicable to an evolving energy industry, especially regarding smart grid technology. Core skills such as engineering, data management, and business management along with more communication and IT skills will be highly valued in smart-grid related jobs. Additional training will be necessary as new technologies are introduced or more widely used. Focusing on developing training programs in the area of grid modernization will provide the opportunity to build and scale up these programs on a statewide basis. Lessons learned could be transferred to other workforce areas.

According to MERIC, Missouri had 6,642 manufacturing companies and employed 252,724 workers in 2013. Manufacturing accounted for $36 billion or 13% of the state's $276 billion overall Gross State Product (GSP). Manufacturing also produces nearly 93% of the state's exports.[326]

MERIC recommends the following actions:

- Establish a National Network of Manufacturing Innovation Institutes (MIIs): formation of MIIs as public-private partnerships to foster regional ecosystems in advanced manufacturing technologies.

Building Operator Certification Training
2006-Present

Supported by the Missouri Department of Economic Development - Division of Energy, the Building Operator Certification (BOC) program trains individuals who are directly responsible for day-to-day building operations to achieve energy savings in the operation of public facilities and commercial buildings.

The BOC program offers a series of seven training courses for energy and resource-efficient operation of buildings that include classroom study, small group exercises, and project assignments based on participants' own facilities. Participants can expect to learn about heating and cooling equipment, facility energy accounting, HVAC energy inspection reporting, facility lighting surveys, and much more.

The program was recognized in 2014 for graduating 152 participants, the highest among all Midwestern states.

- Tap the Talent Pool of Returning Veterans: returning veterans possess many of the key skills needed to fill the skills gap in the manufacturing talent pipeline. MERIC makes specific recommendations on how to connect these veterans with manufacturing employment opportunities.

- Invest in Community College Level Education: the community college level of education is the 'sweet spot' for reducing the skills gap in manufacturing. Increased investment in this sector is recommended, following the best practices of leading innovators.

- Enhance Advanced Manufacturing University Programs: universities should bring new focus to advanced manufacturing through the development of educational modules and courses.

Missouri is home to numerous educational institutions that offer every level of education and training through certification programs, undergraduate and graduate degrees, as well as a variety of training programs for different energy-related trades. Governments, unions, nonprofits, and others offer additional training opportunities. Some of the workforce and educational programs available in the state are shown in Table 25.

Table 25. Energy Education and Workforce Development Programs in Missouri.

Central Region	• University of Missouri - hosts the Center for Sustainable Energy which addresses energy issues broadly, building on MU's Research Reactor; MU's biomass power plant; research in biofuels, biomass and energy efficiency; the College of Engineering; and education programs in nuclear and other kinds of energy. This initiative also examines policy and its implications, business models, environmental impacts, and the cultural and social consequences of energy uses and production. • The Midwest Energy Efficiency Research Consortium located at the University of Missouri-Columbia in partnership with regional industry partners and government agencies is focused on developing academic courses and training programs, advancing development and applications of energy efficient technologies, and disseminating information on the value of energy efficiency. Six consortium partner centers are part of MEERC -Lighting Research Center, High Performance Building Center, Energy Solutions and Service Center, Agricultural Energy Efficiency Center, Low Energy Heating and Cooling Center, and Energy Efficiency in Water and Wastewater Center. • State Technical College - offers an associate of applied science degree in Nuclear Technology to prepare students to work with organizations or businesses that operate nuclear reactors or handle radioactive substances.
Kansas City Region	• Metropolitan Community College - offers North American Board of Certified Energy Practitioners Installer test prep courses. • Vatterott College and Pinnacle Career Institute, both in Kansas City - offer wind turbine technician training. • The Midwest Energy Efficiency Alliance - hosts Building Operator Certification trainings and has already certified more than 500 building operators in Missouri.[314]
Ozark Region	• Mineral Area College - offers an enhanced curriculum with green jobs and workforce training • University of science and technology, at Rolla – is involved in grid stabilization and storage for clean energy technologies[315] • College of the Ozarks – offers a certificate program in Sustainable Agriculture.
Southeast Region	• Southeast Missouri State University, at Cape Girardeau - offers a bachelor of science degree in Technology Management with Sustainable Energy Systems Management specialization. • Mineral Area College, at Park Hills – offers both a Renewable Energy Technology Certificate and an Associate of Applied Science degree plus enhanced curriculum with green jobs and workforce training
Southwest Region	• The Missouri Alternative and Renewable Energy Technology Center at Crowder College - offers certification and transfer degrees encompassing sustainable construction, solar thermal energy, solar electricity, wind, and biofuels.[316]
St. Louis Region	• St. Louis Community College - offers North American Board of Certified Energy Practitioners Installer test prep courses and the Center for Workforce Innovation is developing programs focused on sustainable construction and sustainable energy systems [317] • Washington University - is home to the International Center for Advanced Renewable Energy and Sustainability which foster research on energy, environment, and sustainability across several disciplines through collaborations with the international business community. • Jefferson College offers the following certificates: Senior Certified Sustainability Professional, Building Performance Institute Building Training Analyst, Green Technology Training Institution, Photovoltaic System Design and Installation, Wastewater Training Institute, Water Training Institute, Weatherization Energy Auditor, and Wind Energy Apprentice.[318]
West Central Region	• University of Central Missouri, at Warrensburg - offers a workforce program focused on Green/Sustainable Industries. • State Fair Community College - offers an Associate of Applied Science degree program that offers training in biomass, wind, and solar renewable programs.[319]

Access to a skilled workforce is especially important for economic growth, as illustrated by the fact that more than 75 percent of manufacturers in the nation report a moderate to severe shortage of skilled workers.[333] Missouri has developed a large, highly educated workforce in research and advanced manufacturing, and is well positioned to serve a clean industry. Missouri ranks 15th nationwide for bachelor's engineering degrees granted and more than 4,000 engineering degrees are awarded each year in the state, offering a steady pool of mechanical and electrical engineering graduates.

Research completed recently by the Missouri Energy Initiative found that 38 percent of firms employing clean energy workers report some difficulty in hiring while 22.5 percent report great difficulty. The majority of the employers that reported difficulty in hiring cited applicant complications as the primary reason for the difficulty. Specifically they noted that applicants need additional training, certification or do not have the requisite skills to match their wage demands. The study also found that 9.4 percent of the clean energy workforce, approximately 3,700 workers, expects to retire in the next five years.[334]

While there has been some discussion about the job impacts of the federal greenhouse gas regulations, one analysis estimates that a minimum of 3,700 new, clean jobs could be created in Missouri within the energy efficiency industry, which hires trained professionals such as electricians, HVAC technicians, builders, retailers/suppliers, carpenters, and plumbers and pipefitters. The renewable energy industry would support solar manufacturing and installation jobs and wind turbine manufacturing jobs. Other technical jobs likely to be created include those associated with improved power plant efficiency through boiler upgrades, transmission and distribution line upgrades, and fuel conversions.[335]

Missouri Make it in America Challenge
2013-September 2016

The Missouri Make it in America Challenge grant project is focused on the nuclear energy sector including transportation and logistics, supply chain manufacturers and a trained workforce. Federal funding sources are used to help states develop and implement a regionally driven economic development strategy that includes job creation and training local workers. In Missouri the grant partners are the Missouri Division of Workforce Development (DWD), the University of Missouri Extension and College of Engineering, and Missouri Enterprise.

DWD reports the following progress to date: 191 student participants have been enrolled; 16 have completed a Bachelor of Science degree in engineering, 17 completed an Associate of Applied Science degree and 64 received Nuclear Culture Certificates; 29 obtained employment; and 166 are enrolled in a degree program.

The Northeast Missouri Workforce Investment Board, an oversight and coordinating agent for a sixteen-county area with the responsibility to spearhead a partnership tasked with improving and enhancing the readiness of the area's workforce, researched the potential for clean jobs in northeast Missouri and found that:[336]

- Roughly three quarters of surveyed employers believe that the region's workforce is either somewhat prepared or not prepared to meet skills needed for anticipated green jobs, thus demonstrating the potential opportunity for training investment. The most frequently cited training methods for anticipated green jobs are on-the-job training and specialized, industry certification or training programs;
- Building and construction is the largest green sector in northeast Missouri;
- Recycling and use of recycled products are the most cited sustainable practices in the region, pointing toward possible opportunities in the recycling/salvage sector; and
- Cost of implementation is the most often-cited barrier to expansion of green jobs, after current economic conditions.

Generally, fostering science, technology, engineering, and mathematics (STEM) education and building interest in energy-related careers is part of a longer-term solution to meeting the future energy workforce demands in Missouri. Occupations in the STEM field are some of the highest-paying and most in-demand jobs in Missouri. The need for employees with STEM knowledge will increase with technological innovations in the 21st century. In Missouri the projected job growth for STEM occupations through 2022 is over 10 percent higher than the average expected combined growth of all other occupations in the state (8%).[337]

Many Missouri employers have taken an active role in providing resources and opportunities to advance STEM education in Missouri. Companies across Missouri such as Boeing, AT&T, St. Luke's Health System, and many others have made the commitment to improving Missouri's prospects for stronger STEM education.

Launched in 2012, the Missouri Innovation Campus is a public-private partnership between K-12 school districts, two- and four-year institutions, and private businesses in the state. The Hawthorn Foundation partners with the Governor's Office to provide fiscal oversight and administration of an expanded program helping students lower college costs and debt while accelerating time-to-degree completion. Beginning their junior year, high school students take classes at participating institutions, earning college credits. By the time they graduate participating students can receive both a high school diploma and an associate's degree. These partnerships engage private companies in high-demand industries to provide apprenticeships as an integral part of the training and educational curricula, ensuring graduates that are workforce ready. Companies participating in the Innovation Campus program include Burns & McDonnell, CoxHealth, and Central Bank.[338]

The Innovation Campus model is being replicated around the state by companies and higher education institutions working together to educate and employ the next generation of STEM workers. Exergonix is a start-up merging energy management, battery technology, and renewable energy to develop utility-scale energy storage units. In February 2012, the company announced a partnership with University of Central Missouri and Summit Technology Academy to develop an Innovation Campus at their headquarters. Backed by a Missouri Community Development Block Grant, the program is designed to reduce the cost of student education, increase graduate employment, decrease workforce-training obligations, and advance technological innovation. The Campus will serve as a cooperative learning environment for STEM-focused high school students and will expedite student education by identifying high school students capable of learning on the job at Exergonix. In exchange, Exergonix will commit to pay the student's tuition for an associate's degree at University of Central Missouri and will offer a job to the student upon graduation.

Emerson Electric in St Louis has begun a yearlong campaign to inspire and empower the engineers of tomorrow by connecting science to modern innovations and technological advancements. Emerson also supports STEM initiatives and robotics programs through STEMpact and the Girl Scouts. Continuing to find exciting and innovative strategies to reach students will be critical in meeting the workforce needs of tomorrow in all energy sectors. STEMpact is a collaborative network of St. Louis regional businesses, educators, universities, school districts, parents, community organizations, and government officials who work to ensure that the quality of St. Louis science, technology, engineering, and math education empowers students to graduate with the skills and knowledge they need for STEM careers. Other companies involved in STEMpact include Ameren, AT&T, Bank of America, Boeing, Express Scripts, The Laclede Group, Mallinckrodt, Manifest, Maritz, Mastercard, McDonnell Family Foundation, Monsanto, Peabody Energy, and Sigma-Aldrich.[339]

The Institute for School Partnership (ISP) at Washington University in St. Louis partners with the Monsanto Fund to bring high quality science education to students in St. Louis through its MySci program. The Monsanto Fund awarded the ISP with a $1,935,000 grant, beginning July 1, 2015. Over the three-year grant period, the ISP will create a hands-on, inquiry, and project-based science curriculum for middle school students that integrates elements of STEM.[340]

The KC STEM Alliance is a collaborative network of educators, business affiliates and organizations created in 2011 through a gift from the Ewing Marion Kauffman Foundation. Some of KC STEM's business partners include KCP&L, Johnson Controls, HOK, Kiewit, BNIM, Commerce Bank, Custom Engineering and GMA Architects Engineers. Program initiatives include Project Lead the Way®, KC FIRST® Robotics, KC Engineering Zone for K-12 urban students, and the KC Girls in STEM Initiative that works to increase the participation of girls in STEM through education and career exploration using mentoring, workshops, job shadows, and internships.[341]

The Missouri University of Science and Technology works through the Kaleidoscope Discovery Center in Rolla to provide opportunities for elementary and middle-school students to advance the understanding and appreciation of engineering, science, technology, the environment, arts, and math through hands-on learning experiences.[342]

The Missouri Academy of Science, Mathematics and Computing (Missouri Academy) is an early-entrance-to-college, two-year residential school located at Northwest Missouri State University in Maryville. Replacing the junior and senior years of traditional high school, students are enrolled in a curriculum consisting of all college coursework taught by professors at Northwest Missouri State University and can earn an Associate of Science degree as well as a high school diploma.[343]

4. Summary of Key Points

- Energy Solutions, identified as an industry cluster with higher than normal potential for employment and economic growth in Missouri, focuses on aggressive research, commercialization, and technological advancements to improve the extraction, delivery, and consumption of nuclear power, natural gas, wind, solar, biomass/biofuel, and fossil fuels. Companies are exploring opportunities for research and development around small modular reactors, carbon mitigation, salvage and remediation, energy storage, and renewable energy. Businesses in Missouri have already been working successfully along the rapidly growing renewable energy supply chain.

- Ranked 10th in the nation for growth in clean energy and clean transportation jobs, the state is presented with an opportunity to review its current clean energy policies in order to increase economic growth, create jobs, and help businesses become more energy independent. Investments in energy efficiency improvements generate more jobs than investments in the economy generally. The energy efficiency and renewable energy industries are likely areas of employment growth, and strategic investments in those areas could help spur Missouri's economy.

- As major companies adopt corporate responsibility and renewable purchasing requirements, Missouri businesses will need to be prepared to respond to customer demands to remain competitive. Even government entities such as local cities with emissions reduction targets and the U.S. Department of Defense have established sustainability goals.

- Access to a skilled workforce is especially important for economic growth, given the more than 75 percent of manufacturers in the nation that report a moderate to severe shortage of skilled workers. Missouri is home to numerous educational institutions that offer undergraduate and graduate degrees that relate to the energy industry, as well as a variety of training programs for different energy-related trades. Governments, unions, nonprofits, and others offer additional training opportunities.

- Investments in STEM education will better prepare students to compete for 21st century jobs.

Chapter 6: Energy and the Environment

Energy planning naturally tends to focus on supply, demand, and cost. However, energy extraction, generation, and consumption have environmental and human health impacts that are less easily quantified and thus more difficult to factor into the overall costs and benefits of any particular energy portfolio.

This chapter will address some of the known environmental impacts of Missouri's energy portfolio. Non-renewable energy resources, which represent the bulk of Missouri's energy generation and consumption, will be addressed first, followed by renewable resources. Each section is organized in descending order of relative energy source consumption. While acknowledging that environmental impacts are linked ecologically, we attempt to address, for each energy source, impacts in terms of land, water, air, public health, and risk of energy disaster.

By definition and design, this chapter focuses on adverse environmental impacts. All energy sources have positive and negative attributes, but this chapter only addresses certain negative ones. Positive attributes of energy sources are discussed in other chapters.

While not specifically addressed in the body of this chapter, it should be noted that energy efficiency is considered to be an energy resource that has zero emissions and can result in significant water savings and public health benefits.

I. Non-Renewable Energy Resources

1. Coal and the Environment

Electricity generated from coal represented 82.6 percent of the state's total electricity usage in 2014.[344] Overall, the state consumed nearly 806.5 trillion British thermal units (BTU)[345] of coal in 2013, for which it paid a total of $1.55 billion.[346] Approximately 92.5 percent of this coal was imported from out-of-state, predominantly from Wyoming.[347]

This chapter will address some of the environmental impacts in Missouri from reclamation needs resulting from past coal mining impacts and electricity generation that relies on coal as the source fuel. The out-of-state environmental impacts of coal mining for our supply are significant, but not addressed in this document; also not addressed in this document are the impacts from the limited coal extraction that is occurring in Missouri.

1.1 Land Impacts

The extraction of coal from the earth and the combustion of this resource have meaningful impacts on the land, water, and air around us. The two main land use threats due to coal extraction and combustion are abandoned mines and combustion residue, often referred to as "coal ash."

a) Coal Mining

Coal mining began in Missouri in the 1840s with no regulation of these operations. Historically there have been as many as 67,000 acres left unreclaimed by coal surface mining operations. Missouri has a legacy of acid mine drainage, dangerous highwalls, toxic mine spoils, dangerous mine shaft openings, unvegetated and barren soils, soil erosion, and stream sedimentation resulting from these unreclaimed coal mines. Other land-based environmental problems include toxic mine spoil piles that cannot support vegetation and subsidence caused when old underground mines collapse.[348]

In order to ensure coal mine sites in Missouri are returned to a suitable land use and the adverse impacts from active mining operations are minimized, the Missouri Department of Natural Resources' (MDNR) Land Reclamation Program was established in 1974. To date more than 10,000 acres have been identified that require at least some amount of reclamation work to correct a wide range of environmental, public health, and safety problems.

b) Coal Combustion Residuals or "Coal Ash"

In addition to the land impacts associated with coal mining, the combustion of coal to generate electricity results in residuals and by-products that are generally known as "coal ash" or coal combustion residuals. Although the U.S. Environmental Protection Agency (EPA) regulates coal ash as a non-hazardous solid waste, it contains harmful contaminants including mercury, cadmium, and arsenic and without proper management can pollute waterways, groundwater, drinking water, and the air. Methods for managing residual coal ash include disposal, storage, and reuse. Each method has identified costs, benefits, and risks. Table 26 below shows the different types of coal ash.

Table 26. Description of Types of Coal Ash from Power Plants.

Source: U.S. Environmental Protection Agency (EPA), "Coal Ash Basics," Updated March 11, 2015, http://www2.epa.gov/coalash/coal-ash-basics

Types of Coal Ash	Description
Fly Ash	Fine powder; mostly silica; comes from burning finely ground coal
Bottom Ash	Coarse; too large to emit from smokestacks; lines bottom of coal furnace
Boiler Slag	Molten bottom ash; turns to pellets when cooled
Flue Gas Desulfurization Material	Wet sludge or dry powder; byproduct from process of reducing SO_2 emissions

Missouri generates 2.68 million tons of coal ash each year, ranking 16th among all states in the accumulation of coal ash. In 2014, the EPA finalized a rule for the Disposal of Coal Combustion Residuals from electric utilities. The rule, which falls within the Resource Conservation and Recovery Act, establishes technical requirements for coal ash landfills within the solid waste regulation. In Missouri, there are currently nine permitted coal ash landfill sites, seven of which are active.

Some coal ash residuals are reused as a component in concrete, gypsum board, and asphalt for roads, reducing the volume stored in ponds and landfills. The benefits of reusing coal ash are reduced expenses for disposal and containment, increased revenue from coal ash sold, job creation, and reduced material costs for the beneficial reuse industry.

1.2 Water Impacts

The environmental impacts on water resulting from energy generation from coal and discussed herein include coal ash disposal, mercury contamination, abandoned mine drainage and sedimentation, and water use in electric generation.

Ameren Missouri, Managing Combustion Residuals
Various Locations, 2014

Ameren Missouri, the state's biggest electric investor-owned utility, recycles more than half of its coal combustion residuals into beneficial uses.

Each year, Ameren's fly ash and bottom ash are used in approximately two million bags of concrete mix. Bottom ash is also used for snow and ice melt, blasting grit, and roofing shingles. The synthetic gypsum created from coal ash can serve as a direct replacement for gypsum wall in the construction industry.

In 2014, Ameren Missouri reported that almost two percent of its fly ash was distributed for use on roads by local communities and the Missouri Department of Transportation.

a) Coal Ash Disposal

When combined with water, coal ash becomes a "slurry" that can be piped into specially designated coal combustion waste impoundments for storage. The heavy metals contained in the bottom ash, such as mercury, arsenic, lead, and cadmium, "leach out" into the water in which they are stored, contaminating it. Accidents involving coal ash ponds can result from dam failure in which the heavy metal-laden water and ash "spills" onto the adjacent land and waterways. A recent example of this situation occurred in 2008, when a facility in Kingston, Tennessee suffered a catastrophic release of over five million cubic yards of coal ash slurry that flooded more than 300 acres of land, contaminating the Emery River and drinking water supply. This coal ash disaster resulted in the destruction of homes and property, ruptured gas lines, and downed power lines, the cleanup effort of which lasted several years and cost nearly $1 billion.

As a result of this disaster, the EPA undertook a nationwide assessment of structural integrity of coal ash impoundments. Missouri has 35 coal ash impoundments that were assessed by the EPA.

b) Mercury Contamination

Coal plants were responsible for 47.8 percent of the U.S. human-caused emissions of mercury in 2011[349] and, according to the EPA's 2011 National Emissions Inventory, 1.4 tons of mercury were emitted from Missouri's coal-burning electricity generation operations, ranking the state as the 4th highest emitter of airborne mercury pollution from power plants, behind only Texas, Ohio, and North Dakota.[350] Mercury is a naturally occurring element in coal that is emitted into the air during coal combustion. Airborne mercury then settles onto land and water surfaces and can be washed into water bodies by rain. Once in a water body, mercury bioaccumulates as it moves up the food chain. For example, mercury can be absorbed by filter feeding fish, which are then eaten by larger fish, birds of prey, small mammals, or people. Research shows that mercury impairment in fish affects their endocrine systems, thereby impacting development and reproduction. Just 1/70th of a teaspoon of mercury deposited on a 25-acre lake can make the fish unsafe to eat.[351]

c) Abandoned Mine Drainage And Sedimentation

Unreclaimed, abandoned coal mine land in Missouri continues to have significant impacts on water resources. Acid mine drainage is the formation and movement of highly acidic water rich in heavy metals. This acidic water forms through the chemical reaction of surface water and shallow subsurface water with rocks that contain sulfur-bearing minerals such as coal, resulting in sulfuric acid. Heavy metals can be leached from rocks that come in contact with the sulfuric acid. The resulting acidic, heavy metal-rich liquids may be highly toxic and, when mixed with groundwater, surface water, and soil, may have harmful effects on humans, animals, and plants.

Abandoned mine spoil piles are hills of unconsolidated material that, when mobilized by rainwater, can enter streams, clogging them with sediment and introducing chemicals. Stream bottoms covered with orange or yellow-brown iron oxide can be toxic to benthic algae, invertebrates, and fish. The effects of acid mine drainage on streams have been documented for many years.[352]

d) Water Use in Electric Generation

Coal-fired power plants require large amounts of water for cooling purposes and electricity generation is by far the greatest water user in Missouri. The majority of Missouri's coal-fired plants are once-through systems, in which water is moved through heat exchangers and returned to its original source, a lake or river.[353]

Table 27. 2013 Water Use in Missouri.

Source: Missouri Department of Natural Resources, Water Resources Center. "Major Water User Database, 2013." Personal Contact, Brian Fredrick, March 2015.

2013 Water Use	Billion Gallons
Electrical	5,103
Municipal	295
Irrigation	66
Industrial	27
Commercial	5
Total	**5,495**

Water that is withdrawn from a source for the electric generation process is returned significantly warmer than when it was taken. Warmer waters result in a reduction in the amount of dissolved oxygen in the water, which then affects fish and other organisms by causing stress, reduced growth, or even death. A 2001 review of over 150 toxicology studies found that higher water temperatures also increase aquatic organism vulnerability to chemicals normally found in water.[354] In addition to the impacts of warmer temperatures on aquatic life, fish, and other wildlife can get caught in cooling system water intake structures.

Because of the need to use large quantities of water in energy generation operations, power plants can also be affected by low water levels in the Missouri and Mississippi Rivers. To address this risk, power plant owners can investigate technologies that use less water, with the added benefit of alleviating the impact on the environment. While the electrical category includes water used by all energy sources, coal is the largest water user.

1.3 Air Impacts

The combustion of fossil fuels creates both greenhouse gases and air pollution. Greenhouse gas (GHG) emissions result in long-term, large-scale impacts such as global warming, while air pollution has more immediate, localized human health and environmental impacts. Because of the significance of GHG, a section of this plan is devoted to it. Please refer to Section III. Climate Change, Air Pollution, and the Environment.

1.4 Public Health Impacts

Human health and safety issues associated with abandoned mine land include safety hazards such as steep and unstable highwalls and embankments, open mine shafts, subsidence, abandoned mine equipment and facilities, dangerous impoundments, and unsanitary trash dumps.

Human ingestion of mercury can result in impaired neurological development affecting fetuses and children, growth and development issues, reduced fertility and even death. The Missouri Department of Health issues advisories regarding the number of fish that are safe to eat in certain water bodies. In 2014 EPA listed 42 water bodies as impaired on the basis of mercury found in fish tissue.[355] These water bodies represented almost three percent of the total miles of streams and eight percent of the lakes in Missouri.[356]

Research shows that the public health impacts of electricity generation are greatest for power generated from coal.[357] Specifically, burning coal in power plants produces particulate matter, as well as air pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury, all of which have an impact on human health.

- Particulate matter: Particulate matter can cause chronic bronchitis, aggravated asthma, and premature death, as well as haze, obstructing visibility.
- Sulfur dioxide: contributes to the formation of small acidic particulates that can penetrate human lungs and be absorbed by the bloodstream.
- Nitrogen oxides: NO_x pollution causes ground level ozone, or smog, which can burn lung tissue, exacerbate asthma, and make people more susceptible to chronic respiratory diseases.
- Mercury: a toxic heavy metal that causes brain damage and heart problems.

Other harmful pollutants that may be emitted from a typical coal plant include carbon dioxide (CO_2), arsenic, lead, cadmium, and volatile organic compounds (VOCs), which form ozone.

KCP&L Plans to Stop Burning Coal at Three Plants
Various Locations in Missouri, 2015

In a commitment to sustainable energy and cost management, KCP&L will stop burning coal at three of its plants. By the end of 2016, KCP&L will stop burning coal in one unit at its Lake Road Station plant in St. Joseph, and in one unit at its Montrose Station plant in Clinton. Additionally, the utility will stop using coal as a fuel in two units of its Sibley Station plant in Sibley, by the end of 2019 and in two more units of the Montrose plant by the end of 2021.

KCP&L believes that ending coal use at these plants is not only the most cost-effective option for customers, but also the cleanest. In total, 700 MW of coal-fired generation will be retired or converted, which will lead to a drastic reduction in emissions and improvement in the air quality of the region.

1.5 Risks of Energy Disasters

The risks of energy disasters in Missouri related to coal consumption include coal mining accidents and coal ash spills. Actions should continue to evaluate the location of mines and coal ash ponds and to monitor these locations.

Although coal mining is not a significant activity in Missouri, it is important to recognize that mining activities occurring in the states from which we purchase coal have potential for disasters. Despite various advances in technology and safety practices, coal mining is still considered a dangerous activity. However, death rates have declined significantly in recent times as a result of regulations and enhanced training.[358]

An EPA assessment of the structural integrity of 35 Missouri coal combustion waste (CCW) impoundments resulted in five coal ash impoundments being assessed with a hazard potential of “significant”, meaning that a failure would likely result in economic or environmental damage.[359]

Two of Missouri's coal ash impoundments were assessed by EPA as "high" hazard potential: the City of Sikeston Power Station and the City of Columbia Power Plant.[360] The largest CCW impoundment in Missouri is the 154-acre bottom ash pond at the Labadie Power Station, and it was given a hazard potential rating of "low" by the EPA assessment.[361]

2. Nuclear Energy and the Environment

In Missouri, nuclear power is the second largest source (10.5%) of electric power generation.[362] Missouri has one nuclear power plant, Callaway Nuclear Plant, which is operated in Callaway County by Ameren Missouri. The Callaway Nuclear Plant began operation in 1984 and is a 1,190 MW pressurized light water reactor.[363] Nuclear energy produces two kinds of waste: high-level waste from the reactor itself, and low-level waste such as irradiated equipment or protective clothing. As noted in Chapter 2: Energy Supply, KCP&L owns a significant share of the Wolf Creek Generating Station, a nuclear power plant in Burlington, Kansas.

2.1 Land Impacts

The Callaway Nuclear Plant is located on a 5,228-acre site near Fulton, Missouri. Currently, Ameren Missouri stores high-level waste from the Callaway reactor in pools of water that are located on-site and no waste is transported outside the facility. Some of this fuel will remain highly radioactive for thousands of years and must be kept isolated and contained.

Low-level waste from the Callaway Nuclear Plant is sometimes transported across Missouri to research facilities and on to other states. The transportation of low level spent fuel is coordinated by MDNR with assistance of the Missouri Highway Patrol, the State Emergency Management Agency, Department of Health and Senior Services, and MDNR's Environmental Emergency Response staff.

In 2014, the Nuclear Regulatory Commission estimated that Callaway's wet storage pools would run out of space by 2015 and provided approval to Ameren to begin construction of a long-term dry-storage space for spent fuel. This move to dry storage is standard in the nuclear industry and is typically considered safer than wet storage. Ameren completed construction of its dry cask storage system during summer 2015: four of the five pool-to-pad loading "dry runs" are complete with the final "dry run" scheduled for August 2015. The first loading is scheduled to begin in August or September. Ameren says the site is designed to store fuel from the plant's 40-year operating license plus the 20-year extension.[364]

2.2 Water Impacts

The nuclear power cycle uses water in three ways: extracting and processing uranium fuel, producing electricity, and controlling wastes.

Processing uranium requires mining, milling, enrichment, and fuel fabrication, all of which use significant quantities of water, which leads to consumption and contamination implications. Although uranium mining is not done in Missouri, it is still important to recognize that this impact is occurring elsewhere as a result of fuel being spent in our state to generate electricity.

To produce electricity Missouri's Callaway Plant uses river water and on-site groundwater wells and draws up to 25,000 gallons per minute (GPM) of water from the Missouri River and over 100 GPM of groundwater via on-site wells.[365] In July 2014, Ameren Missouri reported unsafe levels of tritium and cobalt-60 in an underground well. After the leak was contained, Ameren Missouri announced that wells would be tested on a monthly, rather than quarterly, basis.

2.3 Air impacts

Nuclear energy generation does not emit criteria pollutants or greenhouse gases. This is comparable to other non-emitting sources of electricity like wind, solar, and hydropower.

2.4 Public Health Impacts

The most direct and common public health impact of nuclear energy occurs during the uranium-mining process. While uranium mining does not occur in Missouri, mine workers and communities in the states from which we purchase uranium can face significant health risks including lung cancer and other forms of cancer due to high levels of radiation from uranium mines. Uranium mining in the United States currently takes place in Utah, Wyoming, Nebraska, and Texas.

In Missouri, nuclear energy presents the potential for catastrophic health impacts in the event of a major accident as well as implications from long term storage of spent nuclear fuel on-site. Public health impacts associated with a nuclear power accident include radiation and contamination of land and water, which may result in forced evacuations after accidents. Significant exposure can result in cancer, or even death.

2.5 Risks of Energy Disasters

Nuclear facilities are highly regulated by the U.S. Nuclear Regulatory Commission (NRC) and there are safeguards in place to minimize risk and to establish continuous monitoring and oversight. The NRC defines two emergency planning zones around nuclear power plants: 1) a plume exposure pathway zone with a radius of 10 miles, concerned primarily with exposure to and inhalation of airborne radioactive contamination; and 2) an ingestion pathway zone of about 50 miles, concerned primarily with ingestion of food and liquid contaminated by radioactivity.

Long-term storage of spent nuclear fuel on-site at the Callaway Nuclear Plant also presents a risk of radiation leaks from breeched storage facilities.

3. Natural Gas and the Environment

Approximately 52.4 percent of Missouri homes were heated with natural gas in 2013[366] and natural gas fueled 4.5 percent of electric power generation in the state in 2014.[367] As described previously, Missouri does not have significant in-state natural gas resources and is dependent upon the purchase of natural gas from other states.

In its pure form, natural gas is a colorless, odorless gas composed primarily of methane. Methane (CH_4), the simplest and lightest hydrocarbon, is a highly flammable compound consisting of one carbon atom surrounded by four hydrogen atoms.

3.1 Land Impacts

Many of the environmental impacts from natural gas are the result of extraction, which takes place predominantly out of state. There are two general categories of natural gas deposits: conventional and unconventional. Conventional natural gas deposits are commonly found in association with oil reservoirs, with the gas either mixed with the oil or buoyantly floating on top, while unconventional deposits include sources like shale gas, tight gas sandstone, and coalbed methane. Today, shale gas is the fastest growing natural gas resource in the United States as a result of the development of hydraulic fracturing technology.[368]

Extraction of both conventional and unconventional natural gas resources has land impacts. The fracking process injects high-pressure solutions of chemicals, silica sand, and water through wells to create cracks in deep rock formations and remove natural gas. The potential environmental impacts of fracking include increased erosion and sedimentation, increased risk of aquatic contamination from chemical spills or equipment runoff, habitat fragmentation, and reduction of surface waters as a result of the lowering of groundwater levels.

Land impacts in Missouri from natural gas consumption are largely the result of the construction and maintenance of eleven interstate gas pipelines that cross the state. Natural gas pipelines typically bisect large swaths of land and as a result often fragment wildlife habitat and migration patterns. A clearing of 100 to 200 feet around the width of the pipeline is often required and is kept clear after construction for maintenance access. Erosion during construction of pipelines can cause sediment to pollute waterways and alter the landscape.

3.2 Water Impacts

Out-of-state impacts on water resulting from natural gas extraction are significant but not discussed further here. Water impacts from the interstate natural gas pipelines in Missouri are minimal.

3.3 Air Impacts

Although natural gas is a hydrocarbon fossil fuel its combustion emits up to 50 percent less CO_2 when combusted in a new, efficient natural gas power plant compared with emissions from a typical new coal plant. Burning natural gas does produce NO_x, which are precursors to smog, but at lower levels than gasoline and diesel used for motor vehicles. The combustion of natural gas produces negligible amounts of sulfur, mercury, and particulates.

Electricity generated from natural gas results in far fewer GHG emissions than its coal counterpart, but burning this fuel does produce some emissions. These emissions are discussed in Section III of this chapter.

Leakage from natural gas pipelines releases methane, a far more potent greenhouse gas than CO_2, into the atmosphere. Methane emissions occur in all sectors of the natural gas industry, from production, through processing and transmission, to distribution. They primarily result from normal operations, routine maintenance, fugitive leaks, and system upsets. As gas moves through the system, emissions occur through intentional venting and unintentional leaks.

Missouri is home to vast reserves of silicone dioxide, or silica (sand), in the northern half of the state. As of 2012 four sand quarries in Missouri were in operation. When silica is mined, particularly to support hydraulic fracturing of natural gas, silica dust is released into the air and becomes particulate matter.[369]

3.4 Public Health Impacts

While the combustion of natural gas for electricity generation produces significantly less emissions than coal, it still contributes to human health impacts related to air pollution. Exposure to particulate matter released from natural gas combustion contributes to respiratory symptoms including asthma, and may increase emergency room visits. Exposure to some smaller particles has also been linked with lung cancer, cardiovascular disease, and mortality.

Nitrogen oxides released while burning natural gas react with other chemicals in the atmosphere to produce pollution such as ozone, nitrous oxide (N_2O), and nitrogen dioxide (NO_2). NO_2 exposure increases susceptibility to respiratory infections and can cause airway inflammation at higher concentrations. In addition, research has found that even at relatively low concentrations, NO_2 can exacerbate asthma symptoms in children.[370]

Silica dust resulting from mining operations of silica sand, such as those that occur in northern Missouri, represents an occupational hazard to those involved in the mining process, and has been linked to various respiratory diseases, including lung cancer, scleroderma, and chronic obstructive respiratory disease.[371]

3.5 Risks of Energy Disasters

The main disaster risk associated with natural gas in Missouri is from gas explosions, such as those that occurred recently near Sedalia and in Kansas City. If Missouri were to experience another earthquake from the New Madrid fault, some natural gas pipelines could be catastrophically compromised.

4. Petroleum Products and the Environment

Petroleum products include transportation fuels, fuel oils for heating and electricity generation, asphalt and road oil, and the feedstocks used to make chemicals and plastics. Consumption of petroleum products by Missourians in 2012 represented approximately one-third of all energy consumed that year.[372]

As described previously Missouri does not have petroleum refineries operating in the state and is dependent on the production and delivery of petroleum products from other states by pipeline from the Gulf Coast, as well as by barge. The majority of petroleum products are delivered through a network of pipelines into bulk distribution terminals located throughout Missouri including Kansas City, Mt. Vernon, Springfield, Jefferson City, Moberly, and St. Louis. Product is also delivered into Missouri by transport truck and barge. Petroleum pipelines operate 24 hours a day, 7 days a week. Product is moved from these bulk terminals to smaller storage tanks for distribution or directly to retailers. Missourians consumed 3.0 billion gallons of motor gasoline and 1.1 billion gallons of diesel fuel for transportation purposes in 2012[373]; that same year, Missourians consumed 141.5 million gallons of propane in the residential sector.[374]

This section will address some of the in-state environmental impacts of petroleum product distribution and consumption.

4.1 Land Impacts

Even though there are no large scale oil and gas drilling activities in Missouri, pipeline and oil-well accidents and leaking underground storage tanks can cause permanent soil contamination, making sites economically useless as well as dangerous to the environment and public health. Those contaminated sites require significant efforts for clean-up and remediation.

4.2 Water Impacts

Spills and leaks from storage tanks, pipelines, and oil wells are point sources of water pollution, where the origin of the contaminants is a single identifiable point. MDNR estimated that more than 2,000 abandoned oil or gas wells in the state have not been properly closed.[375] These abandoned or improperly constructed or maintained wells can act as conduits for contamination to enter groundwater or to rise to the surface and can leach into underlying groundwater and move into the drinking water system.

The majority of water pollution from oil in Missouri is from nonpoint sources, where small amounts coming from many different places over a long period of time add up to large-scale effects. These minor unreported spills include routine discharges of fuel from commercial vessels or improperly disposed lubricants and solvents. Runoff from asphalt-covered roads and parking lots enters storm drains, streams, and lakes.

4.3 Air Impacts

Petroleum products used in vehicles, domestic heating, and industrial processes directly produce the vast majority of carbon monoxide (CO) and NO_x in the atmosphere. Particulate matter is directly emitted in vehicle exhaust and ozone can also form from the reaction of exhaust gases with water vapor and sunlight.

4.4 Public Health

Petroleum hydrocarbons are highly toxic to many organisms, including humans. Health effects from exposure to petroleum hydrocarbons depend on many factors like types of chemical compounds and the period of exposure. Some compounds in those hydrocarbons like benzene, toluene, and xylene, which are present in gasoline, can affect the human central nervous system. Benzene has been determined to be carcinogenic to humans by the International Agency for Research on Cancer.

4.5 Risks of Energy Disasters

Many disasters, such as the Gulf of Mexico oil spill in 2010, are associated with oil and gas drilling and refining. Even though Missouri has no large-scale oil drilling and refining activities, fuel shortages resulting from energy disasters in other states have the potential to cause energy emergencies in Missouri.

5. Propane and the Environment

Propane is a non-renewable fossil fuel, like the natural gas and oil from which it is produced. Propane is naturally a gas but at higher pressure or lower temperature it becomes a liquid, which is much more compact than gas. For this reason, propane is stored and transported in its liquid state. Propane is transported by underground pipeline to terminals and distribution centers across the country. From these distribution centers, propane is delivered to end users by propane dealers. The average residential propane tank holds between 500 and 1,000 gallons of liquid fuel and, depending upon use, may be refilled several times a year.

In Missouri, propane is an important source of home heating energy in rural areas that do not have access to natural gas service. Based on 2009 to 2013 data, 9.6 percent of households in the state use propane to heat their homes.[376] Propane is also used to dry agricultural crops and power farm equipment. In the instance of an energy disaster or other emergency in which electricity and petroleum supplies are unavailable, propane provides an on-site or in-state energy source to fuel emergency vehicles and generators.

5.1 Land Impacts

Propane is non-toxic, non-caustic and will not create an environmental hazard if released as a liquid or vapor. There are no long term effects following a propane spill even if the quantities are excessively large.

One issue presented with propane usage is disposal of propane tanks. Most landfill sites will not accept propane tanks, because most tanks have residual propane that can result in fire or damage. To address this, most suppliers of propane take back emptied tanks to be refilled with product for a subsequent delivery to a customer.

5.2 Water Impacts

If leaked or spilled, propane becomes a non-toxic gas that does not impact water resources.

5.3 Air Impacts

The combustion of propane has similar air impacts to the combustion of natural gas.

5.4 Public Health Impacts

As propane is non-toxic, it has limited human health impacts. It is a cleaner alternative to many fuels, but its combustion does produce pollutants that include particulate matter, sulfur dioxide, nitrogen oxides, nitrous oxide, carbon monoxide, carbon dioxide, methane, and non-methane total organic carbon.

5.5 Risks of Energy Disasters

It is possible for an explosion to occur during propane transportation or at a propane distribution center.

6. Summary of Key Points

- Missourians are impacted directly by the environmental and health impacts associated with in-state generation, transportation, and consumption of non-renewable energy sources. Many significant impacts result from the mining, extraction, and processing of the non-renewable sources which, for Missouri, primarily occurs out-of-state. While Missourians do not see or directly bear the out-of-state environmental and health impacts, our demand for resources creates them due to Missouri's dependence upon non-renewable energy sources.

- The hazard ratings for some of Missouri's coal ash storage sites are considered dangerous by the federal government. Wherever possible, the state can work with utilities to develop a risk assessment and plan to improve these ponds and landfills. In addition, coal ash reuse among Missouri utilities has been a successful method of reducing the need for coal ash storage. The state should consider additional incentives that encourage more reuse, thereby reducing the risk of coal ash storage in Missouri.

II. Renewable Energy Resources

Renewable energy resources are those that can be naturally replenished within our lifetimes including water, sunlight, wind, and plants. Conventional hydroelectric, wind, and solar renewable energy generate electricity without any direct air pollution or greenhouse gas emissions. While biomass energy systems may have some environmental impacts, in some instances they may be lower than those for fossil fuels.

1. Hydroelectric and the Environment

Conventional hydropower has been Missouri's leading renewable energy source and in 2014 it contributed roughly 0.79 percent of all electricity generation in the state.[377] Electricity generated by conventional hydropower does not directly emit air pollution or greenhouse gases. As described in Chapter 2: Energy Supply, Missouri has four federal hydropower facilities and three major non-federal facilities, as well as over a dozen smaller hydropower facilities.

1.1 Land Impacts

Land impacts associated with hydroelectric power result from disruptions to topography. The size requirements of a reservoir, and thus the land required to build it, varies depending on the desired generation capacity and the characteristics of the land. The dams built to impound water for the hydropower facility effectively replace the natural aquatic and terrestrial resources with a permanently flooded reservoir. Fish, forest, and wildlife habitat is eliminated, as well as any cultural or community resources present. Specific to our state, the creation of the Lake of the Ozarks flooded approximately 55,000 acres of land. This reservoir stretches 92 miles and has over 1,150 miles of shoreline.

1.2 Water Impacts

The major water reservoirs created to store water behind a hydropower facility create artificial bodies of water with dramatically altered flow patterns both up and downstream of the reservoir, which significantly impact fish and wildlife resources. In May and June of 2002, approximately 43,000 fish were killed when they were sucked into turbine generators at Ameren Missouri's Bagnell Dam Hydroelectric Plant, resulting in a settlement agreement for damages of $1.3 million.[378]

A second hydropower location of environmental concern is the Mark Twain Lake reregulation pool below Clarence Cannon Dam. During the summer of 2010 four fish kills occurred in the reregulation pool below the dam at Mark Twain Lake. The fish kills were caused by low dissolved oxygen in water released from the dam. In response to the mortalities, the Missouri Department of Conservation, Missouri Department of Natural Resources, and the U.S. Army Corps of Engineers began developing an operational plan that would provide adequate dissolved oxygen levels using generating units and spillway radial gates.[379]

1.3 Air Impacts

Hydropower generation emits no air pollution or greenhouse gases.

1.4 Public Health Impacts

There are no adverse health impacts from hydropower energy.

1.5 Risks of Energy Disasters

Missouri has experienced a catastrophic failure at a pumped storage hydroelectric power plant. On December 14, 2005, the upper reservoir of Ameren Missouri's Taum Sauk hydroelectric plant failed. Water rushed down the west side of Proffit Mountain into the East Fork of the Black River, damaging the Johnson's Shut-Ins State Park and adjacent properties. Flowing debris and sediment destroyed downstream aquatic and terrestrial habitats. Ameren Missouri's settlement agreement with the state for damages resulting from the Taum Sauk Plant failure was over $177 million.[380] The company also paid $115 million to the Federal Energy Regulatory Commission.[381] However, the construction of Taum Sauk's upper reservoir and the way that the facility was operated leading up to the collapse are very different from the way that conventional (non-pumped-storage) hydroelectric facilities are constructed and operated.

2. Wind Power and the Environment

Wind power in 2014 provided 1.3 percent of the electrical energy used in Missouri.[382] There are currently six wind farms and approximately 252 turbines located in the northwest part of the state,[383] where wind speeds are considered viable for commercial wind development. Wind energy creates electricity by turning a set of blades, which powers a generator. Wind powered generation does not directly emit air pollution or greenhouse gas emissions. The greater and more consistent the wind, the more electricity is produced.

2.1 Land Impacts

Wind energy has a small "footprint" on land. For example, a wind turbine at Conception Wind Project in Nodaway County, Missouri is 80 meters high (264 feet) at the hub and sits on a round concrete/gravel pad that is 398 sq. ft. or 0.009 acres.[384] Road access to each wind turbine is required for maintenance and may necessitate creation of new access driveways. While the wind developer typically leases the entire parcel of land on which the turbine is located, the landowner continues to fully utilize the land. This seems to be a good fit as northwest Missouri, where the strongest wind resources are located, is rural and most land is used for farming.

Awareness of the potential impacts of wind development on bird and bat mortality has increased substantially in recent years. General estimates of the number of birds killed in wind developments appear to be substantially lower than casualty rates associated with other anthropogenic factors including vehicles, buildings and windows, power transmission lines, communication towers, toxic chemicals, and feral and domestic cats.

Bats can die from collisions or rapid pressure changes that cause severe internal organ damage. Studies of bat impacts have demonstrated that fatalities peak in late summer and early fall, coinciding with the migration of many species.[385] Bats are long-lived and have low reproductive rates, making populations susceptible to localized extinction. These impacts may be mitigated by selecting sites that are not on migratory flyways or prime habitat for sensitive species.

2.2 Water Impacts

There are no direct water impacts from wind power.

2.3 Air Impacts

There are no direct air pollution or greenhouse gas emissions associated with wind power.

2.4 Public Health Impacts

The sound of rotating turbine blades may be heard up to a few miles away. Some people affected have claimed systemic health impacts from the low frequency noise.[386]

3. Solar Energy and the Environment

As referenced in Chapter 2: Energy Supply, Missouri has untapped solar potential with over 200 sunny days per year.[387] The Solar

Energy Industries Association ranks Missouri 19th in the nation for its 111 MW of installed solar photovoltaic (PV) capacity.[388] Interest in Missouri solar energy development exists at the individual homeowner level as well as the community and utility-scale level. Utility-scale solar installations in Missouri are estimated to provide about 17 MW of capacity in early 2015 and new installations are coming on line regularly. Solar energy does not directly emit air pollution or greenhouse gas emissions.

3.1 Land Impacts

Utility-scale solar energy facilities require relatively large areas on which to place the solar array. Construction of solar facilities generally requires clearing and grading of land, with potential for soil compaction and increased runoff and erosion. The clearing of land also has the potential to reduce or disrupt local wildlife habitat. Engineering methods can be used to mitigate these impacts.

A unique characteristic of solar energy fields is that in urban areas, solar power systems can target and reutilize brownfield land. Additionally, rooftop PV panels, which are mounted on existing building structures, have a limited footprint, no direct emissions, and enable homeowners and businesses to be more energy independent.

Missourians have embraced residential rooftop solar in response to recent policies and utility incentives. Customer-owned solar PV remains a relatively expensive energy option due to upfront cost and may face barriers associated with financing, subdivision restrictions, and grid interconnection. While the manufacturing process and the panels themselves may contain hazardous materials that have potential to impact the environment, these impacts are believed to be far less than the environmental impacts associated with generation of electricity from non-renewables.[389]

3.2 Water Impacts

Depending upon site conditions, preparation of the land for solar facility placement may result in increased runoff and erosion. The land under the facility will not receive the normal amount of rainfall and may impact local runoff patterns. The PV manufacturing process may result in sludge entering the water system.

O'Fallon Renewable Energy Center
O'Fallon, 2014

In December 2014 Ameren Missouri began supplying solar energy as part of the energy mix delivered to its customers. The O'Fallon Renewable Energy Center, Ameren's first solar facility, delivers power to Ameren's electric customers, and is the largest investor-owned utility-scale solar facility in Missouri. The center is comprised of more than 19,000 solar panels covering over 19 acres, and has a capacity of 5.7 MW.

The addition of this solar farm is part of Ameren's plans to significantly expand its renewable energy generation portfolio. Ameren plans to open a second solar energy center in 2016, which would be the largest in the state of Missouri. Ameren considers the O'Fallon Renewable Energy Center one of its investments on behalf of customers for cleaner air and renewable energy.

3.3 Air Impacts

There are no direct air pollution or greenhouse gas emissions associated with solar power.

3.4 Public Health Impacts

The production of photovoltaic wafers creates small amounts of hazardous materials (e.g., hydrofluoric acid) that must be handled properly to avoid risk to the environment or to people.

3.5 Risks of Energy Disaster

There is no apparent risk of disaster associated with solar energy.

4. Biomass, Biofuels and the Environment

Biomass can be used directly to create heat or generate electricity. It can also be processed to make transporation fuels such as ethanol and biodiesel. The environmental impacts from biomass energy generation include the impacts associated with chemicals and water used to grow and process the biomass into fuel products and the fossil fuel used to process and transport the material.

4.1 Land Impacts

The production of feedstock for biofuels, such as corn-based ethanol, results in land use impacts related to industrial monoculture. Impacts can include extensive pesticide and fertilizer use, fresh water depletion, fossil fuel use for farm equipment and transportation, and removal of agricultural land from food production. This is a complex issue and the suggestion that crops grown for fuel impact food supplies is not always accurate. For example, biomass can be created from crop and forest residues. Other crops that are used for ethanol production, such as native grasses, can alleviate food supply concerns. However, when native grasses are harvested for fuel, soil fertility is reduced because plants are not allowed to decompose and replenish nutrients. If not collected properly, woody biomass harvesting could lead to land and biodiversity degradation. If a waste source such as construction wood waste is used, it can provide a benefit by freeing areas of land that might otherwise have been used for landfills or waste piles.

Hampton Alternative Energy Products
Triplett, 2012

Hampton Alternative Energy Products, a private alternative energy company wholly-owned by Hampton Feedlot Inc., generates renewable energy and produces an organic fertilizer as a by-product using Missouri's first beef cattle anaerobic digester. Completed in 2012, the digester uses manure from Hampton Feedlot's 2,400 beef cattle as a fuel source to generate electricity, creating an alternative use for unwanted waste.

The digester uses a reactor system with six, 33-gallon steel tanks to process the manure and convert it to biogas. The biogas then fuels a 300 kWh generator to supply electricity to Hampton Feedlot's farm, with surplus energy sold back to the local utility, Kansas City Power and Light. The solid waste from the digested manure is dried to kill spores, seeds, and bacteria. After it is dried, this by-product is sold as an organic fertilizer that can be used as an environmentally friendly alternative to commercial fertilizer.

According to the AgSTAR program, Missouri has at least 154 hog farms that are potentially profitable sites for digesters. If built, those operations would be capable of generating 301 GWh of electricity from the methane produced with the estimated value of $22 million in revenue to farms and local communities. Missouri's dairy farms, cattle feed lots and poultry farms could profit from installing biodigesters as well.

Like coal-fired power plants, biomass power plants require large areas of land for equipment and fuel storage.

4.2 Water Impacts

Like their non-renewable coal-fired plant counterparts, biomass power plants generally require significant amounts of water for cooling. Plants with once-through cooling systems use nearby water sources and immediately discharge the water upon usage. On average, biomass plants with once-through cooling systems withdraw 35,000 gallons of water per MWh and consume approximately 300 gallons of water per MWh of electricity generated.[390] Discharged water is significantly warmer when returned to its source, impacting aquatic animal and plant life. The production of ethanol also requires a significant amount of water.

Factors that may also influence water needs are temperature, climate, and soil quality. Some biomass energy crops, such as the perennial grass miscanthus, require significant amounts of water. Native switchgrass, in comparison, does not.

4.3 Air Impacts

Generation of electricity from biomass combustion, like coal-fired generation, emits particulate matter, carbon dioxide, nitrogen oxides, and sulfur oxides. In comparison to coal, biomass emits less sulfur oxides, but similar levels of particulate matter and a higher level of carbon monoxide. The impact on carbon dioxide emissions resulting from displacing fossil fuel feedstocks with biomass for electricity generation varies, and depends to a large extent on assumptions regarding the regeneration rate of the biomass feedstock.

4.4 Public Health Impacts

Burning biomass materials may result in public health impacts, including the release of particulate matter, which as described can create respiratory symptoms and other more serious effects. In addition, release of sulfur dioxide may exacerbate respiratory illnesses by causing inflammation and hyper-responsiveness of the airways, which increases the incidence and severity of asthma symptoms and bronchitis.[391]

4.5 Risks of Energy Disasters

There are no examples of large-scale energy disasters related to biomass generation.

5. Summary of Key Points

- Currently, Missouri's energy portfolio includes 2.2 percent from renewable sources including hydropower, wind, solar, and biomass.[392] Interest in distributed generation is increasing, where energy is generated on a smaller scale and closer to the user. Renewable energy sources are well suited to meet this demand.

- Generating electricity from renewable energy rather than fossil fuels offers significant environmental and public health benefits. While there may be emissions associated with manufacturing renewable equipment, wind, solar, and hydroelectric systems generate electricity with no air pollution emissions. While biomass energy emits some air pollutants, total air emissions are generally much lower than those of coal- and natural gas-fired power plants.[393] In addition, wind and solar energy require essentially no water to operate and do not compete with agriculture, drinking water systems, or other important water needs. Increasing the supply of renewable energy would allow us to replace carbon-intensive energy sources and significantly reduce global warming emissions from the state.

- Wind energy generation, if properly planned, can allow for the land around turbines to be used for farming or other agricultural purposes. Habitat disruption and the impact to birds and bats due to impact with blades or changes in air pressure is a concern.
- A unique characteristic of solar energy fields is that in urban areas, solar power systems, including community solar, can target and reutilize brownfield land.

III. Climate Change, Air Pollution, and the Environment

Most of the world's energy originates from the burning of fossil fuels including coal, petroleum, and natural gas. Fossil fuels consist mostly of hydrogen and carbon, and when burned, the carbon combines with oxygen to create greenhouse gases and air pollution affecting the environment and, in turn, our public health. Greenhouse gases attributed to combustion of fossil fuels include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

On August 3, 2015, the U.S. Environmental Protection Agency (EPA) released final rules setting carbon pollution standards for new, modified, and reconstructed power plants and final rules for existing power plants. Called the Clean Power Plan, the final rules for existing power plants establish interim CO_2 emission performance rates over the period 2022-2029 and final CO_2 emission performance rates by 2030. The final rate-based goal for Missouri is approximately 36.7 percent lower than 2012 adjusted CO_2 levels.

In Missouri the Public Service Commission (PSC) is charged with balancing the multitude of sometimes competing interests to provide Missourians with safe, reliable power at rates that are affordable for the population as a whole. By charter, cost and reliability are the most important factors. Commission Rule 4 CSR 240-22.010 states that the PSC's mission is to provide the public with energy services that are safe, reliable, and efficient, at just and reasonable rates, in compliance with all legal mandates, and in a manner that serves the public interest and is consistent with state energy and environmental policies. In addition, the PSC's resource planning process puts minimization of the present worth of long-run utility costs as the primary selection criterion in choosing the preferred resource plan.[394]

Passage of House Bill 1631 in 2014 (Section 643.640, RSMo) and the PSC's regulatory authority provide some assurance that Missouri will effectively consider factors such as cost and impacts on ratepayers and the economy as we develop our state compliance approach to the Clean Power Plan.[395] The Missouri Department of Natural Resources (MDNR) and Division of Energy are meeting regularly to coordinate efforts and share information.

Although "coal has literally fueled our way of life"[396] and will continue to be a significant part of Missouri's electricity energy portfolio for some time, there are looming externalities related to the environment and public health that are being recognized and could perhaps be addressed with clean coal technologies and carbon capture. The recently completed Iatan II coal-fired power plant that employs high efficiency technology is an example of how cleaner-burning coal facilities can continue to be part of Missouri's generating portfolio. The use of co-firing, where feasible, creates a pathway to using Missouri's abundant indigenous biomass resources.

1. Greenhouse Gas Emissions

Greenhouse gas emissions are typically calculated for the six major greenhouse gases regulated under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). To quantify and evaluate emissions consistently they are converted into a carbon dioxide equivalent (CO_2e) using global warming potentials that represent how much a given mass of a chemical contributes to global warming over a given time period compared to the same mass of carbon dioxide.

In our state, eight of the ten largest emitters of greenhouse gas emissions are coal-fired electricity generation plants.[397] In 2012, approximately 124.9 million metric tons (MT) of CO_2 were emitted from the state. Approximately 58.4 percent of these emissions were attributable to the electricity sector, while transportation accounted for 28.3 percent of emissions – Figure 53.

Missouri Carbon Dioxide Emissions by End-Use Sector, 2012 (124.9 Million MT)

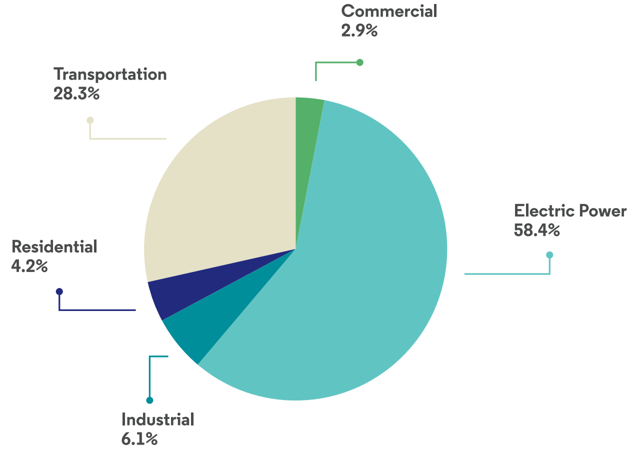


Figure 53. Missouri Carbon Dioxide Emissions by End-Use Sector, 2012.

Source: U.S. Energy Information Administration, "State CO2 Emissions." Data for 2012. Accessed April 2015. http://www.eia.gov/environment/emissions/state/

By source, Figure 54 shows that 58.0 percent of carbon dioxide emissions in the state that year resulted from the combustion of coal, while the use of petroleum products accounted for 31.2 percent of such emissions.

Missouri Carbon Dioxide Emissions by End-Use Sector, 2012 (124.9 Million MT)

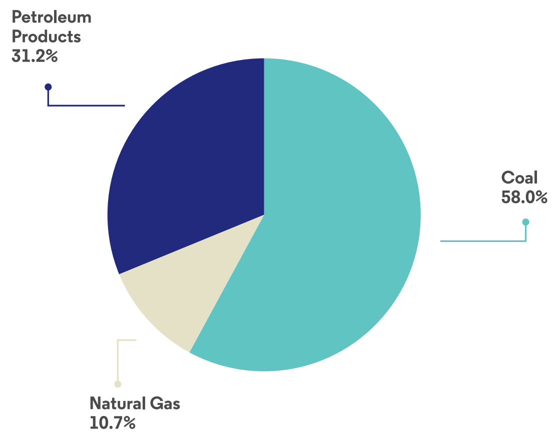


Figure 54. Missouri Carbon Dioxide Emissions by Source, 2012.

Source: U.S. Energy Information Administration, "State CO2 Emissions." Data for 2012. Accessed April 2015. http://www.eia.gov/environment/emissions/state/

Facilities which emit over 25,000 MT CO_2e per year are required to report their emissions annually to the EPA,[398] with certain exceptions. In 2013, there were 118 such reporting entities in the state of Missouri; these facilities emitted a total of 89.5 million MT of CO_2e, 82.7 percent of which originated from power plants – Figure 55.

Missouri Reported Direct Greenhouse Gas Emissions, 2013 (89.5 Million MT CO2e)

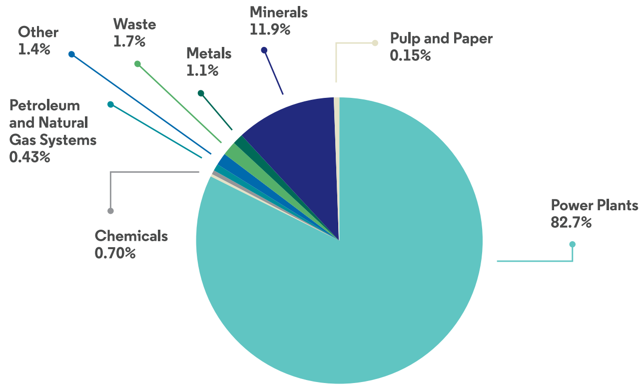


Figure 55. Missouri Direct Emissions of Greenhouse Gases by Sector from Reporting Large Emitters, 2013

Source: U.S. EPA, "2013 Greenhouse Gas Emissions from Large Facilities." Accessed April 2015. http://ghgdata.epa.gov/ghgp/

Of the top 25 reporting emitters in Missouri, 17 are related to energy generation, four consist of cement-related operations, three are lime/mineral facilities, and one concerns aluminum operations.[399] Table 28 describes the top ten emitters in Missouri.

Table 28. Missouri Top Ten Large Emitters, 2013.

Source: U.S. EPA, "Greenhouse Gas Reporting Program, Summary Data: 2013," Accessed April 2015. http://www.epa.gov/ghgreporting/ghgdata/reportingdatasets.html

Facility Name	City	Industry Type	Total Reported Direct Emissions (Million Metric Tons Carbon Dioxide Equivalent)
Labadie	Labadie	Power Plants	15.3
Iatan	Weston	Power Plants	9.9
Thomas Hill Energy Center	Clifton Hill	Power Plants	8.1
New Madrid Power Plant	New Madrid	Power Plants	7.4
Rush Island	Festus	Power Plants	7.1
Sioux	West Alton	Power Plants	4.7
Hawthorn	Kansas City	Power Plants	3.7
Montrose	Clinton	Power Plants	3.0
Holcim (US) Inc Ste. Genevieve Plant	Bloomsdale	Minerals	2.8
Meramec	St. Louis	Power Plants	2.7

Examining these large emitters allows the state to take a more localized approach in identifying solutions and developing mitigation strategies.

2. Carbon Capture and Storage

Carbon Capture and Storage (CCS) is a technology that can capture up to 90 percent of the carbon dioxide emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide, a greenhouse gas, from entering the atmosphere.

To date, there has been little real world experience with utility-scale CCS. One of the largest projects began service in October 2014 at a coal-fired generating unit of the Boundary Dam Power Station in Saskatchewan, Manitoba in Canada. Much of the captured CO_2 from this project will be transported by pipeline to nearby oil fields in southern Saskatchewan where it will be used for enhanced oil recovery. Initial reports on the operation of the system are encouraging.[400]

Missouri is part of the Plains CO_2 Reduction Partnership, a multiyear collaboration of over 80 U.S. and Canadian stakeholders investigating CCS projects in the Partnership Region in the central plains area of North America. In 2008, City Utilities of Springfield organized a consortium of Missouri electric utilities and a research team that included City Utilities, the Missouri Department of Natural Resources, Missouri University of Science & Technology, and Missouri State University to investigate the potential for CCS in Missouri. After initial results from drilling at a site in Springfield were unfavorable, the project was expanded and concluded that there is considerable territory in Missouri that may have characteristics generally favorable for CCS.

To advance CCS efforts in our state the Department of Economic Development's Missouri Technology Commission has invested in companies developing technologies. Akermin, Inc. is developing a technology that stabilizes enzymes that are used to capture CO_2 from industrial gas streams. Coal-fired power plants are an eventual target market. Elemental Enzymes is an enzyme production company based in Columbia, MO, that is using an enzyme production process developed at the University of Missouri. Its technology provides for the mass production of enzymes used in industrial and agricultural processes that have higher stability and lower costs.

3. Air Quality Standards and Pollution

The U.S. EPA regulates six criteria air pollutants harmful to public health and the environment: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter, ground-level ozone (O_3), and lead. The EPA also tracks emissions of volatile organic compounds (VOCs), because they react in the air to produce ground-level ozone.

According to the EPA, electricity generation, particularly generation associated with coal-fired power plants, is a major source of SO_2 and mercury pollution on a national basis. In addition, the largest source of NO_x emissions is the transportation sector, and the largest sources of PM_{10} and $PM_{2.5}$, are fires and fugitive dust from unpaved roads.[401]

Air pollution is measured against the standards established in the National Ambient Air Quality Standards Act, as defined in the Clean Air Act. If an area does not meet standards associated with any of the six criteria pollutants, it is considered a non-attainment area and triggers the development and implementation of a plan to improve air quality. Each infraction is considered a separate type of nonattainment. In Missouri, there are currently 22 non-attainment areas located in eight counties and one metropolitan area, as shown in Table 29.

Table 29. Missouri Non-Attainment Areas

Source: U.S. EPA. "Current Nonattainment Counties for All Criteria Pollutants," January 30, 2015. http://www.epa.gov/airquality/greenbook/ancl.html

Country	Pollutant
Dent	Lead (2008)
Franklin	8-hours ozone (1997) PM 2.5 (1997) 8-hours ozone (2008)
Iron	Lead (2008)
Jackson	Sulfur Dioxide (2010)
Jefferson	8-hours ozone (1997) Lead (1978) Lead (2008) PM-2.5 (1997) Sulfur Dioxide (2010) 8-hours ozone (2008)
Reynolds	Lead (2008)
St. Charles	8-hours ozone (1997) PM 2.5 (1997) 8-hours ozone (2008)
St. Louis (Country)	8-hours ozone (1997) PM 2.5 (1997) 8-hours ozone (2008)
St. Louis (City)	8-hours ozone (1997) PM 2.5 (1997) 8-hours ozone (2008)

The National Emissions Inventory provides a detailed estimate of air emissions from all sources of air pollutants in Missouri. This inventory is prepared every three years by the EPA.

4. Summary of Key Points

- Missouri, like much of the U.S., is heavily dependent upon the burning of fossil fuels, which result in air emissions that have significant environmental and human health impacts. National environmental laws and regulations continue being developed, in part, to address these impacts. At a minimum, Missouri must comply with national environmental laws. As a state we have the opportunity to plan for our energy future, to consider existing and future technologies, and to step forward into an energy future that is more balanced, more distributed, more reliable, and safer.

Chapter 7: Our Vision for the Future

Missouri's energy systems – our laws, regulations, utility planning processes, emergency planning networks, and other programs – have served Missouri well. We have historically had relatively low electricity prices, we were able to manage propane issues in the winter of 2013-2014 better than many surrounding states, and we have systems in place to manage emergencies. Because of this solid foundation, the Missouri Comprehensive State Energy Plan does not recommend sweeping changes to our energy systems; however, there are significant improvements that can and should be made.

This final chapter of the Plan proposes actions or additional steps that can be taken to achieve these improvements. This Plan recognizes our state's needs for clean, reliable, affordable, and abundant energy and incorporates a focus on fostering energy-related economic development.

I. Our Future

Governor Nixon's Executive Order that led to the development of this Plan establishes goals for achieving a clean, reliable, affordable, and abundant energy future for Missouri. Our state has significant resources, human capital, and innovative and world-class businesses and institutions that serve as the foundation needed to achieve these goals.

In conducting our analysis and soliciting public input during the Plan development process it became apparent that Missouri's pathway to achieving these goals is grounded on:

- **Promoting Efficiency of Use:** Energy efficiency leverages all forms of supply by stretching the value of a given unit. Using energy more wisely is a first step in optimizing Missouri's energy system.
- **Ensuring Affordability:** A focus on providing reliable energy at prices that are fair and reasonable for consumers and businesses will support Missouri's continued economic success. It is essential that the state's energy system meet the health, welfare, and economic needs of its citizens with particular emphasis on vulnerable populations.
- **Diversifying and Promoting Security in Supply:** Missouri must identify and capitalize on opportunities to maximize in-state clean energy resources and decrease dependence on imported fossil fuel energy sources.
- **Undertaking Regulatory Improvements:** Modifications to our state's energy laws and regulations are necessary to expand opportunities, deliver enhanced benefits to Missourians, and guide Missouri into our energy future.
- **Stimulating Innovation, Emerging Technologies, and Job Creation:** Missouri can be an energy innovation leader through the creation of research initiatives, development of a skilled and dedicated workforce, education of the public, support of local industry, and fostering a business climate that attracts innovation and creativity.

In order to meet these goals, the recommendations identified in this chapter must be assessed to further understand feasibility, costs and benefits, and timelines for implementation. This assessment can then lead to a prioritization of efforts and development of action plans that provide a concrete path for moving forward.

With a recognition that state energy policy needs to be progressive and remain flexible so as to adapt to today's ever-changing energy industry, Missouri's Comprehensive State Energy Plan will be a living document that serves as a reference point for the state's elected officials, communities, businesses, and all Missourians. Local communities can use this Plan as the basis for developing their own plans that highlight the unique resources and priorities of their region. Additionally, we encourage all Missourians to support our efforts through individual action.

II. Recommendations For Action

The recommendations presented in this section were developed through the analysis of Missouri's current energy outlook, potential for the future, and input gathered from the Plan's comprehensive, transparent, and collaborative stakeholder engagement process. These recommendations also include national best practices and reflect the views and opinions of numerous business leaders, energy innovators, and members of the public.

Strategies and recommendations are organized by topic areas: Efficiency of Use, Energy Affordability, Diversity and Security in Supply, Regulatory Improvements, and Innovation, Emerging Technologies, and Job Creation. It should be noted that many of the recommended actions fit in more than one category and their benefits would assist in achieving multiple interrelated goals.

Many of the recommendations require further investigation and development. In addition, some of the recommended initiatives will require legislative action.

1. Efficiency of Use

Efficiently using available energy resources could be the most cost-effective method of meeting the state's energy needs. Many states have already established progressive energy efficiency policies and goals, and lessons learned elsewhere can help Missouri to use electricity, natural gas, transportation fuels, and other resources more efficiently.

1.1 Modifying the Missouri Energy Efficiency Investment Act

In 2009, the Missouri Energy Efficiency Investment Act (MEEIA) was passed and signed into law to boost investments in electric energy efficiency and save utilities and utility customers money, create jobs, and improve environmental quality. MEEIA directs the Missouri Public Service Commission (PSC) to permit investor-owned electric utilities (IOUs) to implement demand-side management programs with a goal of achieving all cost-effective demand-side savings. The PSC rule provides benchmark targets for cumulative electric annual savings of 9.9 percent by 2020 and one percent reduction of peak demand each year. There are no mandatory targets or penalty to electric utilities for not meeting them. Currently Missouri regulated electric utilities conduct utility-specific potential studies for their utility territory that establish energy efficiency savings targets on which their performance is evaluated and rewarded.

Potential studies are simplified quantitative modeling and should not be viewed as definitive statements of what is possible but as projections of possible future scenarios that by their nature have a degree of uncertainty. When used, they should be one tool considered in the setting of energy efficiency savings targets and approval of program plans.

MEEIA provides for recovery of program costs by allowing adjustments to the rates between rate cases. In addition, utilities that elect to participate are allowed to propose performance incentives that are based on the net-shared benefits resulting from the programs they implement. In order to be approved by the PSC, proposed programs must be deemed cost-effective, with the exception of programs targeting low-income customers or general education.

Recommendations:

- Revise MEEIA such that it establishes mandatory annual electricity and load reduction targets for electric investor-owned utilities.
- Allow investor-owned natural gas and water utilities to voluntarily participate in MEEIA.
- Allow customers who have utilized tax credits for low-income housing to participate in MEEIA programs.
- Allow electric utilities to treat conservation voltage regulation measures in the same manner as other energy efficiency measures.
- Allow electric utilities to treat combined heat and power in the same manner as other energy efficiency measures.
- Consider penalties for utilities that do not meet energy goals.

1.2 Improving Missouri's Evaluation, Measurement, and Verification Approach

Evaluation, measurement, and verification (EM&V) of energy efficiency programs ensures that energy savings are being delivered in the most cost-effective manner. EM&V establishes an accountability mechanism and creates a documented record of success that encourages additional investment in the future. The most reliable and accurate methods of evaluating energy efficiency programs are standardized and transparent.

Several ongoing national efforts aim at developing common frameworks to determine the amount of energy savings associated with a certain technology or measure, such as lighting, boilers, furnaces, or air conditioning units. These frameworks, called Technical Reference Manuals, are typically developed at the state level in collaboration with utilities, government, and energy stakeholders. Missouri does not have a Technical Reference Manual and therefore lacks standardization in how energy savings resulting from programs implemented under MEEIA are calculated and verified.

The MEEIA statute requires that all programs – other than those targeted to low-income consumers or providing general education – pass a cost-effectiveness test in order to receive approval from the PSC. However, the cost-effectiveness tests described in the current rules implementing MEEIA are limited since they do not explicitly consider quantifiable non-energy benefits. There are a number of non-energy benefits to participants (such as increased property values and productivity, lower water and sewer bills, lower operations and maintenance costs, improved tenant satisfaction, and increased comfort, health and safety), to utilities (such as reduced arrearage carrying costs, customer collection calls/notices, termination/reconnection costs, and bad debt write-offs) and to society at large (such as job creation, economic development, energy security, public safety, reduced emissions and emission-related health care costs, and other environmental benefits). The exclusion of non-energy benefits from cost-effectiveness tests restricts the range of energy efficiency measures that utilities can include in their programs and portfolios, since cost-effectiveness tests are skewed to the extent that they do not properly account for all benefits.

The MEEIA statute assigns the PSC responsibility to determine what costs and benefits should be included in the total resource cost test. Consistent with this authority, the PSC should explicitly include quantifiable non-energy benefits in the total resource cost test. A number of states already include non-energy benefits in their cost-effectiveness tests. Adding quantifiable non-energy benefits to the cost-effectiveness calculations under MEEIA would allow investor-owned utilities to offer more cost-effective programs and measures, achieving additional cost-effective savings. This would result in additional ratepayer and utility savings, greater environmental protection, improved public health, and lower-cost regulatory compliance.

Recommendations:

- Develop a comprehensive, statewide Technical Reference Manual as a uniform approach to energy efficiency EM&V.
- Require use of the Technical Reference Manual for utilities participating in MEEIA.
- Incorporate non-energy benefits, to the extent they can be calculated with a reasonable degree of confidence, in the cost-effectiveness tests that are used to determine the cost effectiveness of energy efficiency programs approved under MEEIA.

1.3 Making Improvements in Missouri's Water Infrastructure

Energy use in water treatment is gaining attention due to energy intensity of operations and the high costs associated with the supply, distribution, and treatment of drinking water and wastewater. Across the U.S. it is estimated that approximately four percent of power generation is used for water supply and wastewater treatment.[402] Furthermore, electricity costs represent approximately 80 percent of municipal water processing and distribution costs. Given these issues, a variety of strategies and tactics can be used to increase efficiency at water treatment facilities through the installation of more efficient equipment.

In addition to equipment improvements, distribution systems also present an important opportunity for water savings. Clean water is transported from treatment plants to homes through a vast network of pipes and leakage that occurs during that transportation process not only results in the loss of purified drinking water but also means wasting the energy and material resources used in abstraction, transportation, and treatment.

Missouri has 2,722 water treatment systems that are regulated by the Missouri Department of Natural Resources (MDNR). Of these, 1,433 are community-run systems and the remaining systems are non-community systems.

Recommendations:

- Establish minimum energy efficiency standards for all water infrastructure projects funded by MDNR.
- Prioritize water infrastructure projects that provide energy efficiency savings by incorporating

energy savings into funding allocation criteria.

- Identify opportunities to combine existing funding streams that would accelerate energy efficiency project completion.

1.4 Improving Missouri's State Vehicle Fleet

In 1991, the Missouri General Assembly set standards for economically and environmentally responsible state fleet management through the establishment of the Fuel Conservation for State Vehicles Program. The intent of this Program is to increase the average fuel efficiency of the state fleet and to encourage the use of cleaner alternative transportation fuels in state vehicles.

The Fuel Conservation for State Vehicles Program requires all Missouri state agencies to meet minimum guidelines for efficient vehicle fleet management. In addition, agencies are required to purchase and operate vehicles using alternative fuels, such as E85, propane, compressed natural gas or others, if the purchase is within the incremental lifecycle cost caps designated in the statute.

Since January 1, 2008, the Commissioner of the Office of Administration has been required to ensure that at least 70 percent of new state fleet vehicles are flexible fuel vehicles operating on E85. This requirement does not provide discretion for the purchase of vehicles operating on other alternative fuels or technologies and is somewhat restrictive of improvements in technology that may result in a better performance alternative for our state.

Recommendations:

- Eliminate the technology-specific procurement policies for new state fleet vehicles and, instead, require adherence to fleet performance goals.

1.5 Utilizing Missouri's Property Assessed Clean Energy Act

Some property owners may be unable to make energy efficiency improvements to their buildings because the costs of making these improvements will not be recouped through reduced energy bills for several years. Property Assessed Clean Energy (PACE) programs help eliminate this barrier by providing a simple and effective way to finance energy efficiency, renewable energy, and water conservation upgrades to both residential and non-residential buildings. Under PACE programs, municipalities and counties form special taxing districts that can issue bonds to help property owners finance energy retrofits by allowing a property owner to place an additional tax assessment on his or her property. Both residential and commercial property owners can utilize these loan programs to obtain financing for clean energy improvements that are repaid through property tax assessments over a 20-year period.

PACE in Missouri is gaining momentum but there is great potential to finance more clean energy projects using this innovative model. Additional marketing, outreach, and technical assistance are needed and can play a key role in the program's success. Participating municipalities could publicize their membership in the Missouri Clean Energy Board by using community groups to disseminate public information and by connecting with local community and neighborhood associations, small business groups and clubs, local nonprofit organizations, and others who can become effective advocates for PACE. It is also important to engage energy efficiency contractors and solar installers to help educate their customers about clean energy options and market PACE financing as a tool.

Recommendations:

- Improve marketing efforts and technical assistance for PACE to increase participation rates.

1.6 Developing Statewide Building Energy Codes

Building energy codes ensure a base level of energy efficiency in all newly built or substantially renovated commercial and residential buildings. Because incorporating energy efficiency measures can be less expensive than retrofitting an existing building, requiring new buildings to meet an energy code produces energy efficiency benefits at lower costs.

Every state has its own process for enacting energy codes. In some states, codes are enacted at the state government level, whereas in other states, such as Missouri, municipalities, counties, or other units of local government have the power to act without prior authorization by the state legislature.

Missouri is currently one of nine states that do not have mandatory statewide energy codes. In our state, local jurisdictions, with the exception of Class 3 and Class 4 counties, have the authority to adopt an energy code. Currently, approximately fifty percent of Missouri residents are covered by 2009 or 2012 International Energy Conservation Code (IECC) or equivalent codes.

In the past, Missouri has considered adopting a statewide energy code. In 2010, the Building Codes Assistance Project[i] drafted SB 745, which would have adopted the 2009 IECC and ASHRAE Standard 90.1-2007 statewide. It also would have directed Missouri's Department of Natural Resources to establish an automatic code review cycle, either every three years or within nine months of the publication of a new model code version. In addition, HB 938 (2011) would have established a modified version of the 2006 IECC series as minimum statewide construction standards. Both bills, however, failed to move beyond legislative committees.

[i] The Building Codes Assistance Project (BCAP) is a nonprofit advocacy organization established in 1994 as a joint initiative of the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, and the Natural Resources Defense Council. On June 1, 2014, BCAP became an independent organization and a project of the Trust for Conservation Innovation.

Recommendations:

- Enact a statewide energy code applicable to Class 1 and 2 counties for both residential and commercial new construction activities.
- Allow Class 3 and 4 counties to adopt energy codes for both residential and commercial new construction activities.
- Deliver educational activities at the local level to inform local government and code enforcement officials of the benefits of energy codes and how to enforce them.

1.7 Improving Missouri's Energy Loan Program

The Missouri Energy Loan Program, administered by the Missouri Department of Economic Development – Division of Energy, is available for energy efficiency and renewable energy projects at non-residential buildings. Eligible recipients include public schools, public or private colleges and universities, city and county governments, public water and wastewater treatment facilities, and public or private non-profit hospitals.

Established in 1989, the program has awarded 560 loans to-date for energy-saving investments, such as lighting upgrades, heating and cooling systems, insulation, windows, and other measures affecting energy use. These projects have resulted in more than $175 million in estimated cumulative energy savings.

Although the Energy Loan Program continues to be a resounding success, the limited range of institutions eligible to receive loans under this program constrains the potential for expanded energy efficiency benefits. Furthermore, tying the program to annual funding cycles discourages energy efficiency projects that take a long period of time to implement, but that could result in greater efficiency than loans provided for a narrow range of discrete upgrades.

Some states have established innovative financing tools such as the Warehouse for Energy Efficiency Loans (WHEEL) and green banks to offer low-cost financing for clean energy projects using public funds to leverage private investments through bond sales, loans, and other credit enhancements.

Recommendations:

- Expand the definition of eligible program participants to include industrial energy users.
- Consider establishing other financing options including green banks and a warehouse for energy efficiency loans.

1.8 Expanding Missouri's Linked Deposit Program

The Missouri State Treasurer's Office partners with lending institutions through the Missouri Linked Deposit Program to spur economic development through low-interest loans. Through this program, the state places a deposit with a partner institution that then lends the money for eligible projects at below-market interest rates.

Eligible borrowers include small businesses creating jobs, alternative energy producers and consumers, agriculture operations, and local governments. Businesses, farming operations, multifamily housing, and consumers may use loan proceeds for energy efficiency measures and alternative energy projects, such as solar panels or wind turbines, provided they meet the lending institution's credit requirements.

Recommendations:

- Expand efforts to promote Missouri's Linked Deposit program in order to increase participation, particularly for energy-related projects.

1.9 Expanding Energy Improvements in State Facilities

The Division of Energy plays an integral role in the initiation and development of energy-related programs within the state. Some of these programs are instituted initially as policies and practices within state administration that are then shared with public and private sector entities, a practice known as "leading by example."

Leading by example programs allow state and local governments to provide leadership to businesses and residents by sharing information and practices related to initiatives to improve energy efficiency in government-managed properties. Missouri has already taken significant steps to improve efficiency in government-owned facilities through a number of executive orders and legislative actions that include:

- **Senate Bill 1181 (2008):** required MDNR to establish energy savings standards for state buildings at least as stringent as the 2006 IECC by January 1, 2009. The standard applies equally to state-owned and state-leased buildings over 5,000 sq. ft., for which the design process or the lease began after July 1, 2009.

- **Executive Order 09-18 (2009):** requires that state agencies whose buildings are managed by the Office of Administration adopt policies to reduce energy consumption by two percent each year for 10 years. Additionally, the order requires that all new construction projects by agencies whose buildings are managed by the Office of Administration must be at least as stringent as the most recent IECC. In response to the Executive Order, the Office of Administration, Division of Facilities Management, Design and Construction developed and adopted a State Building Energy Efficiency Design Standard. Missouri state agencies are ahead of overall target reductions goals by decreasing consumption by more than 20 percent since the Executive Order was issued in 2009.

Benchmarking is a key first step in analysis of the energy performance of a facility. It provides a comparison of the facility against similar facilities and also allows comparison of the performance of a facility after energy retrofits to its performance before retrofits. Benchmarking can be used as a tool in developing energy targets for a facility. To date, benchmarking has largely been a voluntary effort undertaken by entities with a high degree of interest in energy efficiency. Some governments around the country have issued benchmarking ordinances requiring that buildings meeting certain criteria be benchmarked, with energy use and other key metrics documented by the governmental entity. Benchmarking ordinances are rare in Missouri and only implemented by a few cities.

Energy performance is commonly measured in terms of Energy Use Intensity (EUI). EUI expresses a facility's energy use as a function of its size or other characteristics. For buildings, EUI is expressed as energy use per square foot and for manufacturing facilities EUI is expressed as energy use per unit produced. Active tracking of facility EUI can be one of the best tools engaged in achieving energy goals.

Over the last forty years, an industry focused on energy services has evolved worldwide. An Energy Services Company (ESCO) is a specialized provider of energy-related services, primarily focused on reducing energy consumption in a customer facility. ESCOs perform work under an Energy Savings Performance Contract (ESPC) model, through which the guaranteed savings of the projects offsets the costs of the work over the contracted time period. The ESPC model has proven to be successful when properly implemented. Such work has been authorized in Missouri since 1997 for public facilities under applicable sections of Chapter 8 RSMo.

Technology is a key element in energy management, particularly for large or complex facility portfolios. A Building Automation System (BAS) is a common technology that is implemented to monitor and control energy systems such as lighting, heating, cooling, and ventilation. BAS are centralized and intelligent networks of hardware and software that maximize the performance of a building from an energy efficiency standpoint and make management of a facility simpler. With the rapid advancement of technology, maintaining the relevance of a BAS can be challenging. Replacement of an outdated or nonfunctional system is essential to optimal energy management, but this process is costly and may be outside the scope of an energy project. This is particularly challenging for state facilities and financial mechanisms that allow updating this technology are necessary to achieve optimal energy management.

In response to Executive Order 09-18, the Office of Administration, Facilities Management Design and Construction implemented the State Facilities Energy Conservation Program, which outlines practices designed to promote energy efficiency within the portfolio of facilities that it manages. The program requires adherence to Building Energy Efficiency Design Standards for new construction and major renovations to existing facilities. These programs and standards relate, in part, to industry standards in effect in 2009 and should be regularly updated.

Recommendations:

- Require that state facilities report annual energy data in a large-scale benchmarking and trending effort.
- Create an interagency collaborative of facility managers and building operators to exchange ideas, lessons learned, and best practices around energy conservation.

- Ensure that energy management, analysis, and technology are a focus of building operation an maintenance. This should include the upgrade and maintenance of automated building controls and enterprise analysis tools to sustain and generate additional energy savings in state buildings.
- Designate an energy champion in each executive department director's office to facilitate the collection and/or confirmation of data required for energy analysis and advocate for energy conservation within the department.
- Examine the potential for Combined Heat and Power (CHP), geothermal, and solar thermal applications at existing and new state facilities as a means of addressing efficiency on a larger scale.
- Promote the development of public-private partnerships to implement energy conservation measures, including CHP projects.
- Update the State Facilities Energy Conservation Program and the State Building Energy Efficiency Design Standards by December 31 of the year coinciding with an update to the International Energy Conservation Code, beginning in 2015 and occurring every three years.
- Require that Request for Proposals for state building construction projects place a high priority on energy efficiency, sustainability, and greenhouse gas reduction and consider these items when awarding contracts.
- Require that an EUI target be specified for new construction projects or substantial renovations of state facilities.
- Develop methodology and best practices for successful execution of Energy Savings Performance Contracts as a means to achieve energy conservation.
- Extend the allowable payback period for ESPC for state buildings from 15 years as currently allowed by statute to a minimum of 20 years to accommodate more comprehensive energy projects, including CHP, geothermal, solar, biomass, and other developed energy technology.
- Provide financial mechanisms by which costs attributable to energy conservation projects, including ESPC, can be paid from the resulting savings in utility costs through defined calculation of avoided future costs. The intent of this action is to allow savings from energy conservation projects to be appropriately applied toward payment of debt and other costs related to the project over the prescribed time period.
- Examine the potential for generating renewable power at state facilities.

1.10 Expanding Division of Energy Activities

The Division of Energy assists, educates, and encourages Missourians to advance the efficient use of diverse energy resources to drive economic growth, provide for a healthier environment, and to achieve greater energy security for future generations. The Division:

- Collects and reports Missouri energy data.
- Conducts energy policy research and analysis.
- Maintains Missouri's plan for energy emergencies.
- Provides technical and financial assistance for energy efficiency and renewable energy projects.
- Supports market research and demonstration projects.
- Serves as a clearinghouse of information and research on energy issues.
- Expanding Division of Energy activities and availability of resources could provide value to Missouri residents and businesses.

Recommendations:

- Expand Division of Energy activities to include:
  - Development of a statewide "one stop shop" of energy resources hosted at energy.mo.gov for home owners, building owners, building operators, and contractors to obtain guidance on energy efficiency, renewable energy, and alternative energy strategies as well as information and direct links to available incentives and programs.
  - Delivering a series of regional seminars for the general public on energy consumption and conservation.
  - Convening a utility and industry stakeholder group to develop technical knowledge of energy efficiency at industrial facilities, including energy assessment training, case studies for industry sectors, and expanded training opportunities for manufacturing workers.
  - Maintaining a statewide Technical Reference Manual.
  - Conducting and updating statewide Potential Studies to explore the potential for energy efficiency in Missouri, if such studies are used.
  - Expanding the number of certified energy auditors throughout the state.

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2. Energy Affordability

The affordability of energy rates significantly impacts the health, safety, and economic well-being of Missouri's families. This is particularly true for vulnerable households such as low-income families and the elderly. Low-income households face disproportionately high energy burdens and greater incidence of late payment, disconnection, and unpaid balances. Collection activities and high rates of disconnect also impact utilities by increasing operating costs, which in turn results in higher bills to all ratepayers.

Energy affordability is critical to the success of many Missouri businesses and key to attracting new industry. Competitive and affordable rates are critical to Missouri's ability to grow its economy and provide a better quality of life to its citizens.

2.1 Improving Missouri's LIHEAP Program

The Low Income Home Energy Assistance Program (LIHEAP) assists low-income households, particularly those that pay a high proportion of household income for home energy, in meeting their immediate home energy needs and paying utility bills.

In addition to LIHEAP, the Low-Income Weatherization Assistance Program (LIWAP) helps low-income customers by offering a longer-term solution that focuses on home weatherization improvements.

Although they serve the same customers LIHEAP and LIWAP currently operate somewhat independently in Missouri and tying the programs together and encouraging cross-participation would result in efficiencies. In addition, this could allow low-income customers to participate in programs that offer both short-term and long-term assistance.

Recommendations:

- Require that a portion of the state's LIHEAP funding be allocated to the state's LIWAP Program to encourage longer-term solutions.
- Require that individuals living in owner-occupied dwellings who receive utility assistance be referred to their local weatherization agency for weatherization of their residence.

2.2 Authorizing Missouri's Utilicare Program

The Missouri Utilicare program provides financial support to eligible low-income, disabled, or elderly citizens through Community Action Agencies that make utility bill payments for eligible customers that may need assistance. Although the program has been in existence for over 30 years, funding through the years has been inconsistent. Utilicare is a state-funded program that essentially mirrors and supplements the federally-funded LIHEAP program.

Recommendations:

- Authorize and adequately appropriate the Utilicare Program on an annual basis.
- Require that a portion of the state's Utilicare funding be allocated to the state's LIWAP Program to encourage longer-term solutions.

2.3 Modifying Missouri's Federal Low-Income Housing Tax Credit Program

The Low-Income Housing Tax Credit (LIHTC) provides a transferable federal and state tax credit to owners of affordable housing developments, which can be sold to investors to generate equity for a proposed development.

For residential new construction projects, energy efficiency performance requirements are attached to these dollars as a way of ensuring that public funding is spent efficiently and effectively. No similar performance requirement exists for preservation and rehabilitation projects. Where prescriptive requirements may result in developers pursuing the incorporation of particular building products, performance-based requirements are intended to allow flexibility to meet energy savings goals in the most efficient manner possible.

Recommendations:

- Apply performance-based energy efficiency requirements to Federal LIHTC Allocations.
- Expand the energy efficiency requirements currently in place for new building projects to preservation and rehabilitation projects.
- Integrate building energy use benchmarking into the Missouri Housing Development Commission funding requirements.

2.4 Establishing Low-Income Rates

The PSC has statutory authority to establish just and reasonable rates for Missouri's IOUs. In fulfilling that responsibility and setting the rates and the terms and conditions of service, the PSC considers affordability among other factors, including the impact on low-income customers. The PSC is uniquely positioned to evaluate affordability relative to the cost of service because it hears evidence on these issues from interested parties in rate proceedings.

In addition to considering affordability in approving the level of rates, the PSC considers affordability in many other aspects of ratemaking. For example, the Cold-Weather Rule prohibits disconnection during extremely cold weather and provides that customers can enter payment arrangements to maintain service. Other PSC rules address general conditions for disconnection, customer deposits, and payment arrangements.

In 2001 the PSC authorized a bill credit program for Missouri Gas Energy and since then it has authorized experimental low-income bill-credit programs for most of Missouri's investor-owned electric and natural gas providers. In 2004 the PSC established a working docket to investigate the affordability of energy for heating.[403]

Although the PSC has not established a low-income customer class or required that regulated energy utilities offer a discounted rate to low-income electric or natural gas customers, the PSC has considered it in recent proceedings.[404] Missouri has established reduced rates for low-income telephone customers. The Missouri Universal Service Fund provides for discounted local telecommunications service rates. In addition, MEEIA explicitly provides the ability to recognize low-income customers as a distinct subclass of residential customers as determined in the rate case and allows programs targeted to those customers to be approved without demonstration that the programs pass a cost-effectiveness test.

Recommendations:

- Clarify and make explicit that the PSC has the statutory authority to consider rates specific to low-income utility customers.

2.5 Developing Residential Energy Efficiency Programs for Hard-to-Reach Sectors

According to the U.S. Energy Information Administration's most recent Residential Energy Consumption Survey, approximately 20 percent of Missouri's households are multifamily properties and there is also a significant percentage of manufactured homes in the state (8.2%).

Multifamily housing has a number of characteristics that should make energy efficiency improvements an appealing investment, but only a fraction of the potential energy savings in the multifamily sector has been realized. One reason for this is that in the multifamily sector there is the "split incentive": although the building owner pays for projects and improvements to the building, the owner cannot recover savings from reduced energy use that accrue to the tenant. For manufactured homes, while there are recent initiatives in some parts of the country for designing newer generations of high-performance manufactured homes to be energy efficient, older units typically show significant opportunities for improvement.

Improving the energy efficiency of multifamily housing and manufactured homes could lead to improved stability of vulnerable households, most of which are renters whose annual income is typically lower than that of homeowners and therefore spend a higher percentage of their income on energy.

Recommendations:

- Create energy efficiency incentive programs specifically targeted at multifamily properties that would benefit both the tenants and the owners consistent with recommended best practice strategies. Some that should be considered include:
  - Ensure an equitable share of available resources.
  - Structure incentives to achieve comprehensive energy savings from a "whole building approach".

- Provide building owners with access to energy consumption data and benchmarking tools.
- Coordinate among utility programs.
- Assure that cost-effectiveness tests appropriately account for non-energy benefits.
- Build partnerships with local market participants and assist building owners with financing.

2.6 Maintaining Business Affordability and Competitiveness

Businesses can improve their bottom line and profit margins, thereby increasing productivity and competitiveness, by adopting cost-effective energy efficiency, demand response programs, and on-site generation, which help businesses reduce their energy consumption and resource use and manage their peak energy usage. On-site generation offers energy security from disruptions and outages and enables business decisions to be made that can lower energy costs by reducing or shifting load served by the utility. Linking new or expanding Missouri businesses to underutilized energy infrastructure benefits the business by reducing the start-up costs, benefits the community by attracting capital expenditures and creating jobs, and benefits the utility by expanding its customer base and improving utilization efficiency of existing infrastructure.

Missouri currently provides an environment conducive to the creation and expansion of businesses through tax incentives, utility rebates, and affordable energy prices. This results in significant economic development benefits for taxpayers and ratepayers. To maintain and capitalize on this competitive advantage, the state and utilities will need to continue to collaborate with businesses to expand private-sector technical knowledge, participation rates and incentive programs in renewable energy and demand-side management programs. To achieve these goals the state should:

Recommendations:

- Convene a utility and industry stakeholder group to develop technical knowledge of energy efficiency at industrial facilities, including energy assessment training, case studies for industry sectors, and expanded training opportunities for manufacturing workers.
- Continue to promote and support industry, commercial, and agricultural energy audits through Missouri's Industrial Assessment Center and Missouri Enterprise.
- Determine how to better align business attraction and retention incentives to maximize the benefits to companies and taxpayers by incorporating energy efficiency strategies designed to increase energy savings and company competitiveness.
- Continue to review and recommend revisions to regulated utility tariffs to eliminate barriers or incent on-site customer generation of electricity for businesses.

- Continue to support regulated utility efforts to encourage industrial and commercial businesses to locate or remain in Missouri, especially in geographies where existing energy infrastructure is underutilized.

- Continue to identify and encourage opportunities for large commercial and industrial customers for cost-effective energy efficiency, demand response programs and on-site generation to help them reduce their energy consumption and resource use and manage their peak energy usage.

- Review and identify opportunities to address businesses' interest in purchasing clean energy for corporate responsibility commitments as well as incorporating competitive processes for selection of new electricity generation.

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3. Diversity and Security of Supply

Investors, from individuals to large institutions, know that a diversified financial portfolio reduces risks and, over time, enhances results. The same is true for a state's energy portfolio: an overreliance on any single energy source can create unnecessary risk.

Broadening the energy sources utilized and consumed in Missouri will make the state less reliant on imported energy, increase economic development, and provide a hedge against future price volatility. The state should make multiple efforts to diversify its energy portfolio, using existing processes and establishing new opportunities for discussion and planning.

3.1 Strengthening Missouri's Renewable Energy Standard

Twenty-nine states, the District of Columbia, and two territories have instituted Renewable Energy Standards (RES) that mandate the amount of electricity that must come from renewable energy annually. Best practices from other states indicate several principles that can increase the success of RES policies. Generally speaking, fostering investment in renewables requires predictable and stable targets and resource eligibility with programs.

Passed in 2008, Missouri's RES requires IOUs to use eligible renewable energy technologies to generate 15 percent of annual electricity retail sales by 2021. Eligible renewable energy technologies, as defined in section 393.1025(5), RSMo, include: wind; solar thermal or solar photovoltaic; dedicated crops grown for energy production; cellulosic agricultural residues; plant residues; clean and untreated wood; methane from landfills, wastewater treatment; agricultural operations; hydropower (not including pumped storage) that does not require a new diversion or impoundment of water, and for which each generator has a nameplate rating of ten megawatts or less; fuel cells; and other sources of energy that may become certified as eligible renewable energy resources.

Missouri's RES contains a carve-out for solar resources, requiring that at a minimum two percent of the renewable energy benchmarks be met through solar photovoltaic technologies. In addition, the RES contains a renewable energy credit provision that allows utilities to meet some or all of the requirements through the purchase of renewable energy credits for energy that is generated out of state.

Although the state's RES represents an accomplishment in furthering diversification of energy resources, its RES targets are lower than those required in other parts of the country. Currently seventeen states have targets of at least 20 percent of annual electricity sales being generated from renewable energy, and six states require 25 percent or more within a comparable period of time. In addition, some states also include non-renewable technologies in their portfolio, such as CHP.

Recommendations:

- Increase the RES to 20 percent of annual retail sales by 2025.
- Establish voluntary RES goals for those electric utilities not presently required to meet the standard and provide the opportunity to demonstrate achievement of the goal and obtain credit for the investment.
- Impose reasonable limits on the use of the renewable energy credit provision of the RES.
- Seek to clarify the definition of the current one percent investment cap.
- Include the benefits provided by distributed renewable energy systems when calculating the investment cap.
- Allow CHP systems that are powered by renewable energy sources to qualify as eligible resources for meeting RES targets.

3.2 Improving Missouri's Interconnection and Net Metering Rule

Net metering and interconnection policies allow consumers with distributed generation resources to earn credits from any electricity generated by their resource that they do not consume. These policies can thus encourage the growth of distributed generation renewables by providing consumers revenue streams from the resource. To date, more than thirty states have adopted comprehensive interconnection standards that allow customer-sited renewable energy systems to connect to the electric grid, regardless of system size. In addition, more than forty states allow customers to bank electricity they have generated but not consumed, often through the form of bill credits. The effectiveness of these policies depends largely on design elements such as program cap, system capacity limit, and credit value.

In 2007 Missouri passed the Net Metering and Easy Connection Act, requiring utilities to allow certain distributed generation resources of 100 kW or less grid interconnection and to provide net metering to these systems.

The Net Metering and Easy Connection Act also requires that consumption and generation be netted every monthly billing cycle, meaning that net metered customers are compensated at the full retail value for all generation up to their monthly usage, but generation in excess of their own monthly needs is compensated at the utility's avoided cost, which is much less than the retail rate paid by the customer. This provision effectively acts as an incentive for customers to install smaller generating systems sized to meet their needs on the lowest-production month of the year and does not act as an incentive for customers to install larger systems that would generate electricity matching 100 percent of their consumption on an annual basis.

The Act does not provide for third-party ownership of net metered systems or for virtual, community or aggregated net metering, which are billing programs that may allow broader participation in distributed generation than is possible under the current provisions of the Act. In addition, the Act does not provide requirements for utilities to track and report interconnected and net-metered systems on a statewide basis, which would allow a better understanding of distributed generation resources in Missouri.

Recommendations:

- Increase the size of net-metered systems to 500 kW while retaining current statutory caps for the total rated generating capacity of net metered systems of one percent annually and five percent cumulatively of a utility's peak load.
- Require netting on an annual basis rather than a monthly basis.
- Include biogas and landfill gas renewable energy systems as net metered systems.
- Allow for virtual net metering, aggregated net metering, and third-party ownership.
- Establish a working group to develop an approach for consistent implementation of the Net Metering and Easy Connection Act that results in a fair and expedited review process for all types of renewable energy systems.
- Require the tracking and reporting of interconnected and net-metered systems by all state electric utilities.
- Establish a "Value of Solar" calculation for all net-metered customers that includes costs associated with the use of the grid as well as benefits provided by solar (or other distributed) generation.
- Use real-time or near-real-time pricing if metering infrastructure allows.

3.3 Establishing Comprehensive Solar Energy System Rights

Some local ordinances and homeowner's association rules in Missouri can prevent the installation of solar energy systems on private land, homes, and businesses, or enforce requirements that result in decreased system efficiencies. Many states are passing laws to protect the rights of property owners by limiting these restrictions.

Recommendations:

- Modify the existing solar energy property rights statutes to ensure that no rule or regulation encroaches or infringes on existing solar energy property statutes or prevents the installation or reasonable operation of solar energy systems on private property.

- Charge the Missouri Office of the Ombudsman for Property Rights with dispute resolution for conflicts involving solar property rights.

3.4 Funding Missouri's Alternative Fuel Infrastructure Tax Credit

Alternative transportation fuels can play a significant role in diversifying Missouri's energy supplies, limiting reliance on imported fuels, and reducing environmental emissions. Furthermore, some alternative fuels, such as biodiesel, can be produced within the state in dedicated refineries therefore adding to overall domestic capacity and economic productivity.

Until recently, one of the greatest barriers to the operation of alternative fuel vehicles (AFV) was the inadequate availability of infrastructure needed to support these vehicles. However, since the mid-90s our state has seen a significant increase in the number of E85 fueling stations and other alternative fuels, including electricity and compressed natural gas, have also experienced increases in the number of available fueling locations. As of the end of 2014 there are a total of 260 public AFV fueling stations and an additional 42 private stations in the state.

Through the Alternative Fuel Infrastructure Tax Credit that was passed in 2008 and extended in 2014, Missouri offers tax credits to business owners and private citizens for installing and operating alternative fueling stations that use ethanol, some forms of natural gas, biodiesel, and hydrogen, as well as electric charging stations. The Tax Credit is subject to appropriations and has played a significant role in furthering the development of alternative fuel vehicle infrastructure in our state. The credit is due to sunset in 2017 unless it is extended.

Recommendations:

- Provide annual appropriations to the Alternative Fuel Infrastructure Tax Credit.
- Re-authorize the Alternative Fuel Infrastructure Tax Credit upon sunset.

3.5 Establishing a Thermal Energy Standard

Renewable thermal technologies, including solar thermal, biomass and biogas thermal, and high efficiency heat pumps present significant opportunities for market growth, greenhouse gas emissions reduction, green job creation, and economic development in Missouri. In contrast with other renewable energy sectors like electricity or transportation fuels, Missouri has not adopted policies supporting development of renewable thermal technologies. There are no statewide financial incentives to offset the higher capital costs for renewable thermal system installations even though these systems have generally lower life cycle costs than fossil fuels due to significantly lower fuel and operational costs.

It is unclear under Missouri's existing energy efficiency and renewable energy policies if renewable thermal technologies are included and if so, whether they are categorized as energy efficiency or generation technologies or both. Complicated by the quantification of benefits and metering, renewable thermal could fail to meet cost-effectiveness requirements in current energy efficiency programs despite its low life cycle costs.

Recommendations:

- Missouri should consider the following policies, which include financial support for the nascent renewable thermal market, to diversify options for fuel used for heating, cooling, and industrial process heat purposes:
  - Technology specific financial incentive programs (performance-based or capacity-based) to encourage renewable thermal technologies at both residential and commercial levels.
  - A statewide technical reference manual that quantifies renewable thermal benefits and a process to measure and verify renewable thermal energy production.
  - Education and outreach programs to increase awareness of renewable thermal energy and non-energy benefits among policy makers, the public, and other major stakeholders such as the commercial building sector with high thermal load.
  - The inclusion of renewable thermal technologies, including renewable CHP, into Missouri's RES and/or under MEEIA.
  - Evaluation of the potential for renewable thermal and renewable CHP for new and state facilities that have significant retrofits.

3.6 Expanding Combined Heat and Power Applications

Combined heat and power systems combine on-site electricity generation with utilization of what would otherwise be waste heat, which is then used for on-site heating, cooling, dehumidification or industrial process applications. CHP energy systems create overall efficiencies of 75 percent when compared to 51 percent for separate heat and power systems.[405] The greater efficiency of CHP results from the use of waste heat and on-site energy generation, which reduces transmission and distribution costs from a large, centralized power producer. CHP offers benefits in three areas: economic, environmental, and security.

In the eight-state Midwest region (Illinois, Iowa, Indiana, Michigan, Minnesota, Missouri, Ohio, and Wisconsin), Missouri has the lowest number of CHP installations (21) and lowest installed CHP capacity (236 MW), which represents about one percent of the state's total generating capacity.[406]

A study recently conducted by the U.S. Department of Energy's (DOE) Midwest CHP Technical Assistance Partnership found that Missouri has a technical potential of over 2,500 MW of CHP. The analysis indicated that commercial buildings have the highest technical potential for CHP because of the large number of buildings and the diverse building stock. Other market sectors such as chemicals, food processing, colleges and universities, hospitals, and the pulp and paper industry are also good candidates for CHP because of high energy demands and long hours of operation.[407] The study cited interconnection into the grid as one of the biggest challenges to CHP deployment in Missouri due to lack of reasonable interconnection standards and lack of adequately constructed standby rates.

Recommendations:

- Develop a statewide CHP potential study that fully assesses both the technical and economic potential of CHP opportunities.
- Establish cost-based stand-by rates and interconnection practices that reflect best practices.

3.7 Guiding the Development of Microgrids

Microgrids are localized grids that are usually connected to the traditional grid but can disconnect from it to operate autonomously. Microgrids can play an important role in transforming Missouri's electric grid and reducing impacts of emergency events by strengthening grid resilience. In addition, microgrids can mitigate grid disturbances because they are able to continue operating while the main grid is down and they can function as a resource for faster system response and recovery.

Missouri currently does not have any policies related to the development and deployment of microgrids.

Recommendations:

- Adopt standardized microgrid interconnection requirements and develop clear rules for how microgrid owners interact with utilities.
- Develop tariff structures applicable to microgrids for Missouri utilities for review and approval by the PSC that would:
  — Not be punitive or discriminating and appropriately price various types of standby power.
  — Encourage microgrid development with an initial focus on areas of the grid that are congested or experiencing rapid demand growth.
- Require that microgrid owners and operators provide utilities with information that could affect planning including information about capacity, system design, and location.

3.8 Developing Emergency Planning Partnerships

For purposes of energy assurance planning, collaboration at all levels of government and with the public should be an ongoing effort and requires continued vigilance and training. Stakeholders involved in managing risks to critical infrastructure are wide-ranging and include partnerships among owners and operators, federal, state, and local governments, regional entities, non-profit organizations, and academia. An integrated approach across this diverse community is required in order to identify and prepare for threats, reduce vulnerabilities, and mitigate the potential consequences of adverse events that do occur.

At the national, regional, and state level, there is a general need to enhance private energy supplier participation in the energy emergency planning process. Since the majority of energy supplies are owned or operated by private business, it is important that public energy emergency planning be expanded to include private energy sector input.

Recommendations:

- Establish a working group to enhance private energy supplier participation in the overall energy emergency planning process at the local, state, regional, and national levels.

3.9 Establishing a Vulnerability Assessment Working Group

Vulnerability assessments identify critical gaps and risks to systems and facilities and help determine which vulnerabilities to mitigate and in which priority. They allow critical infrastructure community leaders to understand the most likely and severe incidents that could affect their operations and communities and use this information to support planning and resource allocation.

Vulnerability and risk assessment is a fundamental and necessary tool for energy assurance. The ability to identify risk allows energy assurance coordinators to better understand what impacts may occur as the result of various threats, risks, and vulnerabilities to vital energy infrastructure. This also allows prioritization of emergency response efforts. Only a handful of states have the resources necessary to support threat assessment on a regular basis and Missouri currently is not one of them.

Recommendations:

- Establish a vulnerability assessment working group to prioritize emergency response efforts.

3.10 Planning for Cybersecurity

A cyber-attack can be any type of offensive maneuver that targets information systems, infrastructures, or computer networks in order to steal information, destroy infrastructure, or produce some other type of vulnerability. It is particularly important to protect the energy industry from cyber-attacks, because the impact to the economy and to other industries can be significant.

Combating cyber threats is a shared responsibility. The public, private, and non-profit sectors, and every level of government all have an important role to play.

The Missouri Public Service Commission has initiated steps to review and consider cybersecurity as well as infrastructure threats to Missouri's regulated utilities. This review will include input from investor-owned electric and natural gas utilities, as well as regulated telecommunications systems.

Recommendations:

- Continue collaboration and coordination on cybersecurity.
- Perform a statewide risk assessment of public and private energy-related systems and facilities.

3.11 Planning for Smart Grid

A key solution to issues associated with aging transmission and distribution systems is the deployment of smart grid technologies. Smart grid generally refers to a class of technology that uses computer-based remote control and automation to modernize utility electricity infrastructure. Many states and utilities are deploying these technologies to support important public policy priorities including improving the reliability and resiliency of electric service, enhancing safety and security, and containing energy costs.

In Missouri, smart grid activities have primarily consisted of workshops conducted by the PSC, four federally funded demonstration projects, and deployment of advanced meter infrastructure (AMI) by a limited number of utilities, electric cooperatives, and municipalities. There has not been regulatory action in Missouri that explicitly addresses smart grid.

Recommendations:

- Establish a working group comprised of smart grid stakeholders and industry experts to develop an integrated smart grid vision and plan for Missouri that includes an assessment of benefits and costs, clearly defined desirable smart grid capabilities, and strategies to manage risks.
- Investigate potential issues related to grid security and customer privacy as it is related to smart grid, perhaps through a rulemaking docket at the PSC.

- Require Missouri utilities to submit an annual report describing the current state of smart grid technologies deployed on a utility's grid and providing an assessment of the costs and benefits of additional smart grid investments.

3.12 Grid Modernization

Accelerating grid modernization by promoting greater automation and decentralization would yield a smarter and stronger electrical grid more capable of meeting our evolving need for diversity and clean energy. Grid modernization in which communication occurs in a two-way fashion would benefit customers by empowering them to make cost-saving decisions, at the same time as it benefits utility and industry stakeholders, and generates economic growth.

In order to realize the benefits of the modern grid the state of Missouri should consider best practices from other regions and take steps to accelerate grid modernization. Similar to other leading states, Missouri should develop an effective policy that allows appropriate cost recovery to utilities for making cost effective grid modernization improvements. The policy should include performance metrics that protect the consumer and insure that the improvements benefit the public.

Recommendations:

- Develop an effective policy that allows efficient and prudent cost recovery to utilities for making grid modernization improvements that go beyond regular repair and replacement activities, so long as performance metrics are maintained in the interest of the public good and penalties are established for non-compliance.
- Grid modernization legislation should require consumer education programs targeted at the energy efficiency, demand response, and dynamic pricing elements of grid modernization activities.
- Legislation should consider both incentives for meeting minimum reliability standards and penalties for falling short of goals to better align utility, state, and customer motivations.
- The PSC, in anticipation of smart grid deployment, should create guidelines or rules about how performance-based rates should be structured.

3.13 Expedited Smart Grid Project Reviews

Even in the absence of comprehensive grid modernization legislation, some Missouri utilities are investing in grid modernization primarily targeted at improving reliability, resiliency, and operating efficiencies in centralized generation and delivery infrastructure. These investments include numerous smart grid infrastructure components ranging from smart line capacitors and microprocessor relays to Supervisory Control and Data Acquisition systems and Automated Metering Infrastructure.

Recommendations:

- The PSC should establish an expedited process to review proposed grid modernization projects in an effort to build upon the momentum that Missouri is starting to experience.
- Encourage all utilities to continue to investigate and invest in new technologies that improve the performance and capabilities of the distribution grid.

3.14 Implementing Changes to Missouri's Propane Storage and Distribution Infrastructure

Propane is of importance to Missouri because it is the primary heating fuel for approximately nine percent of households in the state. In addition, propane is used in agriculture to dry corn after harvesting and within the transportation sector as a clean-burning fuel for application in material handling equipment, landscaping equipment, public transportation, and other fleet vehicles.

As other states struggled with both propane supply and price issues during the 2013-2014 winter heating season, Missouri generally avoided disruptions and curtailments, although as demand spiked at terminals prior to scheduled price increases, propane transporters stalled and waited hours for product. This could have been avoided if on-site storage were available as opposed to the need to fill transports directly from propane pipeline.

Recommendations:

- Consider enhancing bulk terminal storage infrastructure improvements.
- Propane companies should consider a move to a metered service arrangement in which company leased tanks are fitted with meters and customers are billed only for the volume consumed.
- Credit finance opportunities should be provided by propane companies to customers so that customers can enter into monthly payment plans.
- Additional propane fleet opportunities, particularly in rural areas, should be explored to enhance summer propane demand.

3.15 Implementing Wind Tax Policy

The first utility scale wind farm in Missouri became operational in 2007 and by 2011 five additional utility scale wind farms started producing electricity. Combined, these six farms have an installed capacity of 459 MW and consist of 252 wind turbines, primarily ranging from one to two MW in capacity each.

Since 2011 no additional wind farms have been developed in the state and none are scheduled for construction. The stall in development of wind resources is partly tied to uncertainty and implementation of Missouri's Renewable Energy Standard. Another contributing factor is changes in federal policies that supported wind development during the period 2010-2012.

It is possible to encourage further development of wind energy and to maximize the supply chain for production of wind or other renewable equipment, controls, and materials. Through the establishment of policies in our state, Missouri can be more competitive with surrounding states that are capitalizing on wind resources. In addition to an effective renewable energy standard some states around the country have implemented unique tax policies that attract wind development. For instance, special property tax treatment for wind farms can further encourage development and other tax rules applicable to property, generation, or sales of equipment can also impact decisions from a developer when considering one state over another. Iowa has a renewable energy production tax credit, financing, a mandatory utility green power option, corporate tax exemption, and sales and property tax incentives.

Recommendations:

- Examine and identify effective tax policies to create stronger incentives for wind development and maximize supply chain development for renewable energy equipment in Missouri.
- Encourage all utilities to continue to actively plan for transmission needs and expand necessary infrastructure in a cost effective manner.

4. Regulatory Improvements

Modifications to our state's energy laws and regulations may be necessary to expand opportunities, deliver enhanced benefits to Missourians, and further advance our progress to meeting the goals of this Plan.

4.1 Reforming the Ratemaking Process

In our state the PSC oversees every aspect of ratemaking for investor-owned electric, natural gas, and water utilities. The PSC is composed of five commissioners who are appointed by the Governor with advice and consent of the Missouri Senate. The PSC Staff is a party to all PSC cases, takes positions on issues, and files recommendations to the Commission. The Public Counsel is the official state utility consumer advocate and is also a party to all PSC cases. Other parties may include individual energy consumers or their trade associations, environmental organizations, or other interest groups. The Commission itself is responsible for ruling on these proceedings, although parties may come to agreement during negotiations. The Division of Energy also intervenes in many PSC cases related to energy, in order to advocate for the efficient use of diverse energy resources.

Recommendations:

- Convene interested stakeholders for an in-depth examination of current ratemaking practices with a goal of making feasible improvements and exploring:
  - Time-differentiated rates
  - Forward test year for expense items
  - Decoupling
  - Performance-based rates
  - Street lighting rate reform
  - Recovery mechanism for grid modernization activities
  - Utility business models

4.2 Clarifying Green Power Purchasing

Many customers of electric utilities are interested in the purchase of electricity generated from renewable resources even though their utility may have limited renewable energy assets as part of their generation portfolio. In response to this customer interest some utilities offer green power plans that provide customers with an option to pay a premium so that the electricity provided to them is purchased from renewable sources.

Under green power plans it is often unclear to a customer what types of renewable energy sources are supported and whether that energy is produced in or out of state. In addition, some green power plans consist entirely of the purchase and retirement of Renewable Energy Certificates rather than the purchase of electricity. Developing standardized terms and conditions for green power plans can promote fair, accurate, and consistent marketing of green power plans thereby providing customers with the information and clarity necessary for knowledgeable decision-making.

Recommendations:

- Develop standardized terms and conditions through which green power plans can be offered to customers in an effort to increase transparency and availability.

4.3 Establishing Appliance and Equipment Standards

Federal law sets minimum energy efficiency standards for many types of appliances and equipment. Products covered by these standards represent approximately 90 percent of home energy use, 60 percent of commercial building use, and 29 percent of industrial energy use. States have authority to develop and set standards for appliances and equipment (such as televisions, water dispensers, and audio equipment) that are not regulated at the federal level. In addition, federal law does not preempt states from setting appliance and equipment standards that are more stringent than federal requirements. Although eleven states have exercised their authority to set state-level standards for appliances, Missouri has not.

In Missouri, as a means of incentivizing the purchase of ENERGY STAR® appliances, every year there is a one-week period where certified new appliances are exempt from state sales tax. Called the Show-Me Green Sales Tax Holiday, local jurisdictions can choose whether they want to participate in this program.

Recommendations:

- Determine the overall net costs and benefits of setting Missouri-specific standards for certain appliances and equipment.
- Expand the length of the annual, one-week "Show-Me Green" sales tax holiday that waives sales tax on ENERGY STAR® appliances.

4.4 Establishing On-Bill Financing Opportunities

On-bill financing and repayment programs allow customers to receive upfront funding from utilities or third parties for energy efficiency improvements that is conveniently repaid to the lender on the customer's monthly utility bill.

To date 21 states have enacted on-bill financing programs that lower or eliminate upfront installation costs and spread payments for efficiency improvements over time; however, Missouri is not one of them.

Recommendations:

- Establish a "bill neutral" on-bill financing program applicable to investor-owned utilities for energy efficiency and renewable energy equipment.
- Investigate methods that would allow municipalities and cooperatives to offer on-bill financing to their customers.

5. Innovation, Emerging Technologies, and Job Creation

Investing in energy innovation through research initiatives, development of a skilled and dedicated workforce, fostering education of the public, and supporting local industry will position Missouri to meet the goals outlined in this Plan. By promoting a business climate of innovation and creativity it will be possible to attract new businesses that focus on clean technologies and that bring jobs to our state.

5.1 Facilitating Public-Private Investments in Resources and Technology

Missouri is uniquely situated to become the world's hub for the research, development, production, and advancement of lead-acid batteries. For most of the late 19th and early 20th centuries Missouri was the global leader in lead production and even today some of the largest remaining lead deposits in the world are located in southeast Missouri.

Lead-acid batteries currently provide energy storage solutions for vehicles, traditional and renewable power, telecommunications, and more. Advanced "lead-carbon" batteries can now offer a lower-cost alternative to Li-ion batteries for hybrid electric vehicles and have the potential to drive the use of renewable energy through the advancement of low-cost grid-scale energy storage by utilizing a local resource that is over 95 percent recyclable.

Recommendations:

- Develop a comprehensive economic development proposal that includes resource extraction, processing, product development and manufacturing, research and development, as well as end of life recycling for the advancement of lead-acid batteries.
- Pursue initiatives to identify resources and invest in technologies and other measures that make the electricity sector more resilient.

5.2 Pursuing Economic Development Opportunities For Research, Development and Production of Small Modular Reactors In Missouri

Small modular reactors (SMR) present potential for energy job growth in Missouri. SMRs will be highly compact, safe, and reliable reactors that make nuclear power an attractive option for a variety of electric energy providers. Missouri is an ideal state to develop SMRs because of its outstanding workforce, powerhouse research institutions, strong support for nuclear power, and central location along two major rivers.

Recommendations:

- Continue the broad collaboration of utilities, universities, government, and others to pursue the economic development opportunities from the research related to, and production of, SMRs in Missouri.

5.3 Monitoring the Status of Carbon Capture and Storage Pilot Projects

Carbon Capture and Storage (CCS) is a technology that can capture up to 90 percent of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes preventing CO_2, a greenhouse gas, from entering the atmosphere.

As recommended by the 2009 Joint Interim Committee on Missouri's Energy Future Report, carbon sequestration and other methods of accomplishing the goal of producing cleaner energy from coal should be encouraged because Missouri may be dependent on coal for a substantial percentage of our energy needs for many years.[408] The Missouri Technology Corporation has invested in companies developing technologies that could lead to advances in CCS that are related to enzyme production and stabilization. Some of these processes were developed in partnership with Missouri's universities. There is also the potential for U.S. DOE funding assistance for research, development, and demonstration of CCS technologies.

Recommendations:

- Continue to monitor the status of CCS pilot projects.
- Encourage and support research and development through Missouri's universities.
- Explore future opportunities with the U.S. DOE.
- Support market innovation and development through the Department of Economic Development and the Missouri Technology Corporation.

5.4 Developing Hydroelectric Potential at Existing Facilities

According to a U.S. DOE Water Power Program evaluation of the potential for additional hydropower from non-powered dams, there is a technical potential to add up to 12.1 GW (12,100 MW) at non-powered dams (NPDs) in the U.S. The following locks and dams along the upper Mississippi River bordering Illinois and Missouri were identified in the report as having potential:

- The Melvin Price Locks and Dam in Alton, Illinois, which has a generation potential of 299 MW, and has the fifth largest potential of all the non-powered dams in the country.[409]

- Lock & Dams 25 (Winfield, Missouri) and 24 (Clarksville, Missouri), which have about 147 MW of potential each. They rank in the top 15 nationally.

- Mississippi River Dams 20 (Canton, Missouri), 21 (Hannibal, Missouri) and 22 (Ashburn, Missouri), which each have around 90 MW of potential.

In addition, according to the MDNR Educator's Guide, a total of 29 additional hydroelectric sites have been identified in Missouri.[397] Several of these potential sites are located on Ozark riverways where development would be inappropriate for environmental and cultural reasons.

Recommendations:

- Missouri should monitor future U.S. DOE evaluations on the economic potential and other considerations for development of hydropower from non-powered dams for hydropower generation that could benefit Missouri.

5.5 Co-firing Biomass

As a major producer of agricultural and forest commodities in the nation, Missouri has an abundant resource base for biomass energy.

Although the state has significant biomass resources, Missouri currently ranks in the bottom quartile for statewide production of energy from biomass. The National Renewable Energy Laboratory estimates that the state has approximately 18.44 million tons of yearly available biomass resources, with the majority consisting of crop residues and switchgrass.

As a near term, low-cost option for efficiently and cleanly converting biomass to electricity, co-firing biomass with coal makes use of the existing infrastructure investments for coal power plants and offers several economic and environmental benefits such as lower fuel costs, more fuel flexibility, reduced waste to landfills, and reductions in sulfur oxides, nitrogen oxides, mercury, and net carbon dioxide emissions. Current policies do not recognize a number of co-firing's unique benefits including baseload capabilities, high reliability, and flexibility. As one of a very few renewable energy resources that can produce baseload power, various types of biomass, in particular woody biomass, should be incorporated into the state's electricity generation portfolio.

Recommendations:

- Create a Biopower Stakeholders Working Group to investigate and solve many issues around biomass co-firing such as feedstock logistics, forest management, and environmental and public health concerns, and propose policy changes if appropriate.

5.6 Encouraging K-12 Collaboration

Education is vital to economic development and our energy future and energy education is just as important. The support for science, technology, engineering, and mathematics education is concordant with energy, as each discipline attempts to explain a component of energy development. Supporting kindergarten through high school (K-12) education ensures a strong workforce better prepared to respond to today's challenges. To accomplish this, the Division of Energy can work with the Department of Elementary & Secondary Education and other stakeholders to develop a "Best Practices for Energy Education in Missouri K-12 Schools" and to develop a joint energy-related curriculum offering for varying grade levels.

Recommendations:

- The Division of Energy and the Department of Elementary & Secondary Education should collaborate to create energy education curriculum at the K-12 level.

5.7 Encouraging Workforce Development and Higher Education Collaboration

Access to a skilled workforce is especially important for economic growth, as illustrated by the fact that more than 75 percent of manufacturers in the nation report a moderate to severe shortage of skilled workers.

Job training can help workers master the increased use of computers, automation, data management and smarter technology in energy-related fields. Higher education institutions must offer appropriate courses and curricula in order to prepare students for energy-related research and development and energy careers. The Division of Energy can work with the Department of Higher Education and other stakeholders, including the Department of Labor and Industrial Relations and the Division of Workforce Development, to develop a "Best Practices for Energy Education in Missouri Institutions of Higher Education." The collaboration would include:

1. Encouraging the inclusion of energy-related courses or sessions for teacher training and certificate programs;

2. When training future workers and researchers in energy related fields, promoting the sharing of offerings provided by Missouri institutions by encouraging better communication among higher education institutions.

3. Working to identify and highlight all energy-related workforce training offerings, educational courses, research, and programs.

4. Supporting the increase of communication efforts within and among institutions. Using identified offerings in combination with information on needed workforce job skills to assess and fill gaps in energy-related coursework or internships.

5. Continue collaborating with the "Make it in America" grant as well as the Small Modular Reactor Research and Education Consortium (SMRrec) and the Microgrid Research and Education Consortium.

6. Assisting with funding opportunities through public and private funding partners and governmental programs.

Recommendations:

- The Division of Energy, the Department of Higher Education and other stakeholders including the Department of Labor and Industrial Relations and the Division of Workforce Development should collaborate to develop a "Best Practices for Energy Education in Missouri Institutions of Higher Education" program.

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Table of Acronyms

AAO	Accounting Authority Orders
ACA	Actual Cost Adjustment
ACEEE	American Council For An Energy-Efficient Economy
AFS	Automated Feeder Switching
AFV	Alternative Fuel Vehicle
AMI	Advanced Metering Infrastructure
AMR	Advance Meter Reading
APPA	American Public Power Association
ARRA	American Recovery And Reinvestment Act
AWEA	American Wind Energy Association
BAS	Building Automation System
BCF	Billion Cubic Feet
BOC	Building Operator Certification
BTU	British Thermal Unit
CAA	Community Action Agencies
CAES	Compressed Air Energy Storage
CAFE	Corporate Average Fuel Economy
CBECS	Commercial Buildings Energy Consumption Survey
CCS	Carbon Capture and Storage
CCW	Coal Combustion Waste
CDP	Carbon Disclosure Project
CF	Cubic Feet
CH_4	Methane
CHP	Combined Heat And Power
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CVR	Conservation Voltage Reduction
DG	Distributed Generation
DHS	United States Department of Homeland Security
DMS	Distribution Management Systems
DOE	United States Department of Energy
DOT	United States Department of Transportation
DSIM	Demand-Side Programs Investment Mechanism
ECIP	Energy Crisis Intervention Program
EECBG	Energy Efficiency And Conservation Block Grant
EEI	Edison Electric Institute
EERS	Energy Efficiency Resource Standards

EIA	United States Energy Information Administration
EISA	Energy Independence And Security Act
EM&V	Evaluation, Measurement, and Verification
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ESCO	Energy Services Company
ESPC	Energy Savings Performance Contract
EUI	Energy Use Intensity
FAC	Electric Fuel Adjustment Clause
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	U.S. Department of Transportation Federal Highway Adm
FLISR	Fault Location, Isolation, And Service Restoration
FRA	Federal Railroad Administration
GHG	Greenhouse Gas
GPR	Green Project Reserve
GSHP	Ground Source Heat Pump
GSP	Gross State Product
GWh	Gigawatt Hours
HB	House Bill
HFC	Hydrofluorocarbons
HVAC	Heating, Ventilation, And Air Conditioning
ICC	International Code Council
IEC	Electric Interim Energy Charge
IECC	International Energy Conservation Code
IOU	Investor Owned Utility
IPP	Independent Power Producer
IRP	Integrated Resource Plan
ISO	Independent System Operators
ISRS	Infrastructure System Replacement Surcharge
IT	Information Technology
KCP&L	Kansas City Power And Light Company
KCP&L-GMO	KCP&L Greater Missouri Operations Company
kW	Kilowatt
kWh	Kilowatt Hour
LCOE	Levelized Costs Of Energy
LDC	Local Distribution Company
LEED	Leadership In Energy And Environmental Design
LIHEAP	Low-Income Home Energy Assistance Program
LIHTC	Low-Income Housing Tax Credit
LIWAP	Low-Income Weatherization Assistance Program
LMOP	EPA's Landfill Methane Outreach Program

LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
m	Meter
MCF	Thousand Cubic Feet
MDA	Missouri Department of Agriculture
MDNR	Missouri Department of Natural Resources
MEAP	Missouri Energy Assurance Plan
MED	Major Event Days
MEEIA	Missouri Energy Efficiency Investment Act
MERIC	Missouri Economic Research and Information Center
MGD	Million Gallons Per Day
MGE	Missouri Gas Electric
MHDC	Missouri Housing Development Commission
MII	Manufacturing Innovation Institutes
MISO	Midcontinent Independent System Operator
MBTU	Million British Thermal Units
MMGY	Million Gallons Per Year
mmscfd	Million Standard Cubic Feet Per Day
MMT	Million Metric Tons
MMTher	Million Therms
MoDOT	Missouri Department Of Transportation
MPG	Miles Per Gallon
MSA	Missouri Soybean Association
MSMC	Missouri Soybean Merchandising Council
MW	Megawatt
MWh	Megawatt Hour
N_2O	Nitrous Oxide
NAICS	North American Industry Classification System
NARUC	National Association Of Regulatory Utility Commissioner
NASEO	National Association Of State Energy Officials
NO_x	Nitrogen Oxides
NPD	Non-Powered Dams
NRC	United States Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NTSB	National Transportation Safety Board
O_3	Ozone
OCS	Missouri Office Of Cyber Security
OMS	Outage Management Systems
PACE	Property Assessed Clean Energy
PFC	Perfluorocarbons
PGA	Purchased Gas Adjustment
PHMSA	Pipeline and Hazardous Materials Safety Administration

PM	Particulate Matter
PPA	Power Purchase Agreement
PSC	Missouri Public Service Commission
PV	Photovoltaic
REA	Rural Electrification Administration
RECS	Residential Energy Consumption Survey
RES	Renewable Energy Standard
RESRAM	Renewable Energy Standard Rate Adjustment Mechanisı
REX	Rockies Express Pipeline
RTO	Regional Transmission Organization
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SEDS	EIA State Energy Data System
SEMA	State Emergency Management Agency
SF_6	Sulfur Hexafluoride
SGIG	Smart Grid Investment Grants
SMR	Small Modular Reactor
SO_2	Sulfur Dioxide
SOC	Security Operations Center
SPP	Southwest Power Pool
SRF	State Revolving Fund
STEM	Science, Technology, Engineering And Mathematics
TBTU	Trillion British Thermal Units
TCF	Trillion Cubic Feet
THIRA	Threat and Hazard Identification and Risk Assessment
TOU	Time-of-Use
TRM	Technical Reference Manual
USDA	United States Department of Agriculture
VOCs	Volatile Organic Compounds
WHEEL	Warehouse for Energy Efficiency Loans
WNC	West North Central

Glossary

Concept	Definition
Advanced Metering Infrastructure	Advanced metering infrastructure is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers. Customer systems include in-home displays, home area networks, energy management systems, and other customer-side-of-the-meter equipment that enable smart grid functions in homes, offices, and factories.
Alternative Fuel Vehicles	A vehicle designed to operate on an alternative fuel (e.g., compressed natural gas, electricity). The vehicle could be either a dedicated vehicle designed to operate exclusively on alternative fuel or a non-dedicated vehicle designed to operate on alternative fuel and/or a traditional fuel.
Alternative Fuels	For transportation applications, include the following: methanol, denatured ethanol, and other alcohols, fuel mixtures containing 85 percent or more by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels, natural gas, liquefied petroleum gas (propane), hydrogen, coal-derived liquid fuels, fuels (other than alcohol) derived from biological materials (biofuels such as soy diesel fuel), electricity (including electricity from solar energy), and "... any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits." The term "alternative fuel" does not include alcohol or other blended portions of primarily petroleum-based fuels used as oxygenates or extenders, i.e. MTBE, ETBE, other ethers, and the 10-percent ethanol portion of gasohol.
Biodiesel	A fuel typically made from soybean, canola, or other vegetable oils; animal fats; and recycled grease. It can serve as a substitute for petroleum-derived diesel or distillate fuel. Biodiesel can be used in its pure form (B100) or blended with petroleum diesel. Common blends include B2 (2% biodiesel), B5, and B20. Most vehicle manufacturers approve blends up to B5, and some approve blends up to B20.
Biofuels	Liquid fuels and blending components produced from biomass feedstocks, used primarily for transportation.
Biogas	Biogas is usually 50%-80% methane and 20%-50% carbon dioxide, with traces of gases such as hydrogen, carbon monoxide, and nitrogen. In contrast, natural gas is usually more than 70% methane, with most of the rest being other hydrocarbons (such as propane and butane) and traces of carbon dioxide and other contaminants.
Biomass	Organic nonfossil material of biological origin constituting a renewable energy source.
Bituminous Coal	A dense coal, usually black, sometimes dark brown, often with well-defined bands of bright and dull material, used primarily as fuel in steam-electric power generation, with substantial quantities also used for heat and power applications in manufacturing and to make coke.
British Thermal Units	The British thermal unit (BTU) is a traditional unit of energy that represents the amount of energy needed to cool or heat one pound of water by one degree Fahrenheit. The notation MBTU is defined as one thousand BTU, and the notation MMBTU represents one million BTU.
Brownfield Sites	With certain legal exclusions and additions, the term "brownfield site" means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.
Buildings Sector	For purposes of this Plan, consists of a combination of the residential and commercial sectors, which primarily use energy in built structures.
Capacity	The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for ambient conditions.
Brownfield Sites	With certain legal exclusions and additions, the term "brownfield site" means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.
Buildings Sector	For purposes of this Plan, consists of a combination of the residential and commercial sectors, which primarily use energy in built structures.
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Concept	**Definition**
Carbon Dioxide (CO2)	A colorless, odorless, non-poisonous gas that is a normal part of Earth's atmosphere. Carbon dioxide is a product of fossil-fuel combustion as well as other processes. It is considered a greenhouse gas as it traps heat (infrared energy) radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming.
Cellulosic Ethanol	Cellulosic feedstocks are non-food based feedstocks that include crop residues, wood residues, dedicated energy crops, and industrial and other wastes. These feedstocks are composed of cellulose, hemicellulose, and lignin (typically extracted to provide energy for production).
Class 1,2,3 and 4 Counties	Per Mo Rev Statute 48.020, all counties in Missouri are classified for the purpose of establishing organization and powers in accordance with the provisions of section 8, article VI, Constitution of Missouri. Missouri classifies counties based on the assessed value of the property (over a five year period) in each county. As such, there are four county "classes" in Missouri: 17 counties are considered Class 1; four counties are considered Class 2; 89 counties are considered Class 3; and four counties are considered Class 4.
Coal Ash	Coal combustion residuals (CCRs), commonly known as coal ash, are byproducts of the combustion of coal at power plants by electric utilities and independent power producers.
Coal-bed Methane	Methane is generated during coal formation and is contained in the coal microstructure. Typical recovery entails pumping water out of the coal to allow the gas to escape. Methane is the principal component of natural gas. Coal-bed methane can be added to natural gas pipelines without any special treatment.
Combined Heat And Power	Combined heat and power is an efficient and clean approach to generating electric power and useful thermal energy from a single fuel source. CHP places power production at or near the end-user's site so that the heat released from power production can be used to meet the user's thermal requirements while the power generated meets all or a portion of the site electricity needs.
Commercial Sector	An energy-consuming sector that consists of service-providing facilities and equipment of businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment.
Community or Shared Solar Energy	Shared renewable energy arrangements allow several energy customers to share the benefits of one local renewable energy power plant. When the power is supplied strictly by solar energy, it is sometimes called "community solar."
Comparison States	For purposes of this Plan, the states that have been used to benchmark different energy metrics in comparison to Missouri. The states that are part of the comparison group include: Kansas, Illinois and Iowa. In addition, most data provided in this Plan compares energy metrics to the U.S. average. These states were selected because of their geographic proximity to Missouri, similar climate and industries
Compressed Air Energy Storage	The basic idea of CAES is to capture and store compressed air in suitable geologic structures underground when off-peak power is available or additional load is needed on the grid for balancing. The stored high-pressure air is returned to the surface and used to produce power when additional generation is needed, such as during peak demand periods.
Compressed Natural Gas	Natural gas compressed to a pressure at or above 200-248 bar (i.e., 2900-3600 pounds per square inch) and stored in high-pressure containers. It is used as a fuel for natural gas-powered vehicles.
Cooperative Electric Utility	An electric utility legally established to be owned by and operated for the benefit of those using its service. The utility company will generate, transmit, and/or distribute supplies of electric energy to a specified area not being serviced by another utility. Such ventures are generally exempt from Federal income tax laws. Most electric cooperatives have been initially financed by the Rural Utilities Service (prior Rural Electrification Administration), U.S. Department of Agriculture.
Cost-Effectiveness Tests	Energy efficiency cost-effectiveness is measured by comparing the benefits of an investment with the costs associated with that same investment.

Concept	Definition
Criteria Pollutants	The federal Environmental Protection Agency (EPA) regulates six criteria air pollutants harmful to public health and the environment: sulfur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO), particulate matter smaller than 10 μm (PM10) or smaller than 2.5 μm (PM2.5), ground-level ozone (O3), and lead.
Decommission ing	The process of safely taking a plant offline and removing it from service.
Deregulation	The elimination of some or all regulations from a previously regulated industry or sector of an industry.
Distributed Generation	Refers to electricity that is produced at or near the point where it is used. Some common examples include rooftop solar panels, energy storage devices, fuel cells, microturbines, small wind, and combined heat and power systems.
Demand Side Management (DSM)	The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of energy usage (electric or natural gas), including the timing and level of energy demand. It refers to only energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shaped changes arising from the normal operation of the marketplace or from government-mandated energy efficiency standards. Demand-side management covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.
E85	A fuel containing a mixture of 85 percent ethanol and 15 percent gasoline.
Electric Motor Vehicle	A motor vehicle powered by an electric motor that draws current from rechargeable storage batteries, fuel cells, photovoltaic arrays, or other sources of electric current.
Electric Power Sector	An energy-consuming sector that consists of electricity only and combined heat and power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public—i.e., North American Industry Classification System 22 plants.
Energy Assurance	Defined as a set of actions and projects to ensure key assets will function and deliver services during an energy emergency – also referred to as Energy Resiliency or Energy Security.
Energy Efficiency	A ratio of service provided to energy input (e.g., lumens to watts in the case of light bulbs). Services provided can include buildings-sector end uses such as lighting, refrigeration, and heating: industrial processes; or vehicle transportation. Unlike conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service. May also refer to the use of technology to reduce the energy needed for a given purpose or service.
Energy Efficiency Resource Standards (EERS) Or Energy Efficiency Portfolio Standards (EEPS)	State policies that require utilities to meet specific targets for energy savings according to a set schedule. EERS policies establish separate reduction targets for electricity sales, peak electric demand and/or natural gas consumption. In most cases, utilities must achieve energy savings by developing demand-side management (DSM) programs, which typically provide financial incentives to customers to install energy-efficient equipment. An EERS policy is sometimes coupled with a state's renewables portfolio standard (RPS). In these cases, energy efficiency is typically included as a lower-tier resource. EERS policies are also known as Energy Efficiency Portfolio Standards (EEPS).[1]
Energy Savings Performance Contract	An ESPC is an agreement between a facility and an Energy Services Company (ESCO). The ESCO designs a project to increase the energy efficiency at a facility. The ESCO then purchases and installs the necessary equipment, such as new energy-efficient windows, automated controls, and updated heating, ventilation, and air conditioning equipment. In exchange for not having to pay for the equipment, the facility manager promises to pay the company a share of the savings resulting from the energy efficiency improvements. The ESCO is responsible for maintaining the equipment, as well as measuring the energy consumption and savings.
ENERGY STAR® Portfolio Manager	Portfolio Manager is an interactive energy management tool that allows users to track and assess energy and water consumption across an entire portfolio of buildings in a secure online environment.
Energy Use Intensity	Expresses a building's energy use as a function of its size or other characteristics, usually as energy per square foot per year.

[1]DSIRE. http://www.dsireusa.org/support/glossary/

Concept	Definition
Ethanol	A clear, colorless, flammable alcohol. Ethanol is typically produced biologically from biomass feedstocks such as agricultural crops and cellulosic residues from agricultural crops or wood. Ethanol can also be produced chemically from ethylene. Fuel ethanol: ethanol intended for fuel use. Fuel ethanol in the United States must be anhydrous (less than 1 percent water). Fuel ethanol is denatured (made unfit for human consumption), usually prior to transport from the ethanol production facility, by adding 2 to 5 volume percent petroleum, typically pentanes plus or conventional motor gasoline. Fuel ethanol is used principally for blending in low concentrations with motor gasoline as an oxygenate or octane enhancer. In high concentrations, it is used to fuel alternative-fuel vehicles specially designed for its use.
Flex-Fuel Vehicles	Flexible fuel vehicles are designed to run on gasoline or gasoline-ethanol blends of up to 85% ethanol (E85).
Geothermal Energy	Geothermal energy is a renewable energy resource that represents heat from the earth. Geothermal resources are reservoirs of hot water that exist at varying temperatures and depths below the Earth's surface. Mile-or-more-deep wells can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface for use in a variety of applications, including electricity generation, direct use, and heating and cooling.
Greenhouse Gases	Greenhouse gases are gases that trap heat in the atmosphere. The Environmental Protection Agency recognizes the following gases as greenhouse gases: Carbon Dioxide, Methane, Nitrous Oxide, and Fluorinated Gases.
Gross State Product (GSP)	GSP is the state counterpart of the Nation's gross domestic product, the Bureau's featured and most comprehensive measure of U.S. economic activity. GSP is derived as the sum of value added from all industries in the state.
Ground-Level Ozone	Ground level ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma.
Ground-Source Heat Pumps	A Ground Source Heat Pump is a central building heating and/or cooling system that takes advantage of the relatively constant year-round ground temperature to pump heat to or from the ground.
Home-Rule	The power of a local city or county to set up its own system of governing and local ordinances without receiving a charter from the state, which comes with certain requirements and limitations.
Hydraulic Fracturing	Commonly called fracking, is a method for mining natural gas. The method involves injecting high-pressure solutions (chemicals, sand and water) through wells to create cracks in deep rock formations to remove natural gas.
Hydroelectric Energy	The use of flowing water to produce electrical energy.
Independent Power Producers	A corporation, person, agency, authority, or other legal entity or instrumentality that owns or operates facilities for the generation of electricity for use primarily by the public, and that is not an electric utility.
Industrial Sector	An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity manufacturing (NAICS codes 31-33); agriculture, forestry, fishing and hunting (NAICS code 11); mining, including oil and gas extraction (NAICS code 21); and construction (NAICS code 23). Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products.
Integrated Resource Planning	An integrated resource plan is a utility plan for meeting forecasted annual peak and energy demand, plus some established reserve margin, through a combination of supply-side and demand-side resources over a specified future period.
Interconnection	Two or more electric systems having a common transmission line that permits a flow of energy between them. The physical connection of the electric power transmission facilities allows for the sale or exchange of energy.
Investor-Owned Utilities	A privately owned electric utility whose stock is publicly traded. It is rate regulated and authorized to achieve an allowed rate of return.

Concept	Definition
Kilowatt-hour (kWh)	A unit of energy equal to that expended by one kilowatt in one hour. Energy sold by utilities to customers is typically measured in kWh within a billing period (month or year).
Kyoto Protocol	The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.
LEED Certified Buildings	LEED, or Leadership in Energy & Environmental Design, is a green building certification program operated by the U.S. Green Building Council that recognizes best-in-class building strategies and practices.
Levelized Costs	Levelized cost of electricity (LCOE) is often cited as a convenient summary measure of the overall competiveness of different generating technologies. It represents the per-kilowatt hour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle. Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance costs, financing costs, and an assumed utilization rate for each plant type.
Lignite Coal	The lowest rank of coal, often referred to as brown coal, used almost exclusively as fuel for steam-electric power generation. It is brownish-black and has a high inherent moisture content, sometimes as high as 45 percent The heat content of lignite ranges from 9 to 17 million BTU per ton on a moist, mineral-matter-free basis. The heat content of lignite consumed in the United States averages 13 million BTU per ton, on the as-received basis (i.e. containing both inherent moisture and mineral matter).
Megawatt (MW)	A unit of power equal to one million watts, especially as a measure of the output of a power station. Megawatts are usually a representation of the capacity that electrical power plants have to generate energy at a given point in time.
Methane (CH4)	A colorless, flammable, odorless hydrocarbon gas, which is the major component of natural gas. It is also an important source of hydrogen in various industrial processes. Methane is a greenhouse gas.
Microgrid	Localized grids that can disconnect from the traditional grid to operate autonomously.
Midwest Region (U.S. Census)	Defined by the U.S. Department of Commerce, Bureau of the Census as: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
Mobile Homes	A housing unit built on a movable chassis and moved to the site. It may be placed on a permanent or temporary foundation and may contain one room or more. If rooms are added to the structure, it is considered a single-family housing unit. A manufactured house assembled on site is a single-family housing unit, not a mobile home.
Municipal Utility	A municipal utility district is a special-purpose district or other governmental jurisdiction that provides public utilities (such as electricity, natural gas, sewage treatment, waste collection/management, wholesale telecommunications, water) to district residents.
Natural Gas	A gaseous mixture of hydrocarbon compounds, the primary one being methane.
Net Metering	For electric customers who generate their own electricity, net metering allows for the flow of electricity both to and from the customer – typically through a single, bi-directional meter. When a customer's generation exceeds the customer's use, electricity from the customer flows back to the grid, offsetting electricity consumed by the customer at a different time during the same billing cycle. In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to purchase at the utility's full retail rate.[2]
Non-Attainment Zones	Any area that does not meet, or that contributes to ambient air quality in a nearby area that does not meet, the national primary or secondary ambient air quality standard for a criteria pollutant.
Oil Sands	Oil sand is a naturally occurring mixture of sand, clay or other minerals, water and bitumen, which is a heavy and extremely viscous oil that must be treated before it can be used by refineries to produce usable fuels such as gasoline and diesel.
On-Bill Financing	On-bill financing programs allow utility customers to receive funding from utilities or third parties for energy efficiency improvements that is repaid through a surcharge on the customer's monthly utility bill.
Particulate Matter	Also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Particulate Matter is identified as a criteria pollutant by EPA.

[2]DSIRE. http://www.dsireusa.org/support/glossary/

Concept	Definition
Peak Demand	The maximum load during a specified period of time.
Poverty Level	Following the Office of Management and Budget's Statistical Policy Directive 14, the Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically (with the exceptions of Hawaii and Alaska), but they are updated for inflation using Consumer Price Index. The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits.
Power Purchase Agreement	A Power Purchase Agreement is a contract between one party that generates electricity, the seller, and a party, usually an electricity distribution utility, who purchases the electricity.
Propane or LPG	Any fuel gas supplied to a building in liquid form, such as liquefied petroleum gas, propane, or butane. It is usually delivered by tank truck and stored near the building in a tank or cylinder until used.
Public Benefits Charges	A mandatory financial charge imposed by State, Tribal, or Federal law upon a customer under its jurisdiction to support one or more of the following: energy efficiency, conservation, or demand-side management; renewable energy; efficiency or alternative energy-related research and development; low-income energy assistance; and/or other similar programs defined by applicable State, Tribal, or Federal law. This term is also known as a public goods or system benefit charge in the utility industry.
Pumped Storage	A plant that usually generates electric energy during peak load periods by using water previously pumped into an elevated storage reservoir during off-peak periods when excess generating capacity is available to do so. When additional generating capacity is needed, the water can be released from the reservoir through a conduit to turbine generators located in a power plant at a lower level.
Renewable Energy Resources	Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.
Renewable Energy Standard	A renewable energy standard, also called renewable portfolio standard, is a regulatory mandate to increase production of energy from renewable sources such as wind, solar, biomass and other alternatives to fossil and nuclear electric generation. It's also known as a renewable electricity standard.
Residential Sector	An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters.
Retail Prices (Electricity And Natural Gas, Gasoline)	The total price charged for a product sold to a customer, which includes the manufacturer's cost plus a retail markup.
Shale Gas	Natural gas produced from wells that are open to shale formations. Shale is a fine-grained, sedimentary rock composed of mud from flakes of clay minerals and tiny fragments (silt-sized particles) of other materials. The shale acts as both the source and the reservoir for the natural gas.
Silica	A grey-white powder soluble in alkali and water, insoluble in alcohol and acid. Used to fireproof textiles, in petroleum refining and corrugated paperboard manufacturing, and as an egg preservative. Also referred to as liquid gas, silicate of soda, sodium metasilicate, soluble glass, and water glass.
Smart Grid	Refers to a class of technology being used to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers, mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users' homes and offices.

Concept	Definition
Solar Photovoltaic (Solar Electric)	Energy radiated by the sun as electromagnetic waves (electromagnetic radiation) that is converted into electricity by means of solar (photovoltaic) cells.
Solar Thermal	Form of energy and a technology for harnessing solar energy to generate thermal energy or electrical energy for use in industry, and in the residential and commercial sectors. Solar thermal collectors are classified by the United States Energy Information Administration as low-, medium-, or high-temperature collectors.
Split Incentive	A form of market failure that exists when the benefits of a transaction accrue to someone other than the party paying the cost.
Thermal Energy Storage	The storage of heat energy during utility off-peak times at night, for use during the next day without incurring daytime peak electric rates.
Transit-Oriented Development	Refers to residential areas and commercial centers designed to maximize access by transit and non-motorized transportation, and with other features to encourage public transit ridership.
Transportation	An energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles; trucks; buses; motorcycles; trains, subways, and other rail vehicles; aircraft; and ships, barges, and other waterborne vehicles. Vehicles whose primary purpose is not transportation (e.g., construction cranes and bulldozers, farming vehicles, and warehouse tractors and forklifts) are classified in the sector of their primary use.
Weatherization	Comprises a comprehensive series of energy efficiency measures that are based on sophisticated analyses of individual homes. These analyses take the whole-house approach, which maximizes energy and dollar savings. Because of this rigorous approach and analyses backing it up, weatherization has become a leader in advancing home energy science and in helping spawn a new industry providing home energy efficiency services to the wider public.
West North Central Division (U.S. Census)	Defined by the U.S. Department of Commerce, Bureau of the Census as: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota. The WNC Division is part of the Midwest Region.
Wind Energy	Kinetic energy present in wind motion that can be converted to mechanical energy for driving pumps, mills, and electric power generators.
Zero Net Energy Buildings	A residential or commercial building with greatly reduced energy needs. In such a building, efficiency gains have been made such that the balance of energy needs can be supplied with renewable energy technologies.

Appendix A– Acknowledgements

The Missouri Comprehensive State Energy Plan (Plan) is the product of the dedication and hard work of more than 300 stakeholders. We would like to recognize and thank those who participated by providing input and analysis into the development of this Plan including members of the Steering Committee, members of Working Groups who contributed throughout the process and members of the public who shared their opinions and ideas with us.

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Appendix B – Energy Policy Inventory

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Alternative Fueling Infrastructure Tax Credit	Missouri	Business owners and private citizens may be allowed a tax credit for the installation and operation of a qualified alternative fuel vehicle refueling property, subject to appropriations. An income tax credit is available for the cost of constructing a qualified alternative fueling station. The credit is 20% of the costs directly associated with the purchase and installation of any alternative fuel storage and dispensing equipment or electric vehicle supply equipment, up to $15,000 for individuals or $20,000 for businesses. Eligible fuels include any mixture of biodiesel and diesel fuel, as well as fuel containing at least 70% of the following alternative fuels: ethanol, compressed natural gas, liquefied natural gas, liquefied petroleum gas or propane, hydrogen, and electricity. This tax credit expires on January 1, 2018. No appropriations have been made at this time.	2015 - 2018	Section 135.710, RSMo
Alternative Fuels Requirements for State Vehicles	Missouri	Specifically requires MoDOT to use biodiesel blend in 75% of its fleet as long as the incremental cost between standard diesel and biodiesel does not exceed 25-cents per gallon.	2002	SB 729 (2014)
Appliance and Equipment Standards	Missouri	Missouri has limited authority to create appliance and equipment efficiency standards.	2009	Sections 701.500 - 701.515, RSMo
Appliance and Equipment Standards	Federal	Provides efficiency standards for over 50 categories of appliances and equipment. Products covered by standards represent about 90% of home energy use, 60% of commercial building use, and 29% of industrial energy use. Missouri does not have a state-enforced appliance and equipment standard.	1975; various dates for each individual standard.	42 USC 7411 et seq.
Biodiesel Producer Incentive Fund	Missouri	The Missouri Department of Agriculture administers the Missouri Qualified Biodiesel Producer Incentive Fund, which was established in 2002 to encourage biodiesel production in Missouri. The Fund provides that, subject to appropriation, biodiesel produced in the state by a facility that is at least 51 percent owned by Missouri agricultural producers or which uses feedstock that is at least 80 percent of Missouri origin, is eligible for a grant in any fiscal year equal to thirty cents per gallon for the first 15 million gallons produced from Missouri agricultural products and ten cents per gallon for the next 15 million gallons. Expired December 31, 2014.	2002	Section 142.031, RSMo
Building Energy Codes	Missouri	All local jurisdictions except class III counties have the right to adopt an energy code. Several large jurisdictions have adopted the 2009 IECC or equivalent codes. Missouri has no statewide mandatory residential or commercial building code standard for private developments, but has established a stakeholder advisory group for building codes.	State: none. Local: varies.	DED Division of Energy: Energy Codes
Business Energy Investment Tax Credit	Federal	30% tax credit for solar, fuel cells, small wind; 10% for geothermal, microturbines and CHP. Established under 26 USC § 48 and extended by the Energy Improvement and Extension Act of 2008 and ARRA.	2013, extended through 2016	26 USC 48
Carbon Pollution Standards for Existing Stationary Sources: Clean Power Plan	Federal	The Clean Power Plan will limit carbon emissions from existing power plants. The Clean Power Plan sets carbon reduction goals for each State, tailored to reflect the characteristics of local energy policies and power plants.	Final rules published August 2015.	http://www2.epa.gov/cleanpowerplan/clean-power-plan-final-rule

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Carbon Pollution Standards for Modified and Reconstructed Stationary Sources: Electric Utility Generating Units	Federal	Amends the electric generating units New Source Performance Standards for modified and reconstructed facilities for greenhouse gas under Clean Air Act section 111(b). Proposes standards to limit emissions of carbon dioxide from affected modified and reconstructed electric utility steam generating units and from natural gas-fired stationary combustion turbines. Natural gas-fired stationary combustion turbines that supply less than one-third of their potential electric output to the grid are not subject to the proposal.	Final rules published August 2015.	http://www2.epa.gov/cleanpowerplan/clean-power-plan-final-rule
Clean Air Act	Federal	The Clean Air Act is a landmark law intended to improve and protect air quality in the U.S. Many of the federal rules located elsewhere within this assessment implement the Clean Air Act.	Enacted 1970; Revised 1977 and 1990.	42 USC 7401 et seq.
Clean Air Interstate Rule (CAIR)	Federal	CAIR will be superseded by the CSAPR rule when it goes into effect on Jan 1, 2015. Addresses power plant pollution that drifts from one state to another, using a cap and trade system to reduce the target pollutants, sulfur dioxide (SO2) and nitrogen oxides (NOx), by 70 percent. CAIR covers 27 eastern states and the District of Columbia.	2005	Final Rule – Federal Register
Clean Air Interstate Rule (CAIR)	Missouri	Federal CAIR will be superseded by the CSAPR rule when it goes into effect on Jan 1, 2015. Missouri is covered by federal Clean Air Interstate Rule (CAIR), and subsequently established a NOx cap and trade program, under the Missouri CAIR Energy Efficiency and Renewable Energy Set-Aside Program. Missouri sets aside 300 annual NOx allowances to be awarded annually to energy efficiency and renewable energy projects located in Missouri, or for out-of-state renewable generation projects that are sponsored by Missouri electric utilities. NOx allowances can be sold to the highest bidder.	2007	10 CSR 10-6.362
Clean Air Act	Federal	The Clean Water Act is a landmark law intended to improve and protect water quality in the U.S. It establishes the basic structure for regulating discharges of pollutants into public waterways.	1972	US EPA Clean Water Act Summary
Clean Air Law	Missouri	Under the Missouri Clean Water Law, the Department of Natural Resources Water Pollution Control Branch sets limits and monitors for water pollution, which includes changes in temperature. Water protection rules are currently in development for water pollution, including water quality standards.	1973	Chapter 644, RSMo Missouri Clean Water Law
Clean Water State Revolving Loan Fund	Missouri	Missouri's 2015 Clean Water State Revolving Fund Intended Use Plan includes energy efficiency measures as an eligible project.	Amended 2009	2015 Intended Use Plan
Coal Ash Rules	Federal	This rule, finalized in Dec. 2014, sets comprehensive requirements for the safe disposal of coal combustion residuals, commonly known as coal ash.	2014	US EPA Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities
Combined Heat and Power	Federal	Calls for increased coordination among federal agencies to promote CHP deployment. Sets a goal of 40 GW of new CHP capacity by 2020.	2012	Executive Order -- Accelerating Investment in Industrial Energy Efficiency

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Federal	Established Superfund and provided Federal authority to respond to contamination by hazardous chemicals that endanger public health.	1980; Amended 1986.	US EPA CERCLA Summary
Corporate Average Fuel Economy Standards	Federal	Requires automakers to meet sales-weighted average fuel economy for their new vehicle fleet each year. See entry for Energy Independence and Security Act of 2007, above, for 2007 amendments.	1975	49 USC 32902 pdf
Cross State Air Pollution Rule (CSAPR)	Federal	This rule supersedes the CAIR rule. It requires states to reduce power plant emissions that contribute to ozone and/or fine particle pollution in other states. In a related regulatory action, EPA's December 15, 2011 supplemental rule requires five states, including Missouri, to make summertime NOx reductions under the CSAPR ozone season control program.	2011	US EPA CSAPR Summary
Electric Demand-Side Programs Investment Mechanism	Missouri	A part of MEEIA, the Demand-Side Programs Investment Mechanism allows electric utilities to recover costs for programs that could include energy efficiency, load management, demand response, and interruptible or curtailable load. The DSIM allows recovery of costs that could include program costs, accelerated depreciation, lost revenues, and utility performance incentives.	Oct 4, 2010 / May 30, 2011	4 CSR 240-3.163
Electric Utility Fuel and Purchased Power Cost Recovery Mechanisms	Missouri	These mechanisms, the Interim Energy Charge and the Fuel Adjustment Clause, allow electric utilities to recover prudent fuel and purchased power costs outside of general rate proceedings.	Jun 15, 2006 / Jan 30, 2007	4 CSR 240-20.090
Energy Code for State Buildings	Missouri	Senate Bill 1181 requires that by July 1, 2009, all design for state buildings over 5,000 square feet involving new construction or substantial renovation and any building over 5,000 square feet considered for purchase or lease by a state agency shall comply with the minimum energy efficiency standard. The act also set the minimum energy efficiency standard so that it is at least as stringent as the 2006 International Energy Conservation Code (2006 IECC), or the latest version of the Code rather than the current standard of ASHRAE, Standard 90.	2008	Section 8.812, RSMo Senate Bill 1181 (2008)
Energy Codes Applicable to Public Buildings	Federal	Establishes a minimum energy efficiency standard (the latest version of the IECC) for construction of a state building, substantial renovation of a state building where major energy systems are involved, or a building which the state or state agency considers for acquisition or lease.	2013	4 CSR 340-7.010 S
Energy Emergency Planning Authority	Missouri	Vests the Missouri Department of Natural Resources with authority to prepare plans for reducing energy use in an event of a supply emergency.	1979	Section 640.150, RSMo
Energy Independence and Security Act of 2007	Federal	Key provisions include stronger CAFE standards for automobiles (see CAFE standard entry also); the Renewable Fuel Standard, which increased the biodiesel requirement; and updated appliance and lighting efficiency standards. Other energy efficiency provisions addressed USDOE's regional heating and cooling standards, and industrial and commercial building programs; and CHP, recycled energy and district energy.	2007	Public Law 110-140
Energy Loan Program	Missouri	Low-interest loans to public schools (K-12), public/private colleges and universities, city/county governments, public water and wastewater treatment facilities, and public/private not-for-profit hospitals to help reduce energy costs for energy-saving improvements. These loans do not require electorate assent and are not considered as "debt" created, and do not count against debt limits or require a public vote or bond issuance.	1989	Sections 640.651-640.686, RSMo Energy Loan Program

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Energy Standard for Public Buildings	Missouri	Mandated that all state agencies adopt policies designed to reduce energy consumption by 2% each year for the following 10 years. Since 2009, the Office of Administration has worked with Missouri state agencies to successfully reduce energy consumption by 22.51 percent at an annualized rate of 4.45 percent per year; more than double the target of two percent per year laid out in an executive order signed by the Governor in 2009.	2009	Executive Order (EO-09-18)
Enhanced Enterprise Zone	Missouri	Provides tax credits to new or expanding businesses in a Missouri Enhanced Enterprise Zone. Enhanced Enterprise Zones are specified geographic areas designated by local governments and certified by the Department of Economic Development (DED).	2013	Executive Order (EO-09-18)
Ethanol Production Incentive Fund	Missouri	The Missouri Department of Agriculture manages the Missouri Ethanol Producer Incentive Fund (Fund), which provides monthly grants to qualified Missouri ethanol producers who are actively engaged in agricultural production for commercial purposes and own at least 51% of the production facility. The grants are available for a maximum of 60 months at a rate of $0.20 per gallon for the first 12.5 million gallons and $0.05 for the next 12.5 million gallons of ethanol produced from Missouri agricultural products or qualified biomass each fiscal year, up to $3.125 million per producer per fiscal year. Ethanol must meet ASTM specification D4806 or subsequent specifications. This incentive expires on December 31, 2015.	Amended 2008	Sections 142.028 - 142.029, RSMo
Fuel Conservation for State Vehicles Program	Missouri	Establishes targets for state fuel consumption reduction, requires 70% of all light duty state vehicles (less than 8,500 lb. gross vehicle weight) purchased and assigned to administrative functions be alternative fuel capable and 30% of the fuel consumed in the alternative fuel capable vehicles be alternative fuel.	1991	Sections 414.400 – 414.417
Industrial Development Bonds	Missouri	Industrial development bonds ("IDBs") were developed by the US Congress and the Missouri General Assembly to facilitate the financing of business projects. In 1986, a significant change in the federal tax laws severely limited the use of tax-exempt IDBs. Sec. 100.010 to 100.200, RSMo allows cities or counties to purchase or construct certain types of projects with bond proceeds and to lease or sell the project to a company. These "industrial development" bonds may be issued either as a "revenue" bond or a general obligation bond.	1986	Sections 100.010 - 100.200, RSMo
Infrastructure System Replacement Surcharge (ISRS)	Missouri	The Infrastructure System Replacement Surcharge appears on bills of natural gas customers and Missouri-American's St. Louis water customers. The ISRS, established in 2003, provides timely cost recovery for infrastructure replacement.	Sep 19, 2003 / May 30, 2004	4 CSR 240-3.265 (natural gas) 4 CSR 240-3.650 (water)
Integrated Resource Planning - Electric Utilities	Missouri	All electric utilities selling over one million megawatt-hours to Missouri retail electric customers during calendar year 2009 are required to file an IRP every three years, using a 20-year planning horizon. The IRP consists of analyses of supply-side resources, transmission and distribution, demand-side resources, integrated resources and risk, and resource acquisition strategies. Demand-side resources must be evaluated with a goal of achieving all cost-effective demand-side savings.	Amended, effective 2011	Sections 640.651-640.686, RSMo Energy Loan Program
Interconnection and Net Metering Rules	Missouri	Requires electric utilities to offer net metering & interconnection to Missouri customers who wish to interconnect a solar, wind, or small hydroelectric system to their home or business. A proposed rule modifying net metering requirements is currently under review.	Enacted 2007, Effective 2008	4 CSR 240.065
Interdepartmental Collaboration to Secure Federal Grants	Missouri	Requires Missouri state agencies to collaborate to secure federal grants related to energy.	2008	Section 251.650, RSMo
Linked Deposit Program	Missouri	Low Interest Loan program for various purposes - including alternative energy systems, energy efficiency, and affordable multifamily housing.	Revised 2011	Section 30.750 – 30.765, RSMo

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Low-Income Home Energy Assistance Program	Federal	Provides financial assistance with energy bills through the Energy Assistance/Regular Heating program and the Energy Crisis Intervention Program. Eligibility requirements are based on income, household size, available resources and responsibility for payment of home heating costs. In 2013, an estimated 145,279 households were served. Funding for 2015 is $66,506,016.	1981	LIHEAP Program Website
Low-Income Weatherization Assistance Program (LIWAP)	Federal	The Missouri Division of Energy administers federal funds and funding from some utilities to local agencies that provide weatherization services, training and guidance. Funding allocations are based on the percentage of the state's total low-income households within each service area.	1976	LIWAP Program Website
Mercury and Air Toxics Standards (MATS)	Federal	Mercury and Air Toxics Standards (MATS) limits mercury, acid gases and other toxic emissions from power plants. On June 29th, 2015, the Supreme Court ruled that the EPA needed to take compliance costs into consideration before determining if regulation was appropriate.	2011;2014	MATS rule 40 CFR 60 and 63
Missouri CNG Tax Structure Revision	Missouri	Compressed natural gas used as a vehicle fuel is taxed on a gasoline gallon equivalent (GGE) basis as follows: $0.05 GGE from January 1, 2016 until December 31, 2019; $0.11 GGE from January 1, 2020 until December 31, 2024; and $0.17 from January 1, 2025 until December 31, 2019. If natural gas is used for fueling vehicles as well as for another use, such as home heating, the tax applies to the entire amount of the natural gas consumed, unless the Missouri Department of Revenue approves a separate meter and accounting system.	2016	Section 142.869, RSMo HB 2141 (2014)
Missouri Energy Efficiency Investment Act (MEEIA)	Missouri	Provides guidelines for electric utilities engaging in energy efficiency programs. Guidelines ramp up to 1.9% annual electricity reductions by 2020, and authorize demand-side mechanisms and cost recovery for energy savings and demand savings programs. Program filings are voluntary by the utility. The MEEIA rules are currently undergoing review.	2009	Section 393.1075, RSMo
Missouri Heating Assistance Legislation	Missouri	Establishes guidelines for the Utilicare plan, which provides financial assistance to eligible elderly, disabled, and individual households for heating and cooling. Guidelines include eligibility, payment, procedure, source of funds, and limitations to this plan.	1979; amended multiple times, most recently 2014	Section 660.100, RSMo
Missouri LNG Tax Structure Revision	Missouri	Liquefied natural gas used as vehicle fuel is taxed on a diesel gallon equivalent (DGE) basis as follows: $0.05 DGE from January 1, 2016 until December 31, 2019; $0.11 DGE from January 1, 2020 until December 31, 2024; and $0.17 from January 1, 2025 and beyond. If natural gas is used for fueling vehicles as well as for another use, such as home heating, the tax applies to the entire amount of the natural gas consumed, unless the Missouri Department of Revenue approves a separate meter and accounting system.	2016	Section142.803, RSMo
Missouri Water Resource Law	Missouri	Any surface or groundwater user with a water source and the equipment necessary to withdraw or divert 100,000 gallons or more per day from any stream, river, lake, well, spring or other water source is considered a major water user. All major water users are required by law to register water use annually. Missouri Department of Natural Resources (MDNR) does not regulate the use of water, only the amount of water a major water user has the potential to use. MDNR is in the process of completing a State Water Plan, as directed by RSMo 640.415.	1989	Sections 640.400 – 640.435, RSMo

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Missouri Works Program	Missouri	Missouri Works offers tax breaks to businesses that add a certain number of full-time jobs, meet wage requirements, generate new capital investment and offer certain health benefits to their full-time employees. In addition, the program offers potential incentives for the “High Impact” (100 or more new jobs) or “Retention” (50 or more existing jobs) qualifications outlined in the program’s eligibility requirements. Qualified businesses can retain state withholding tax on qualified jobs and, in particular cases, receive refundable state tax credits based on a percentage of payroll of the qualified jobs.	2013	Sections 620.2000 to 620.2020, RSMo
National Ambient Air Quality Standards (NAAQS)	Federal	The National Ambient Air Quality Standards (NAAQS) apply to air quality in communities, which are determined to either an attainment area (within the air quality limits) or nonattainment area. U.S. EPA issued a proposed revision of the NAAQS for ground-level ozone in Nov. 2014. Electric power plants are one source of ozone emissions.	1971. Proposed ozone standards revision November 2014. Revised nonattainment area designations expected to be finalized in 2017.	40 CFR 50 NAAQS
National Environmental Policy Act (NEPA)	Federal	Major projects that are performed by a federal agency, receive federal funding, or are subject to federal permitting, are subject to the requirements of the National Environmental Policy Act. Proposed projects must be evaluated based on the need; possible adverse economic, social, and environmental impacts; and governmental environmental goals.	1969	42 USC 4321
Personal Income Tax Deduction for Home Energy Audits	Missouri	Homeowners may take an income tax deduction of the cost of home energy audits and associated energy efficiency improvements incurred on or after January 1, 2009. The deduction cannot exceed $1,000 per year for individual taxpayers or exceed $2,000 per year for taxpayers filing combined returns. A deduction can’t be claimed for work that received any type of incentive or rebate through the state or through a utility-sponsored program. To qualify, the home energy audit must be performed by a home energy auditor certified by the Division of Energy before any efficiency improvements are made.	2009 – 2020	Section 143.121.1(8), RSMo
Price Volatility Mitigation - Natural Gas	Missouri	Natural gas utilities should engage in resource planning efforts to mitigate upward natural gas price volatility and secure adequate natural gas supplies. No required filings for local distribution companies. Natural gas plans are reviewed for prudence on a case-by-case and year-by-year basis.	Amended, effective 2011	4 CSR 240-40
Property Assessed Clean Energy Act (PACE)	Missouri	The Missouri Property Assessed Clean Energy (PACE) Act allows municipalities (county, city, or incorporated town or village) to create Clean Energy Development Boards, which can issue bonds and create and manage a local PACE program. PACE is a financing mechanism that allows building owners to repay energy upgrades through a property tax assessment. In January 2011 the Missouri Clean Energy District (MCED) was created for PACE financing for most of Missouri’s participating communities and counties. MCED currently funds commercial building projects within the district. Set the PACE St. Louis program implements PACE in St. Louis. A third clean energy district, Show Me PACE, was created in June of 2015 and was designed to serve the entire state using a system of on-demand financing.	2010	Section 67.2800.1, RSMo
Qualified Energy Conservation Bonds (QECBs)	Federal	Creates a direct subsidy bond that can be used to finance certain energy-related projects.	2008	US EPA QECB Summary Page, US DOE QECB Primer
Ratemaking Process	Missouri	Missouri has a two-step ratemaking process. The first step is determining the utility revenue requirement, and the second step is to design rates from each customer class. The PSC generally has 11 months to make a decision on a proposal.	Amended 1996	4 CSR 240-3.030

Policy Name	Level	Description / Highlights	Date of Enactment / Effective Date	Citation
Renewable Energy Standard	Missouri	The Renewable Energy Standard (RES) requires all investor-owned utilities to use renewable energy technologies to meet 15% of annual retail sales by 2021, subject to a cost cap. The RES established a utility rebate program but subsequent legislation decreased the rebate size and implemented a phase out period. A proposed rule modifying RES requirements is currently in review (PSC Case EX-2014-0352).	2008	Sections 393.1020-393.1030, RSMo
Renewable Energy Standard Rate Adjustment Mechanism	Missouri	A part of the RES, the Renewable Energy Standard Rate Adjustment Mechanism allows periodic rate adjustments to recover prudent costs related to the renewable energy standard and allows pass-through of benefits from that standard to customers.	Jan 8, 2010 / Sep 30, 2010	4 CSR 240-20.100
Renewable Fuel Standard Act	Missouri	Requires all gasoline sold in Missouri to be a blend of 90% gasoline and 10% fuel ethanol.	2006	Section 414.255, RSMo
Residential Renewable Energy Tax Credit	Missouri	A taxpayer may claim a credit of 30% of cost for system serving a dwelling in the U.S. Established by the Energy Policy Act of 2005 and extended by the Energy Improvement and Extension Act of 2008 and ARRA.	2005, extended through 2016	26 USC 25D
Resource Conservation Recovery Act (RCRA)	Missouri	RCRA regulates solid waste, underground storage tanks and hazardous waste.	1976; amended 1984	US EPA RCRA Summary Page
Rules for Transportation Fuel Taxation	Federal	Relates to the motor fuel tax, including aviation fuel. Motor fuel used for highway use (gasoline, diesel, kerosene and blended fuel) are taxed at 17 cents per gallon. Aviation fuel used to propel aircraft is taxed at 9-cents per gallon.	1998; amended 2002 and 2014 / Jan 1, 2016	Chapter 142, RSMo
Show-Me Green Sales Tax Holiday	Federal	During a seven-day period starting in April, sales of qualifying ENERGY STAR certified new appliances will be exempt from state sales tax. Local jurisdictions can choose to participate in the Show-Me Green Sales Tax Holiday.	2008-2009	Section 144.526.1, RSMo
Solar Easements and Rights	Missouri	The right to use solar energy is a property right that eminent domain may not be used to obtain. Solar easements are considered a negative easement and cannot be attained by prescription.	1979	RSMo 442.012
Solar Property Tax Exemption	Missouri	Solar energy systems not held for resale are exempt from state, local, and county property taxes (100% exemption).	2013	Section 137.100.1, RSMo
State Fleet Biodiesel Fuel Use	Missouri	The Missouri Biodiesel Fuel Revolving Fund uses the money generated by the sale of Energy Policy Act of 1992 credits to cover the incremental cost of purchasing fuel containing biodiesel blends of at least 20% for state fleet vehicle use.	2007	Section 414.407, RSMo
Steam Electric Power Generating Effluent Standards	Federal	The standards address wastewater discharges from power plants operating as utilities. U.S. EPA is currently developing revisions to the regulation, and issued a proposed rule in 2013.	1974. Final action on the proposed rule is expected in September 2015.	40 CFR 423
Taxability of Servicing Wind Turbine Blades Used to Generate Electricity	Missouri	Imposes a tax upon all sellers for the privilege of engaging in the business of selling tangible personal property or rendering taxable service at retail in this state.	1975; amended 2004 and 1989; amended 2005 / May 30, 2006	Section 144.020.1, RSMo ,12 CSR 10-113.200 LR 7528 LR7095
Wood Energy Production Tax Credit	Missouri	Allows individuals or businesses processing Missouri forestry industry residues into fuels a state income tax credit of $5.00 per ton of processed material. A multiplier of 4 applies to charcoal. In 2014 the tax credit was extended to June 30, 2020 and an annual cap of $6 million per fiscal year was established.	1985; January 1, 1997 – June 30, 2020	Sections 135.300-135.311, RSMo 4 CSR 340-4.010

Appendix C – Role of Government

Government serves an important role in the energy industry and is responsible for policy development, regulation of markets and industry, enacting laws and regulations, providing technical assistance and financial resources and incentives, and planning for the distribution of resources. Authority for regulating energy development is assigned to agencies under all three branches of government and shared by federal, state, and local officials, which makes for a complex and often complicated web of laws, rules, and regulations.

Several federal laws, such as the Clean Air Act and the 2005 Energy Policy Act, govern aspects of energy production, transmission, distribution, and consumption. Federal agencies, empowered by Congress to enforce the laws, often delegate responsibilities for implementation to state governments. However, states do not have the authority to change laws established at the federal level. While the federal government does not preempt states from adopting policies and standards that are more stringent than federal law, the state of Missouri has enacted laws that limit state agency authority to adopt environmental rules and regulations that are more stringent than those required by federal law. For instance, rules and regulations promulgated by Missouri's Air Conservation Commission may not be more stringent than those required under the federal Clean Air Act (Mo. Rev. Stat. §643.055) and the state's Department of Natural Resources is prohibited from adopting any rules concerning emissions from coal-fired power plants that are more stringent than federal law (Mo. Rev. Stat. §640.033). If disputes of authority arise, the rule of preemption usually prevails.

The sections that follow showcase the main entities tasked with oversight of energy resources at the federal and state level.

1. Federal Government

Several federal entities are tasked with the planning, development, and oversight of the country's energy infrastructure. These organizations also provide essential national guidance and programs, as well as regulation for interstate commerce of energy products. In certain instances, some of these organizations delegate authority to Missouri agencies for implementation or monitoring of activities related to federal legislation.

Included below is a brief listing of federal agencies that play a significant role in Missouri's energy industry.

The U.S. Department of Energy (DOE) has primary responsibility for federal energy policies and programs. Its functions include energy technology research and development, scientific innovation promotion, federal power marketing, energy conservation, energy regulation, and national energy data collection and analysis. DOE manages the nuclear weapons program including environmental cleanup and security. Smaller agencies including the Energy Information Administration and the National Laboratories System are under its jurisdiction as well. DOE also administers the State Energy Program, which provides formula and competitive funding as well as technical assistance to state energy offices to help them advance their clean energy economies while contributing to national energy goals.

The Federal Energy Regulatory Commission's (FERC) main purpose is to regulate the interstate transmission of electricity, natural gas, and oil. This includes regulating new construction, setting reliability standards, monitoring energy markets, and enforcing regulatory requirements. FERC also handles requests for the construction of liquefied natural gas terminals and the licensing of hydroelectric projects.

The U.S. Environmental Protection Agency (EPA) implements and enforces Congressional laws pertaining to the environment and public health including areas that affect air, land, water, and hazardous waste. EPA then delegates authority to the states to monitor and enforce its established standards and regulations in accordance with the Clean Water or Clean Air Act, for example.

The U.S. Nuclear Regulatory Commission (NRC) is tasked with ensuring the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environment. Its jurisdiction includes regulation of nuclear materials used in both commercial power generation and medical isotopes. The NRC regulates these materials through licensing and enforces its requirements through inspections. Recently, the NRC renewed the operating license for the Callaway nuclear power plant through October 2044.

The U.S. Department of Agriculture (USDA) has traditionally focused on food, agriculture, and rural development; however, its scope has evolved to include promoting sustainability, preservation, and conservation. In relation to energy, this expanded role has led USDA to participate in renewable energy promotion, development of biofuels and biomass policies and programs, and energy efficiency implementation. USDA administers numerous rural community development grant and loan programs including the Energy Efficiency and Conservation Loan Program, the Rural Energy for America Program, Rural Economic Loans and Grants, and the Water & Waste Disposal Loans & Grants Program.

The U.S. Department of Defense (DoD) is the nation's largest energy user and is required to decrease its energy intensity by three percent annually relative to a 2003 baseline year, or 30 percent overall from the baseline, by the end of fiscal year 2015. In recent years, DoD has launched initiatives to reduce energy and fuel use and shift to renewable energy to improve energy security and operational effectiveness, reduce greenhouse gas emissions and protect the DoD from energy price fluctuations. DoD entered into a memorandum of understanding with DOE because energy efficiency serves as a force multiplier, increases the range and endurance of forces in the field, reduces the number of combat forces required to protect energy supply lines, and reduces long term energy costs. Solving military challenges through innovation benefits the civilian community as well. DoD is also leveraging private sector partnerships to accomplish those objectives through purchase power agreements, energy savings performance contracts, enhanced-use leases, and utilities energy service contracts.

The U.S. Department of Transportation (DOT) ensures a fast, safe, efficient, accessible, and convenient transportation system that meets the nation's vital interests. The DOT is involved in sustainability initiatives as well as regulations pertaining to transportation fuels and pipeline safety. Congestion Mitigation and Air Quality program funds are provided to states to support surface transportation projects and efforts that contribute to air quality and relieving congestion.

The U.S. Department of the Interior manages the country's natural and cultural resources through nine technical bureaus including Land Management (BLM), Ocean Energy Management (BOEM), U.S. Fish & Wildlife (FWS), and the U.S. Army Corp of Engineers (USACE). While BLM manages public lands with energy potential including federal onshore oil, gas, and coal operations, the BOEM promotes energy independence, environmental protection, and economic development through responsible, science-based management of offshore conventional and renewable energy and marine mineral resources. FWS manages fish and wildlife, enforces the endangered species act, and maintains natural habitats including its protection in projects that might involve the extraction of energy fuels and natural resources and the transmission of energy resources across pipelines, roads, or rail. The USACE helps dredge America's waterways to support the movement of critical commodities and to provide recreation opportunities. In addition, they own and operate more than 600 dams and produce 24 percent of the nation's hydropower capacity, restore or create wetlands, devise storm damage reduction infrastructure, and research and develop technologies to protect the nation's environment.

2. State Government

In Missouri, policy makers set energy governance through state statutes and regulations and agencies implement programs to provide information, and technical and financial assistance for energy-related activities. The following state agencies are particularly relevant to energy stakeholders because of their roles as regulators of energy-related industries and infrastructure, stewards of natural resources, and in providing services to support Missouri's energy policies.

The mission of the Missouri Department of Economic Development (DED) is to create and maintain high-paying jobs and boost economic development across the state in order to help local communities grow and prosper. DED administers a wide array of services and programs designed to enhance Missouri's economic growth in the 21st century in the areas of community, economic, and workforce development. The Business and Community Services Division includes the sales, research (Missouri Economic Research and Information Center), marketing, finance (Missouri Development Finance Board), and compliance teams who facilitate job creation and private investment in the state through existing business expansion and new business location, as well as support planned community development and growth. The Division of Workforce Development (DWD) helps Missourians access gainful employment and train for the high-tech jobs of tomorrow's economy. Missouri's workforce system is a collaborative partnership that includes the Missouri Department of Labor and Industrial Relations, 14 local workforce investment boards, and 12 community college districts and other local educational agencies across the state. Since Missouri's businesses are critical to the success of a long-term healthy economy, DWD provides industry-training programs, cost-saving financial incentives, hiring assistance, and other business services.

Missouri's Division of Energy (the Division) is a state agency under the umbrella of the Missouri Department of Economic Development that assists, educates, and encourages Missourians to advance the efficient use of diverse energy resources to drive economic development, provide for a healthier environment, and to achieve greater energy security for future generations. The Division accomplishes these goals by collecting, analyzing, and disseminating energy data, planning for energy emergencies, assisting in energy efficiency and renewable energy projects, and supporting the expansion of clean energy resources. The main ways in which Division advances its mission are: education and advocacy, direct financial assistance in the form of loans for energy efficiency projects, and administering low-income weatherization. The Division also administers the Missouri Home Energy Certification (MHEC) program, which relies on certified home energy auditors throughout the state to audit homes and then apply for certification. Home energy auditors, in addition to their role in MHEC, are extremely helpful in identifying cost-effective efficiency measures for homeowners.

The Missouri Public Service Commission (PSC) is the state agency charged with regulating the state's investor-owned electric and natural gas, as well as steam, water, and sewer utilities. The PSC also has some jurisdiction over rural electric cooperatives and municipally owned natural gas utilities, specifically in regards to operational safety regulations. The PSC aims to ensure that utility services are safe and reliable at a fair and reasonable cost. Decisions are often made at the PSC in a trial-like setting, where the PSC hears contested cases with presented evidence and makes decisions to uphold administrative rules and regulations.

The Office of the Public Counsel is Missouri's consumer advocate in the area of utility regulation for safe and adequate utility services at just and reasonable rates. The public counsel educates and communicates with consumers about their rights and guards against consumer fraud. The office also provides assistance to citizens seeking guidance about condemnation process and procedure through the Office of the Property Ombudsman.

The Missouri Housing Development Commission (MHDC) provides financing for the construction of affordable housing and funding for home loans to qualified first-time homebuyers. MHDC administers several tax credit programs including the Low-Income Housing Tax Credit and Affordable Housing Assistance as well as other housing assistance programs.

The Missouri Department of Natural Resources (MDNR) is charged with protecting air, land, and water, preserving Missouri's unique natural and historic places, and providing recreational and learning opportunities. MDNR has been delegated primary implementation and enforcement authority by EPA and regulates entities to ensure protection of Missouri's air, water, and land resources through various commissions. MDNR provides financial assistance to local governments using federal and state revolving loan funds made available through grants and low-interest loans to help with the construction of wastewater, drinking water, and storm water facilities. This revolving loan program also provides financial and technical assistance to protect and preserve water quality and for the control of nonpoint source pollution caused by agriculture, mining, transportation, and other activities. MDNR's Water Resources Center addresses the development, conservation, and utilization of the state's water while the State Oil and Gas Council promotes the economic development and production of Missouri's oil and gas resources. In addition, MDNR's Industrial Minerals Advisory Council assists the industry in the collection, processing, management, and distribution of geologic and hydrologic information and its Geological Survey Program gathers data that is important in making land-use decisions and is necessary for locating mineral deposits, managing groundwater resources, selecting waste disposal facilities, and evaluating geologic hazards.

The Environmental Improvement and Energy Resources Authority (EIERA) was established to protect Missouri's environment, promote economic development, develop energy alternatives and conduct research. The EIERA assists businesses, institutions, municipalities and government agencies with energy conservation and environmental projects by providing financing with tax-exempt bonds, conducting environmental studies and providing technical and financial assistance for market development.

The Missouri Department of Agriculture's (MDA) mission is to serve, promote, and protect the agricultural producers, processors, and consumers of Missouri's food, fuel, and fiber products. The department's divisions include Agriculture Business Development, Animal Health, Grain Inspection and Warehousing, Plant Industries and Weights, Measures and Consumer Protection. The department also houses the Missouri Agricultural and Small Business Development Authority (MASBDA), which is a financing authority that promotes the development of agriculture and small business and works to reduce, control, and prevent environmental damage in Missouri. It offers low interest loans and grants through a number of programs for farmers and related businesses. Since 2000, MDA has partnered with MASBDA to administer incentive programs that have resulted in more than 2.5 billion gallons of renewable fuels produced by farmers in Missouri. This partnership also provides a program to conduct on-farm energy audits that so far has resulted in a statewide annual savings of more than 1.4 million kWh. MDA works with producers to develop potential renewable energy using anaerobic digesters, and crop waste for both cellulosic ethanol and direct-burn technology.

The Missouri Department of Transportation (MoDOT) works with the public, transportation partners, state and federal legislators, and other state and local agencies to provide a safe, modern, and efficient transportation system to the people of Missouri. MoDOT designs, builds, and maintains roads and bridges and works to improve airports, river ports, railroads, public transit systems, and pedestrian and bicycle travel. The agency also administers motor carrier and highway safety programs.

3. Local Governments

State law provides Missourians with local control of their communities through duties and powers granted to local political subdivisions. The legislature has empowered or delegated jurisdictional authority to county and municipal governments and special taxing districts. These local governments have authority to enact policies that enable the advancement of energy goals. The policies can take the form of appropriating funds, collecting taxes, and passing and enforcing ordinances, regulations, and codes. Local governments can participate in energy regulation through municipal utilities, mayoral offices, and local agencies or departments. Some cities throughout Missouri have created offices of sustainability or sustainability initiatives to achieve specific energy and environmental goals.

Appendix D – List of Missouri Utilities

Name	Service	Type	Electric/Gas Combo?
The Empire District Electric Company	Electric	Investor	
Kansas City Power & Light Company	Electric	Investor	
KCP&L Greater Missouri Operations Company	Electric	Investor	
Union Electric Company (Ameren Missouri)	Electric	Investor	
City of Albany	Electric	Municipal	Yes
City of Ava	Electric	Municipal	
City of Bethany	Electric	Municipal	Yes
City of California	Electric	Municipal	
City of Cameron	Electric	Municipal	
City of Carrollton	Electric	Municipal	
City of Carthage	Electric	Municipal	
City of Centralia	Electric	Municipal	
City of Chillicothe	Electric	Municipal	
City of Columbia	Electric	Municipal	
City of Crane	Electric	Municipal	
City of Cuba	Electric	Municipal	Yes
City of Easton	Electric	Municipal	
City of El Dorado Springs	Electric	Municipal	
City of Farmington	Electric	Municipal	
City of Fayette	Electric	Municipal	
City of Fredericktown	Electric	Municipal	
City of Fulton	Electric	Municipal	Yes
City of Gallatin	Electric	Municipal	
Galt Municipal Utilities	Electric	Municipal	
City of Gilman City	Electric	Municipal	
City of Hannibal	Electric	Municipal	
City of Harrisonville	Electric	Municipal	
City of Hermann	Electric	Municipal	Yes
City of Higginsville	Electric	Municipal	
City of Houston	Electric	Municipal	
City of Hunnewell	Electric	Municipal	
City of Independence	Electric	Municipal	
City of Jackson	Electric	Municipal	
City of Kahoka	Electric	Municipal	
City of Kennett	Electric	Municipal	Yes
City of Kirkwood	Electric	Municipal	
City of Lamar	Electric	Municipal	
City of La Plata	Electric	Municipal	
City of Lebanon	Electric	Municipal	Yes
City of Liberal	Electric	Municipal	
City of Linneus	Electric	Municipal	

Name	Service	Type	Electric/Gas Combo?
City of Lockwood	Electric	Municipal	
City of Macon	Electric	Municipal	Yes
City of Malden	Electric	Municipal	
City of Mansfield	Electric	Municipal	
City of Marceline	Electric	Municipal	
City of Marshall	Electric	Municipal	
City of Meadville	Electric	Municipal	
City of Memphis	Electric	Municipal	
City of Milan	Electric	Municipal	Yes
City of Mindenmines	Electric	Municipal	
City of Monett	Electric	Municipal	
City of Monroe City	Electric	Municipal	Yes
City of Mount Vernon	Electric	Municipal	
City of Mountain View	Electric	Municipal	
City of New Madrid	Electric	Municipal	
City of Newburg	Electric	Municipal	
City of Nixa	Electric	Municipal	
City of Odessa	Electric	Municipal	
City of Osceola	Electric	Municipal	
City of Owensville	Electric	Municipal	
City of Palmyra	Electric	Municipal	
City of Paris	Electric	Municipal	Yes
City of Perry	Electric	Municipal	Yes
City of Poplar Bluff	Electric	Municipal	
City of Rich Hill	Electric	Municipal	
City of Richland	Electric	Municipal	Yes
City of Rock Port	Electric	Municipal	
City of Rolla	Electric	Municipal	
City of Salem	Electric	Municipal	
City of Salisbury	Electric	Municipal	
City of Seymour	Electric	Municipal	
City of Shelbina	Electric	Municipal	Yes
City of Sikeston	Electric	Municipal	
City of Slater	Electric	Municipal	
Springfield City Utilities	Electric	Municipal	Yes
City of St. James	Electric	Municipal	Yes
City of St. Robert	Electric	Municipal	Yes
City of Stanberry	Electric	Municipal	Yes
City of Steelville	Electric	Municipal	
City of Sullivan	Electric	Municipal	
City of Thayer	Electric	Municipal	
City of Trenton	Electric	Municipal	
City of Unionville	Electric	Municipal	Yes

Name	Service	Type	Electric/Gas Combo?
University of Missouri	Electric	Municipal	
City of Vandalia	Electric	Municipal	
City of Waynesville	Electric	Municipal	Yes
City of West Plains	Electric	Municipal	
City of Willow Springs	Electric	Municipal	
City of Winona	Electric	Municipal	
Associate Electric Cooperative, Inc.	Electric Generation	Cooperative	
Central Electric Power Cooperative	Electric Transmission	Cooperative	
KAMO Power	Electric Transmission	Cooperative	
M & A Electric Power Cooperative	Electric Transmission	Cooperative	
Northeast Missouri Power Cooperative	Electric Transmission	Cooperative	
N. W. Electric Power Cooperative, Inc.	Electric Transmission	Cooperative	
Sho-Me Power Electric Cooperative	Electric Transmission	Cooperative	
Atchison-Holt Electric Cooperative	Electric Distribution	Cooperative	
Barry Electric Cooperative	Electric Distribution	Cooperative	
Barton County Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Black River Electric Cooperative	Electric Distribution	Cooperative	
Boone Electric Cooperative	Electric Distribution	Cooperative	
Callaway Electric Cooperative	Electric Distribution	Cooperative	
Central Missouri Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Citizens Electric Corporation	Electric Distribution	Cooperative	
Co-Mo Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Consolidated Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Crawford Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Cuivre River Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Farmers' Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Gascosage Electric Cooperative	Electric Distribution	Cooperative	
Grundy Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Howard Electric Cooperative	Electric Distribution	Cooperative	
Howell-Oregon Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Intercounty Electric Cooperative Assn.	Electric Distribution	Cooperative	
Laclede Electric Cooperative	Electric Distribution	Cooperative	
Lewis County Rural Electric Cooperative	Electric Distribution	Cooperative	
Macon Electric Cooperative	Electric Distribution	Cooperative	
Missouri Rural Electric Cooperative	Electric Distribution	Cooperative	
New-Mac Electric Cooperative, Inc.	Electric Distribution	Cooperative	
North Central Missouri Electric Cooperative,	Electric Distribution	Cooperative	
Osage Valley Electric Cooperative Assn.	Electric Distribution	Cooperative	
Ozark Border Electric Cooperative	Electric Distribution	Cooperative	
Ozark Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Pemiscot-Dunkin Electric Cooperative	Electric Distribution	Cooperative	
Platte-Clay Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Ralls County Electric Cooperative	Electric Distribution	Cooperative	
Sac Osage Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Se-Ma-No Electric Cooperative	Electric Distribution	Cooperative	
SEMO Electric Cooperative	Electric Distribution	Cooperative	

Name	Service	Type	Electric/Gas Combo?
Southwest Electric Cooperative	Electric Distribution	Cooperative	
Three Rivers Electric Cooperative	Electric Distribution	Cooperative	
Tri-County Electric Cooperative Association	Electric Distribution	Cooperative	
United Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Webster Electric Cooperative	Electric Distribution	Cooperative	
West Central Electric Cooperative, Inc.	Electric Distribution	Cooperative	
White River Valley Electric Cooperative, Inc.	Electric Distribution	Cooperative	
Laclede Gas Company	Natural Gas	Investor	
The Empire District Gas Company	Natural Gas	Investor	
Liberty Utilities	Natural Gas	Investor	
Missouri Gas Energy	Natural Gas	Investor	
Southern Missouri Gas Company, L.P. d/b/a Southern Missouri Natural Gas	Natural Gas	Investor	
Union Electric Company d/b/a Ameren	Natural Gas	Investor	
Albany (Municipal Gas System)	Natural Gas	Municipal	Yes
Altenburg-Frohna (Municipal Gas System)	Natural Gas	Municipal	
Bernie (Municipal Gas System)	Natural Gas	Municipal	
Bethany (Municipal Gas System)	Natural Gas	Municipal	Yes
Bismarck (Municipal Gas System)	Natural Gas	Municipal	
Clarence (Municipal Gas System)	Natural Gas	Municipal	
Cuba (Municipal Gas System)	Natural Gas	Municipal	Yes
Fulton (Municipal Gas System)	Natural Gas	Municipal	Yes
Granby (Municipal Gas System)	Natural Gas	Municipal	
Grant City (Municipal Gas System)	Natural Gas	Municipal	
Green City (Municipal Gas System)	Natural Gas	Municipal	
Hermann (Municipal Gas System)	Natural Gas	Municipal	Yes
Kennett (Municipal Gas System)	Natural Gas	Municipal	Yes
Liberal Municipal Gas System	Natural Gas	Municipal	Yes
Macon (Municipal Gas System)	Natural Gas	Municipal	
Mercer (Municipal Gas System)	Natural Gas	Municipal	
Middletown (Municipal Gas System)	Natural Gas	Municipal	
Milan (Municipal Gas System)	Natural Gas	Municipal	Yes
Monroe City (Municipal Gas System)	Natural Gas	Municipal	Yes
Montgomery City (Municipal Gas System)	Natural Gas	Municipal	
New Florence Municipal Gas System	Natural Gas	Municipal	
New Haven and Berger (Municipal Gas	Natural Gas	Municipal	
Oronogo (Municipal Gas System)	Natural Gas	Municipal	
Paris (Municipal Gas System)	Natural Gas	Municipal	Yes
Pattonville Landfill Gas System	Natural Gas	Municipal	
Perry (Municipal Gas System)	Natural Gas	Municipal	Yes
Perryville (Municipal Gas System)	Natural Gas	Municipal	
Plattsburg (Municipal Gas System)	Natural Gas	Municipal	
Potosi (Municipal Gas System)	Natural Gas	Municipal	
Princeton Municipal Gas System	Natural Gas	Municipal	
Richland (Municipal Gas System)	Natural Gas	Municipal	Yes
Shelbina (Municipal Gas System)	Natural Gas	Municipal	Yes
City Utilities of Springfield (Municipal Gas	Natural Gas	Municipal	Yes

Name	Service	Type	Electric/Gas Combo?
St. James (Municipal Gas System)	Natural Gas	Municipal	Yes
St. Robert (Municipal Gas System)	Natural Gas	Municipal	Yes
Stanberry (Municipal Gas System)	Natural Gas	Municipal	Yes
Trigen-St. Louis Energy Corporation (Municipal Gas System)	Natural Gas	Municipal	
Unionville (Municipal Gas System)	Natural Gas	Municipal	Yes
Waynesville (Municipal Gas System)	Natural Gas	Municipal	Yes
Wheaton (Municipal Gas System)	Natural Gas	Municipal	

Appendix E – Private Energy Efficiency Initiatives in Missouri

Program Name/Sponsor	Targeted Energy Users	Goals and Targets	Missouri Participants (as of end of 2014)	Website
Energy Star Partners/EPA	Building owners, suppliers/ installers of energy efficient goods, and service providers.	Partners pledge to take certain actions related to lighting, electronics, appliances & water heaters, heating & cooling, and sealing/ insulating.	275 Energy Star Partners in Missouri, including universities, school districts, hospitals, commercial & industrial facilities. Boeing has earned the ENERGY STAR® Partner of the Year Sustained Excellence award every year since 2011.	http:// www.energystar.gov/
Carbon Disclosure Project (CDP)	Many publicly traded S&P 500 shareholder companies report greenhouse gas emission status and progress. CDP reports details to 767 institutional investors	Publicly disclose carbon emissions, set corporate reduction targets, and generate return on investments. Some participating companies also set renewable energy and water conservation goals.	3M, Ameren, Best Buy, Boeing, ConocoPhillips, Home Depot, PepsiCo, Sears, Union Pacific, Wal-Mart, Waste Mgt. Inc., Sigma-Aldrich, Kohl's, AT&T, ConAgra Foods, Praxair, et.al.	https://www.cdp.net/
LEED Building Certification/ US Green Building Council, Gateway and Central Plains Chapters	New and retrofitted commercial and residential buildings. Many Missouri architecture and design firms develop significant in-house LEED expertise as a service to clients and a competitive advantage.	Energy efficiency, on-site renewables, and water use form a significant portion of LEED scorecards.	Over 200 certified commercial buildings and 26 residential homes, multifamily, or subdivisions in eastern, central, and southwest MO as of 8/1/14. Another 250 certified buildings in western MO and eastern KS. Boeing specifies LEED Silver level for new construction and major renovations.	http://www.usgbc-mogateway.org/ http:// www.usgbccentralplain s.org/
Coalition for Environmentally Responsible Economies (CERES)	Consumer product companies, retailers, and companies that have high GHG or energy usage profiles	Ceres Principles are a 10-point code of corporate environmental ideals, including energy conservation. Ceres manages Global Reporting Initiative (GRI) used by over 1200 companies for corporate environmental reporting. 60% of the combined Fortune 100 and Global 100 companies have set a renewable energy goal, GHG reduction goal, or both.	Allstate, Bank of America, Citi, Coca-Cola, CVS Health, Dunkin' Brands, Ford, Gap Inc., General Mills, General Motors, Jones Lang LaSalle, Morgan Stanley, Nike, PepsiCo, Prudential, Seventh Generation, Sprint Nextel, The North Face, Timberland, Time Warner, Wells Fargo	http://www.ceres.org/

Program Name/Sponsor	Targeted Energy Users	Goals and Targets	Missouri Participants (as of end of 2014)	Website
Federal Executive Memorandum on Federal Leadership on Energy Management (12/5/13) and Executive Order 13514 (10/8/09)	All federal agencies and facilities	Set renewable energy target of 20% by 2020, additional electricity and water metering and enter into Energy Star Portfolio Manager, GHG reduction targets, reduce fleet usage of petroleum fuels 2% annually through 2020. Beginning 2020, design new federal buildings to achieve net-zero-energy by 2030.	Ft. Leonard Wood, Whiteman AFB, Marine Corps Mobilization Command, federal courthouses, National Archives, other agency offices	http://www.gpo.gov/fdsys/pkg/FR-2009-10-08/pdf/E9-24518.pdf http://www.gpo.gov/fdsys/pkg/FR-2013-12-10/pdf/2013-29669.pdf
St. Louis Green Business Challenge/St. Louis Regional Chamber of Commerce	Private businesses, colleges and universities, public institutions in St. Louis metro area. Building owners and tenants.	Energy efficiency, on-site renewables, RECs, and water use form a significant portion of scorecards.	More than 125 St. Louis metro companies and institutions.	http://stlouisgreenchallenge.com/sustainblebusinessadvantage.html
Federal Energy Conservation Standards for Equipment/US Dept. of Energy (DOE)	Affects manufactured goods produced after the effective date of the final rule.	DOE is drafting or has proposed energy consumption standards for over 40 types of common equipment.	All Missouri entities that purchase new or replacement equipment subject to a DOE standard	http://www.reginfo.gov/public/do/eAgendaMain;jsessionid=4212F85CA1CAD5296966829F8FE7C450?operation=OPERATION_GET_AGENCY_RULE_LIST&currentPub=true&agencyCode=&showStage=active&agencyCd=1900&Image58.x=43&Image58.y=16
Independent Corporate Goals/Individual Companies	Companies that commit to individual corporate goals are motivated by a variety of concerns. In some cases, such as motor vehicles and commercial aircraft, energy consumption of the products manufactured is a significant driver.	Proctor and Gamble's goal is to reduce energy usage per unit of production by 20% between 2010 and 2020, with a long-term goal of using 100% renewable energy. Honeywell Kansas City moved to a smaller complex, reducing energy consumption by more than 50%.	Voluntary energy conservation and installation of renewable capacity is widespread, but not always well advertised outside the company.	Individual company websites and Environment Reports
Pure Power Renewable Energy Credits/Ameren Missouri	Residential, municipalities, commercial, and industrial Ameren customers	Voluntary purchase of Renewable Energy Credits	43 Platinum level, 60 Gold level, over 150 Silver level, plus residential buyers	https://www.ameren.com/missouri/environment/pure-power

Program Name/Sponsor	Targeted Energy Users	Goals and Targets	Missouri Participants (as of end of 2014)	Website
Federal Energy Conservation Standards for Equipment/US Dept. of Energy (DOE)	Affects manufactured goods produced after the effective date of the final rule.	DOE is drafting or has proposed energy consumption standards for over 40 types of common equipment.	All Missouri entities that purchase new or replacement equipment subject to a DOE standard	http://www.reginfo.gov/public/do/eAgendaMain;jsessionid=4212F85CA1CAD5296966829F8FE7C450?operation=OPERATION_GET_AGENCY_RULE_LIST&currentPub=true&agencyCode=&showStage=active&agencyCd=1900&Image58.x=43&Image58.y=16
Independent Corporate Goals/Individual Companies	Companies that commit to individual corporate goals are motivated by a variety of concerns. In some cases, such as motor vehicles and commercial aircraft, energy consumption of the products manufactured is a significant driver.	Proctor and Gamble's goal is to reduce energy usage per unit of production by 20% between 2010 and 2020, with a long-term goal of using 100% renewable energy. Honeywell Kansas City moved to a smaller complex, reducing energy consumption by more than 50%.	Voluntary energy conservation and installation of renewable capacity is widespread, but not always well advertised outside the company.	Individual company websites and Environment Reports
Pure Power Renewable Energy Credits/Ameren Missouri	Residential, municipalities, commercial, and industrial Ameren customers	Voluntary purchase of Renewable Energy Credits	43 Platinum level, 60 Gold level, over 150 Silver level, plus residential buyers	https://www.ameren.com/missouri/environment/pure-power
Kansas City Energy Project	Kansas City is one of 10 cities nationwide selected to participate in a 3-year initiative to promote energy efficiency improvements in large commercial and institutional buildings.	Help 50 buildings achieve ENERGY STAR certification	Numerous Kansas City companies and institutions	http://kcmo.gov/city-energy-project/

MISSOURI
Department of Economic Development
Division of Energy

To obtain more information on this document:

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