4. Existing Supply Side Resources

Highlights

- *Ameren Missouri currently owns and operates 10,280 MW of supply side resources: 5,364 MW of coal, 1,190 MW of nuclear, 2,896 MW of peaking natural gas, and 830 MW of renewables and storage.*
- *Ameren Missouri is scheduled to complete two unit upgrades at Keokuk Energy Center (Units 5 and 6) in 2016. In addition, upgrades of Units 14 and 15 at Keokuk Energy Center are scheduled to be complete in 2018.*
- *Ameren Missouri is considering options for Meramec Energy Center including combinations of unit retirements and gas conversion, with all units retired by the end of 2022*
- *Ameren Missouri is planning for additional retirements of fossil-fueled generating units during the planning horizon:*
  - *Sioux Energy Center is assumed to be retired in 2033.*
  - *Assumed retirement by 2020 of 367 MW (summer net capacity) of older, less efficient gas and oil fired CTGs.*
  - *Ameren Missouri has developed assumptions for an evaluation of retirements of Labadie and Rush Island Energy Centers.*

Ameren Missouri owns and operates thermal, nuclear, hydroelectric and storage energy centers to serve the energy needs of its customers. About 92% of generation comes from its coal-fired, nuclear, and oil/natural gas-fired energy centers. Ameren Missouri continuously evaluates energy center performance and upgrades that are necessary to operate its plants in an efficient, safe, cost-effective and environmentally-friendly manner.

During the 20-year planning horizon, Ameren Missouri is considering four Keokuk Energy Center Units for upgrades, adding a new CTG unit at the Maryland Heights Renewable Energy Center (MHREC), adding the largest investor-owned utility solar center in Missouri with approximately 5.7 MW [direct current (DC)] capacity, and the potential retirement of eight CTG units.

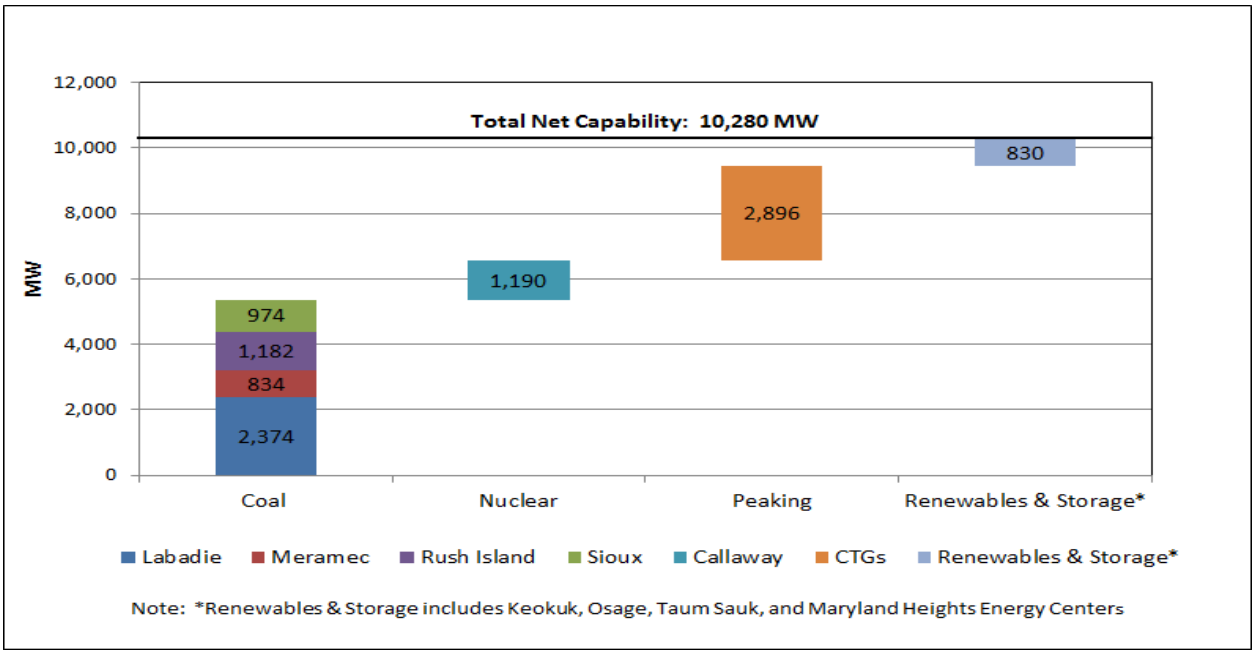
Ameren Missouri retained the services of Burns & McDonnell to complete a Condition Assessment of the Meramec Energy Center to determine ongoing costs necessary to keep the plant operating safely and reliably through the planning horizon. Ameren Missouri is considering options for Meramec Energy Center including combinations of unit retirements and gas conversion, with all units retired by the end of 2022.

Ameren Missouri has implemented various initiatives to improve efficiency and reduce greenhouse gas (GHG) emissions at its existing facilities. In addition, Ameren Missouri has evaluated a range of generation efficiency options as part of the End-to-End Efficiency Study performed with the assistance of the EPRI. As of 2012, the successful implementation of several projects identified in the End-to-End Efficiency Study, as well as other efforts, helped Ameren Missouri reduce heat rate by over 0.8% from a 2009 baseline. Ameren Missouri has also been proactively monitoring the status of light–emitting diode (LED) technology and engaged the Electric Power Research Institute (EPRI) to conduct a pilot program testing LED street lights. The overall conclusion is that while LEDs appear to be a viable technology, current economics and associated uncertainty do not support near-term adoption. Ameren Missouri will continue assessing and implementing projects that prove to be feasible on an ongoing basis.

4.1 Existing Generation Portfolio[1]

Ameren Missouri owns and operates thermal, nuclear, hydroelectric and storage energy centers to serve the energy needs of its customers. Figure 4.1 reflects the 2014 summer net capability of Ameren Missouri's existing supply side resources. Appendix A includes a unit rating summary table. Appendix B includes the existing capacity position table for 2014-2034.[2]

Figure 4.1 Existing Supply Side Resource Installed Capacity



[1] 4 CSR 240-22.040(1); 4 CSR 240-22.040(2)
[2] 4 CSR 240-22.060(4)(B)9

4.1.1 Existing Coal Resources

Ameren Missouri has four coal-fired energy centers in its generation fleet. The Labadie, Rush Island, Meramec, and Sioux energy centers have a total summer net generating capability of 5,364 MW.

Labadie Energy Center

Labadie plant is located outside Labadie, MO, on more than 1,100 acres adjacent to the Missouri River, 35 miles west of downtown St. Louis. The plant consists of four generating units with a summer net capability of 2,374 MW. The first unit started operating in 1970, and the plant was fully operational in 1973.

Labadie Energy Center is a national leader in generating electricity cleanly and efficiently:

- The state of Missouri presented Labadie Energy Center with the Resource Steward Award in 1983 to honor the company's efforts toward "preserving and wisely using Missouri's precious resource" by removing PCBs from our environment. Between 1981 and 1997, Labadie converted more than 4.5 million gallons of PCB-contaminated oil into an estimated 56,000 MWhs of electricity.
- In 1998, Labadie was one of three Ameren Missouri plants to earn the Missouri Governor's Pollution Prevention Award for successfully reducing nitrogen oxide (NO_X) emissions- 50% more than required by Missouri regulations.
- In 2000, Labadie was recognized by the Environmental Protection Agency as the nation's lowest emitter of NO_X.
- In 2011, Labadie was recognized as the Best Large Plant Performer by the Electric Utility Cost Group (EUCG).
- In 2014, Navigant awarded Labadie a plant operational excellence award as the top performing large unit coal-fired energy center in the U.S.

From 2000 to 2009, Labadie set generation records in six out of ten years. Labadie Unit 2 Low Pressure (LP) turbine retrofits were among the existing plant upgrades included in the Company's 2008 IRP. In Spring 2012, the high pressure (HP) and intermediate pressure (IP) turbines were cleaned, some turbine seals and packing were replaced, and new LP turbines were installed at Labadie Unit 2. For the same turbine inlet conditions, these new LP turbines are designed to provide an additional 12 MW of net generation.

Rush Island Energy Center

Rush Island Energy Center is located 40 miles south of downtown St. Louis, in Jefferson County, Mo., on 500 acres on the western bank of the Mississippi River. The plant has two units with a net summer capability of 1,182 MW. The first unit started operation in 1976 and the second unit in 1977.

In Spring 2011, the HP and IP turbines were cleaned, some turbine seals and packing were replaced, and new LP turbines were installed at Rush Island Unit 1. The cleaning and seal replacement improved the efficiency of the HP and IP turbines. For the same turbine inlet conditions, these new LP turbines are designed to provide an additional 12 MW of net generation.

Meramec Energy Center

Meramec Energy Center is located in South St. Louis County on the Mississippi River on 420 acres. The plant began operation in 1953. Net summer capability of the four coal-fired units at the site is 834 MW. It is the oldest coal plant in Ameren Missouri's fleet. An updated detailed condition assessment study of the Meramec coal-fired units was completed by Burns and McDonnell in May 2014.

Sioux Energy Center

Sioux Energy Center is located in St. Charles County, Mo., 28 miles northwest of downtown St. Louis, on the Mississippi River. It consists of two cyclone boiler units which started operations in 1967 and 1968, respectively, and has a total net summer capability of 974 MW.

Sioux Energy Center has accomplished many industry firsts:

- Pioneered slag-removal techniques now used nationwide.
- One of the first to install cyclone furnaces that can burn multiple fuels.
- One of the first to receive coal on the unit train concept.

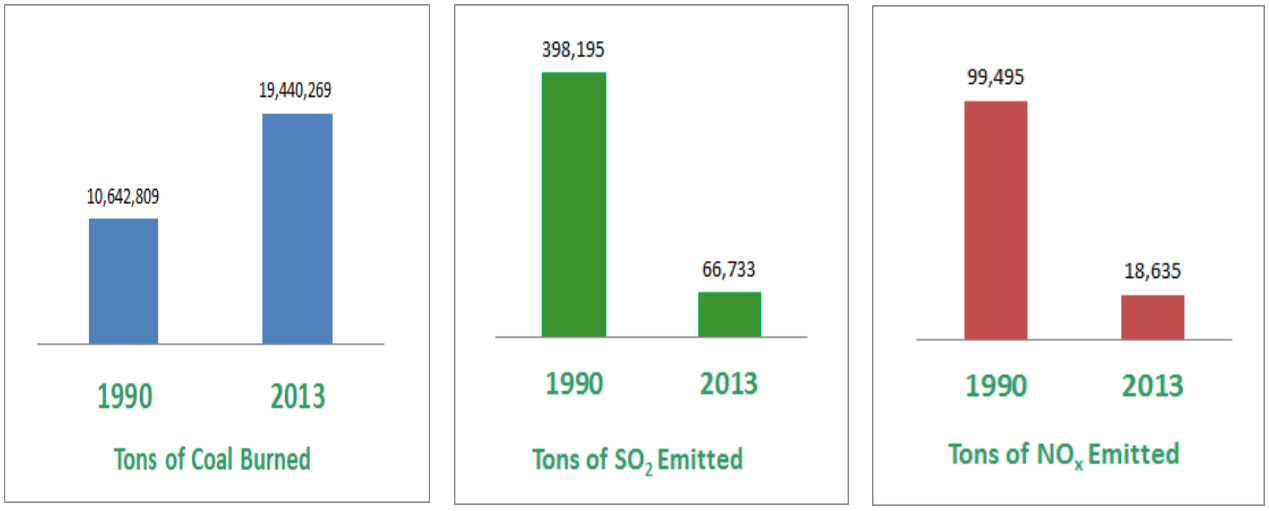
- Became the first generating plant in Missouri to burn chipped rubber tires to augment coal as an alternate fuel source. Sioux Energy Center has burned more than 19 million discarded tires, which would otherwise end up in a landfill, without adversely affecting power plant emissions from 1992 to 2006.

Ameren Missouri has installed wet flue gas desulfurization (FGD) equipment (i.e., scrubbers) at Sioux to comply with the federal Clean Air Interstate Rule (CAIR). CAIR required a major reduction in sulfur dioxide (SO_2) and NO_X emissions on a regional scale by 2015 to help areas in the eastern U.S. achieve improved air quality. The Sioux scrubbers will now help Ameren Missouri to comply with the Cross-State Air Pollution Rule (CSAPR), which will replace CAIR when implemented. When the scrubbers were installed, the tire handling facilities were removed and chipped tires can no longer be burned. The Sioux scrubbers are capable of removing up to 99% of the SO_2 from the boiler flue gas and started operating in October and November 2010.

Historical Emissions from Coal Resources

Ameren Missouri has achieved dramatic decreases in SO_2 and NO_x emissions during the past two decades, despite an increase in the amount of coal consumed to meet our customer's growing energy needs over that period. Over the years, Ameren Missouri has been able to reduce pollutant emissions by using lower-sulfur fuels, by installing cleaner-emitting burners with computer-controlled operation, by improving operation of existing precipitators -- collecting more than 99% of particulates -- and by installing scrubbers at Sioux Energy Center. In addition, Ameren Missouri developed an early, progressive approach to meeting NO_x control regulations. Figure 4.2 shows the decrease in Ameren Missouri's SO_2 and NO_x emissions as coal consumption has increased.

Figure 4.2 SO_2 and NO_x Emissions Reductions



4.1.2 Existing Gas & Oil Resources

Ameren Missouri owns and operates oil or natural gas-fired combustion turbine generators (CTG) to provide electricity during times of high demand or when its higher utilization plants are not operating due to a forced outage or scheduled maintenance.

In Fall 2011, two CTG plants were retired: Venice 1 (Net Capability: 25 MW) and Viaduct (Net Capability: 25 MW).

Table 4.1 lists the Ameren Missouri combustion turbines and their 2014 summer net generating capabilities.

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[redacted]

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Table 4.1 CTG Capability

Plant	Fuel	Net MW
Audrain	Gas	600
Goose Creek	Gas	432
Kirksville	Gas	13
Pinckneyville	Gas	316
Raccoon Creek	Gas	300
Kinmundy	Gas/Oil	206
Meramec CTG	Gas/Oil	99
Peno Creek	Gas/Oil	188
Venice	Gas/Oil	487
Fairgrounds	Oil	54
Howard Bend	Oil	39
Mexico	Oil	54
Moberly	Oil	54
Moreau	Oil	54
Total		2,896

4.1.3 Existing Nuclear Resource

Callaway Energy Center is located about 100 miles west of St. Louis, Missouri, in Callaway County. The plant started operations in December 1984 and is the only power plant that uses nuclear fuel in Ameren Missouri's generation fleet. It is the second largest power generator on the Ameren Missouri system with a net capability of 1,190 MW, after Labadie. More than 900 Ameren Missouri employees and contractors work at the plant.

[3] 4 CSR 240-22.040(3)(B)

4.1.4 Existing Renewable and Storage Resources

Currently, Ameren owns and operates 381 MW of hydroelectric resources and 440 MW of pumped storage with an additional purchase power agreement for 102 MW of wind generation. In December 2010, Ameren Missouri completed the installation of approximately 100 kW of solar panels at its St. Louis General Office Building (GOB) using monocrystalline, polycrystalline and thin-film technologies. In June 2012, Ameren Missouri began operation of 9 MW (net) of landfill gas generation at the Maryland Heights Renewable Energy Center (MHREC) in west St. Louis County.

Existing Hydroelectric Resources
Keokuk

Ameren Missouri's Keokuk hydroelectric plant is located on the Mississippi River at Keokuk, Iowa, 180 miles north of St. Louis. The Keokuk Energy Center has a total net summer capability of 141 MW.

More than a million cubic yards of earth and rock were excavated to build the Keokuk dam and plant, which began operation in 1913. The history of the site as a power source began as far back as 1836, when Robert E. Lee conducted a survey for what was then known as the War Department and called attention to the power potential of this section of the Mississippi. An engineering marvel of its time, Keokuk is the largest privately owned and operated dam and hydroelectric generating plant on the Mississippi River. Over the years, Ameren Missouri has continued to invest millions of dollars for the modernization and repair of the plant and dam.

Ameren Missouri also owns some 12,000 acres of flowage land and land covered by water. The company controls or has flowage rights on a total of 55,000 acres of land above the dam, including many islands, wetlands, and timberlands. The lake is a haven for boating and fishing and hosts several nationally recognized bass tournaments.

As it passes through the power plant, falling water spins turbines, or water wheels, which drive generators that produce electricity. Keokuk Plant is a "run-of-river plant," meaning that all water flowing downstream passes the plant on a daily basis. No water is stored. An average day of operation at Keokuk Plant saves the equivalent of nearly 1,000 tons of coal. The Keokuk Energy Center was certified as a qualified renewable energy resource by the MoDNR in September 2011.

Keokuk Energy Center completed two unit upgrades in July 2012. As a result, the ratings on Keokuk Units 2 and 4 increased by 2 MW each.

Osage

Ameren Missouri's Osage hydroelectric plant is located in Lakeside Missouri on the Osage River at the Lake of the Ozarks. The Osage Energy Center has a total net summer capability of 240 MW.

Osage began operation in 1931. For early settlers, the rolling Osage River in the heart of Missouri's Ozark wilderness provided a way of life and a source of livelihood, whether that was fishing, farming, logging or other pursuits. Then in the 1930s, the river was harnessed when Union Electric Company (now Ameren Missouri) built Bagnell Dam to provide power for a growing state and a budding economy. The 1930s-era building of Bagnell Dam and Ameren Missouri's Osage hydroelectric plant created a range of recreational opportunities in the now popular Lake of the Ozarks.

Every hour the Osage Plant operates, other energy resources, which take thousands of years to replace, are preserved. As water passes through the dam, the pressure of the falling water spins water wheels, which drive generators that produce electricity. In a typical year, Osage Plant uses the clean energy of falling water to produce as much power as 225,000 tons of coal or one million barrels of oil.

Existing Pumped Storage
Taum Sauk

The Taum Sauk pumped storage plant is located approximately 120 miles southwest of St. Louis in the scenic Ozark highlands. The Taum Sauk Energy Center has a total net summer capability of 440 MW.

Taum Sauk Plant began operation in 1963, the turbines were completely rebuilt in 1999, and the upper reservoir rebuild project was completed in 2010. Taum Sauk is used primarily on a peaking basis and is put into operation when the demand for electricity is greatest. The pump storage system works much like a conventional hydroelectric plant, but is usually used only to meet daily peak power demands for short periods. Water stored in an upper reservoir is released to flow through turbines and into a lower reservoir during high energy demands. Then, overnight, when the demand for electricity is low, the water is pumped back into the upper reservoir, where it is stored until needed. As water passes through the powerhouse, water spins the turbines, which drive generators to produce electricity. The Taum Sauk facility has a pump back efficiency of 71.4%.

Existing Renewables
Pioneer Prairie Wind Farm

In June 2009, Ameren Missouri executed an agreement to purchase 102 MW of wind power from Phase II of Horizon Wind Energy's Pioneer Prairie Wind Farm in northeastern Iowa in Mitchell County. The wind farm is fully operational with both phases having a total capacity of more than 300 MW. This Purchase Power Agreement runs from September 2009 through August 2024. The Pioneer Prairie Wind Farm was certified as a qualified renewable energy resource by the MoDNR in September 2011. The power Ameren Missouri is purchasing ties into the MISO transmission grid, of which the company is a member. Since Phase II does not currently meet the MISO deliverability requirements of a Capacity Resource, Ameren Missouri would be required to pay for a study to determine deliverability and possibly need to purchase firm transmission to utilize this capacity to meet the planning reserve margin requirements in Missouri. Because MISO only provides for 14% of the nameplate rating of a wind generator to be counted as capacity when it is deliverable and because capacity prices in MISO remain relatively low, incurring the expense to establish deliverability has not been considered economically viable to this point.

Ameren Missouri Headquarters Solar Installation

In December 2010, Ameren Missouri completed the installation of approximately 100 kW of various photovolatic solar technologies using monocrystalline, polycrystalline and thin-film technologies at its headquarters office building located in St. Louis. The Ameren Missouri GOB solar installation was certified as a qualified renewable generation facility by the MoDNR in September 2011. The goal of Ameren Missouri's Solar Energy Project is to provide a state-of-the-art testing ground to compare various solar technologies. This allows our customers to determine which photovoltaic components will best suit their home or business needs. In addition, Ameren Missouri established an Energy Learning Center at our St. Louis Headquarters where visitors are able to see our rooftop solar energy system and learn more about renewable energy at Ameren.

Maryland Heights Renewable Energy Center

The MHREC is located in St. Louis County approximately 18 miles northwest of St. Louis. The MHREC is the largest landfill-gas-to-electric facility in Missouri and one of the largest in the country, generating enough renewable energy to power approximately 10,000 average Missouri homes.

The MHREC began operation in June 2012. It has a total net summer capacity of 9 MW (net). This facility burns methane gas produced by the IESI Landfill in Maryland Heights, MO, in three Solar 4.9 MW Mercury 50 gas turbines to produce electricity. The current contract with the landfill guarantees enough gas supply for three generators until 2022. In August 2012, the MHREC was certified as a qualified renewable energy resource by the MoDNR.

4.1.5 Levelized Cost of Energy Evaluation for Existing Resources[4]

The levelized cost of energy was calculated for Ameren Missouri's existing resources. It is important to note that the levelized cost of energy figures do not fully capture all of the relative strengths and challenges of each resource type. Table 4.2 shows the component analysis for the levelized cost of energy for each energy center. The average levelized cost of energy for Ameren Missouri's coal energy centers is approximately $58/MWh. The average levelized cost of energy for Ameren Missouri's entire generating fleet is approximately $82/MWh.

Table 4.2 Levelized Cost of Energy Component Analysis for Existing Resources

Resource	Levelized Cost of Energy (¢/kWh)										
	Non-Environmental Costs					Probable Environmental Costs					Total Cost
	Non-Env Capital	Fixed and Variable O&M	Fuel	Decommission	Pump MWh	Env Capital	Env O&M	CO2	SO2	NOx	
Existing Resources											
Labadie	0.52	0.45	3.06	--	--	0.68	0.23	0.37	0.00	0.01	**5.33**
Rush Island	0.44	0.60	3.19	--	--	0.20	0.05	0.41	0.00	0.00	**4.89**
Meramec	0.26	1.71	2.82	--	--	2.10	0.17	0.09	0.00	0.00	**7.16**
Sioux	1.06	0.85	2.88	--	--	0.74	0.09	0.25	0.00	0.00	**5.88**
Audrian	0.00	0.46	7.00	--	--	--	0.00	0.15	0.00	0.00	**7.61**
Goose Creek	0.01	0.57	8.09	--	--	--	0.00	0.18	0.00	0.00	**8.84**
Kirksville	0.00	0.02	8.61	--	--	--	--	0.00	0.00	0.00	**8.63**
Pinckneyville	0.00	1.59	8.01	--	--	--	--	0.17	0.00	0.00	**9.78**
Raccoon Creek	0.00	0.78	8.68	--	--	--	--	0.19	0.00	0.00	**9.64**
Kinmundy	0.00	1.61	8.01	--	--	--	--	0.17	0.00	0.00	**9.80**
Meramec CTG	0.02	0.12	4.70	--	--	--	--	0.00	0.00	0.00	**4.85**
Peno Creek	0.01	3.49	8.01	--	--	--	--	0.17	0.00	0.00	**11.69**
Venice	0.00	0.97	6.46	--	--	--	--	0.14	0.00	0.00	**7.57**
Fairgrounds	0.80	0.12	8.61	--	--	--	--	0.00	0.00	0.00	**9.52**
Howard Bend	4.84	2.56	6.02	--	--	--	--	0.00	0.00	0.00	**13.42**
Mexico	0.00	0.39	8.89	--	--	--	--	0.00	0.00	0.00	**9.28**
Moberly	0.00	0.34	5.90	--	--	--	--	0.00	0.00	0.00	**6.25**
Moreau	0.00	0.17	9.74	--	--	--	--	0.00	0.00	0.00	**9.91**
Callaway	1.82	1.99	1.16	0.07	--	--	--	0.00	0.00	0.00	**5.05**
Keokuk	1.80	0.51	0.00	--	--	--	--	0.00	0.00	0.00	**2.31**
Osage	2.00	1.34	0.00	--	--	--	--	0.00	0.00	0.00	**3.34**
Taum Sauk	0.75	1.20	0.00	--	7.74	--	--	0.00	0.00	0.00	**9.69**
Maryland Heights CTG	0.04	10.41	7.39	--	--	--	0.00	0.00	0.00	0.00	**17.84**

[4] 4 CSR 240-22.040(2)(A); 4 CSR 240-22.040(2)(B); 4 CSR 240-22.040(2)(C)1

4.1.6 Planned Changes to Existing Non-Coal Resources

During the 20-year planning horizon, Ameren Missouri is considering four Keokuk Energy Center Units for upgrades, adding a new CTG unit at MHREC, adding the largest investor-owned utility solar center in Missouri with approximately 5.7 MW [direct current (DC)] capacity, and the potential retirement of eight CTG units.

Portfolio Upgrades

Keokuk Energy Center is scheduled to complete two unit upgrades in 2016. The net output on Keokuk Units 5 and 6 will increase by 2 MW each with a total capital cost of approximately $23.5 million (for the turbine component upgrades only) budgeted in 2014, 2015, and 2016. In addition, two unit upgrades at Keokuk Energy Center are scheduled to be complete in 2018. The net output Keokuk Units 14 and 15 will increase by 2 MW each with a total capital cost of approximately $25 million (for the turbine component upgrades only) budgeted in 2016, 2017, and 2018.

Ameren Missouri is considering adding a fourth CTG unit at MHREC that will be in service in 2018. The fourth unit will provide an additional 3-4 MW of summer net capacity with a total capital cost of $16-18 million in 2017-2018 and will provide additional renewable energy needed for meeting the requirements of Missouri's Renewable Energy Standard (RES).

Ameren Missouri intends to install 5.7 MW (DC) of solar photovoltaic generation next to the Ameren Missouri Belleau substation in St. Charles County. The solar center, O'Fallon Renewable Energy Center (OREC), will feature approximately 19,000 solar panels covering approximately 20 acres on land owned by Ameren Missouri. Construction is anticipated to begin in spring 2014. The installation is scheduled to be in service by 2015 with a total capital cost ranging from $10-$20 million in 2014.

CTG Retirements

In 2013, Ameren Missouri conducted a high level retirement evaluation of the existing CTG fleet. The potential retirement recommendation is based on operating experience, condition of the assets, and qualitative analysis. The qualitative analysis considered factors such as condition of subsystems, obsolesce of control systems, availability of spare parts, and building condition. Based on the evaluation, Ameren Missouri should consider retiring some or all of its eight older gas and oil fired CTG units (i.e., Kirksville, Howard Bend, Fairgrounds, Meramec CTG-1, Meramec CTG-2, Mexico, Moberly, and Moreau) with a total net capacity of 367 MW over the next 20 years. A combination of factors lead to the potential CTG retirement recommendations, including the fact that the average age of seven of the units is 38 years; and for some of the units, the long-term availability of spare parts is questionable. The lead time for obtaining spare parts

is unknown. Table 4.3 provides a summary of the planned CTG retirements. The planned CTG retirements are included in the base capacity position (see Appendix B).

In 2013, only one engine at Howard Bend successfully operated during testing for MISO operating compliance. The existing stack is also severely deteriorated and must be replaced. In order for both engines at Howard Bend to be operated reliably, approximately $2.4 million of capital and approximately $1.4 million of O&M improvements would be needed to operate the unit in the near-term. In addition, annual expenses of at least $100,000 are anticipated at Howard Bend for items including maintenance, monthly runs, and inspections. An economic analysis was conducted to determine the present value of revenue requirements (PVRR) if the improvements were implemented at Howard Bend. The PVRR, which includes benefits of capacity value, is approximately $2 million net costs to customers, indicating that the improvements are not beneficial. It is likely that Howard Bend will be retired in early 2015 due to the age of the unit, long-term availability of spare parts, safety and the poor economics associated with refurbishment.

The existing stack at Fairgrounds is severely deteriorated and needs to be replaced. There is a strong possibility that Fairgrounds will be retired in 2015 due to costs associated with replacing the stacks, the age of the unit, long-term availability of spare parts, and safety. With respect to the remaining CTGs listed in Table 4.3, as the assumed retirement date for each unit approaches, a detailed condition assessment of each unit will be developed to accurately assess the asset's condition and develop a work scope with estimated costs to make the assets reliable and operational.

Table 4.3 Ameren Missouri Potential CTG Retirements during the Planning Period

Unit	Capacity (MW)	Fuel Type	Commerical Operation Date	Age as of 12/31/2013	Retirement Time Frame
Kirksville	13	Natural Gas	1967	46	12/31/2017
Howard Bend	39	Oil	1973	40	01/31/2015
Fairgrounds	54	Oil	1974	39	06/30/2015
Meramec CTG-1	54	Oil	1974	39	12/31/2017
Meramec CTG-2	45	Natural Gas/Oil	1999 (1)	37	12/31/2020
Mexico	54	Oil	1978	35	12/31/2020
Moberly	54	Oil	1978	35	12/31/2020
Moreau	54	Oil	1978	35	12/31/2020

Note: (1) Meramec CTG 2 was acquired by Ameren Missouri in 1999 and is 1976 vintage.

The results of the detailed condition assessment for each unit will be used as the basis for economic analysis to be considered along with other factors such as overall age, condition, reliability, safety and cost and availability of spare parts.

4.2 Existing Coal Generation Evaluation

Ameren Missouri has evaluated its coal energy centers in terms of condition, base retirement assumptions, reliability trends, operation and maintenance costs, and capital expenditures. Table 4.4 lists the commercial operation date for each generating unit, the average age at each energy center as of 12/31/2013, and the base retirement assumptions based on the 2014 Black & Veatch Report on Life Expectancy of Coal-Fired Power Plants.

Table 4.4 Ameren Missouri Coal Energy Center Commercial Operation Dates, Average Age, and Base Retirement Assumptions

	Commercial Operation Date				Average Age as of	Base Retirement Assumptions
Energy Center	Unit 1	Unit 2	Unit 3	Unit 4	12/31/2013	(Retirement Date)
Labadie	1970	1971	1972	1973	42	2042
Meramec	1953	1954	1959	1961	57	2022
Rush Island	1976	1977			37	2046
Sioux	1967	1968			46	2033

4.2.1 Reliability Trends

One of the key measures used by Ameren Missouri to measure coal energy center performance is the equivalent availability factor (EAF). The EAF is a measure of how much energy could be produced if the plant is operated at its full capability after taking into account down time for repairs. Down time could be for long term planned outages, short term forced or maintenance outages for minor repairs, or equipment or other limitations that prevent the unit from operating at its rated output. Figures 4.3 to 4.6 present the EAF charts contain a rolling 12 month, a rolling 36 month, and a rolling 72 month trend for each coal energy centers. The rolling 72 month (6 year) measure is the most relevant to resource planning because the planned outages, which occur at long intervals, distort the EAF trends produced by the rolling 12 month or rolling 36 month trends. The EAF calculations were done with the North American Electric Reliability Corporation (NERC) conversion method of Outside Management Control events. Some events may be excluded from the calculations.

Figures 4.3 to 4.6 do not indicate any sustained downward trends in EAF which would indicate a deterioration of energy centers as they age. It is important to note that

maintaining levels of reliability is in part dependent on the continued maintenance of and investments in equipment.

Figure 4.3 Labadie Energy Center Equivalent Availability

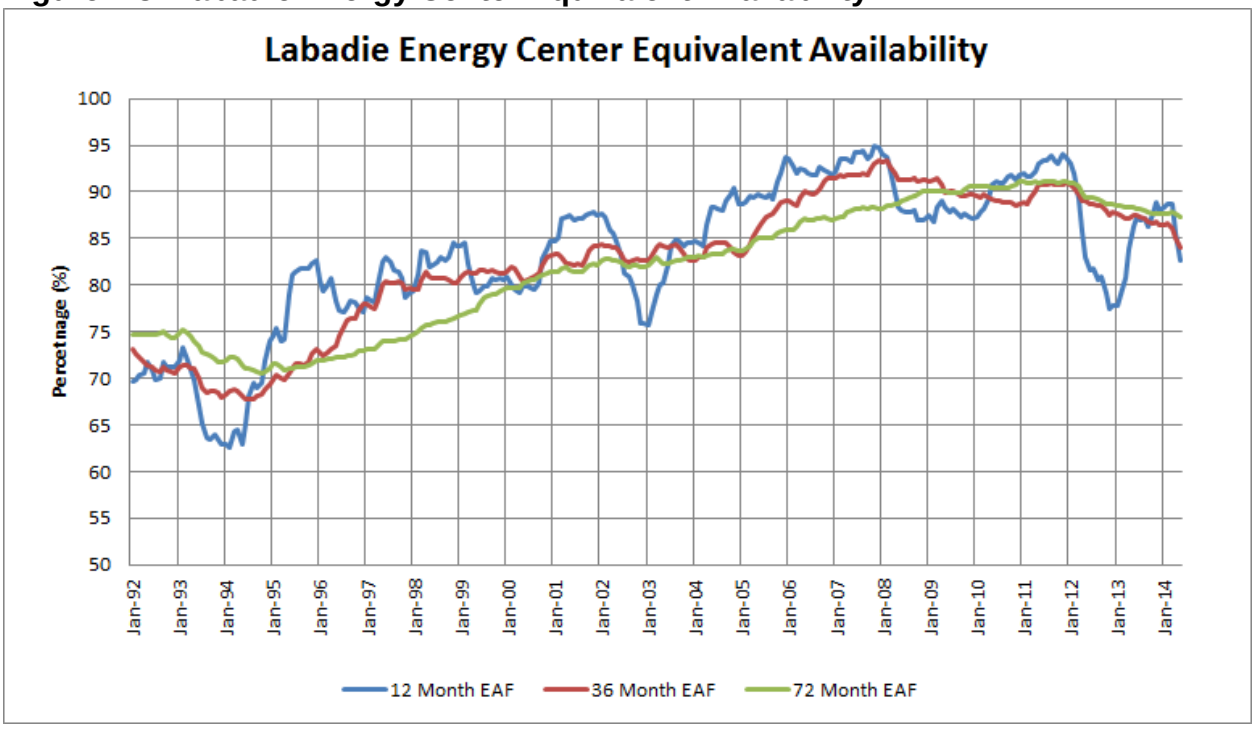


Figure 4.4 Meramec Energy Center Equivalent Availability

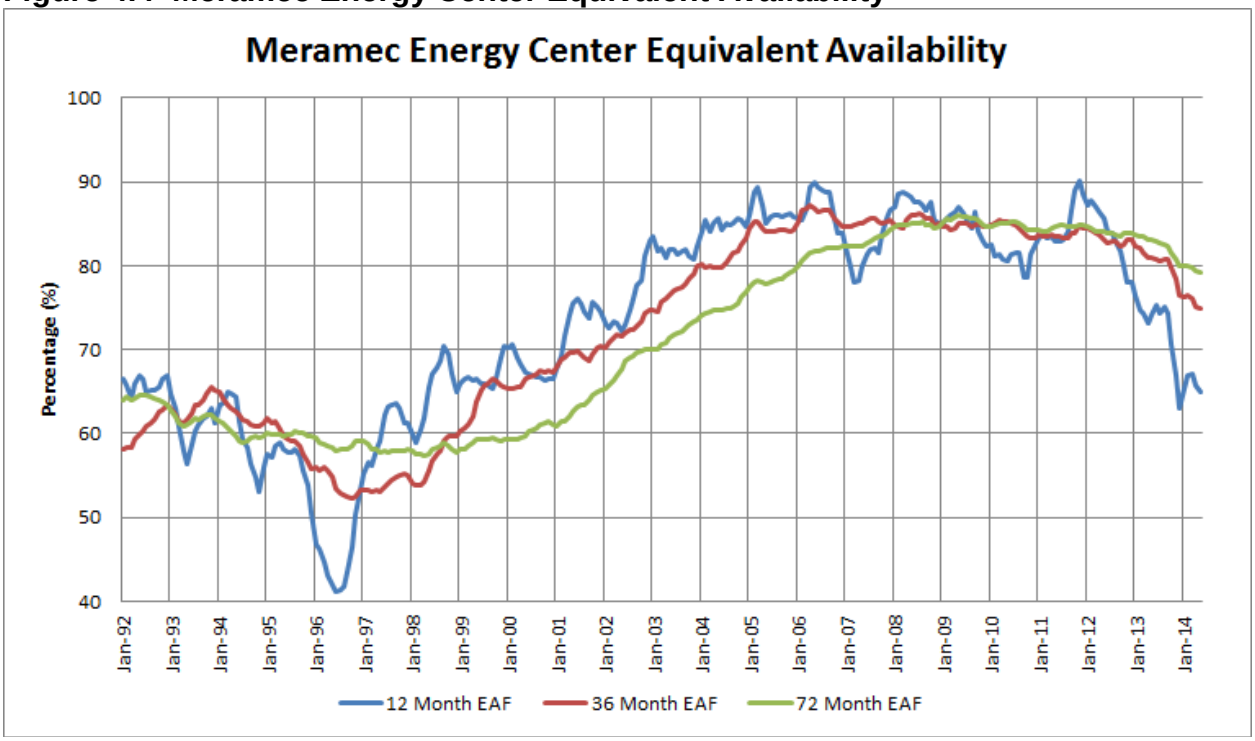


Figure 4.5 Rush Island Energy Center Equivalent Availability

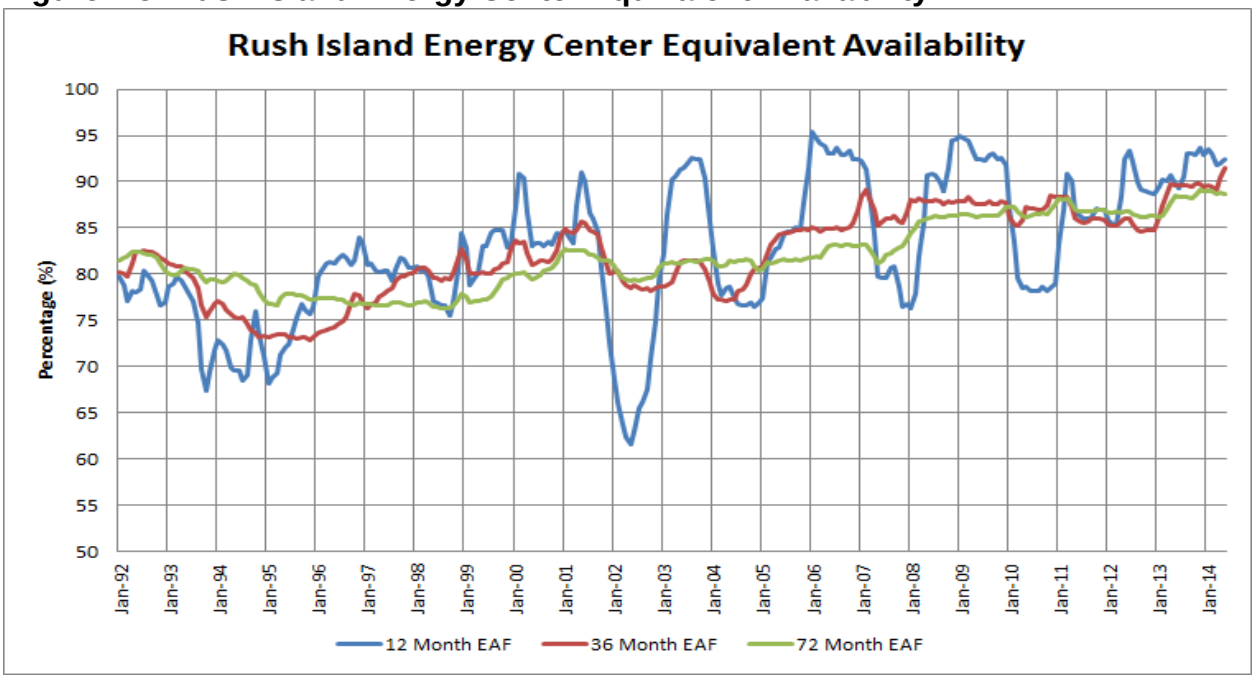
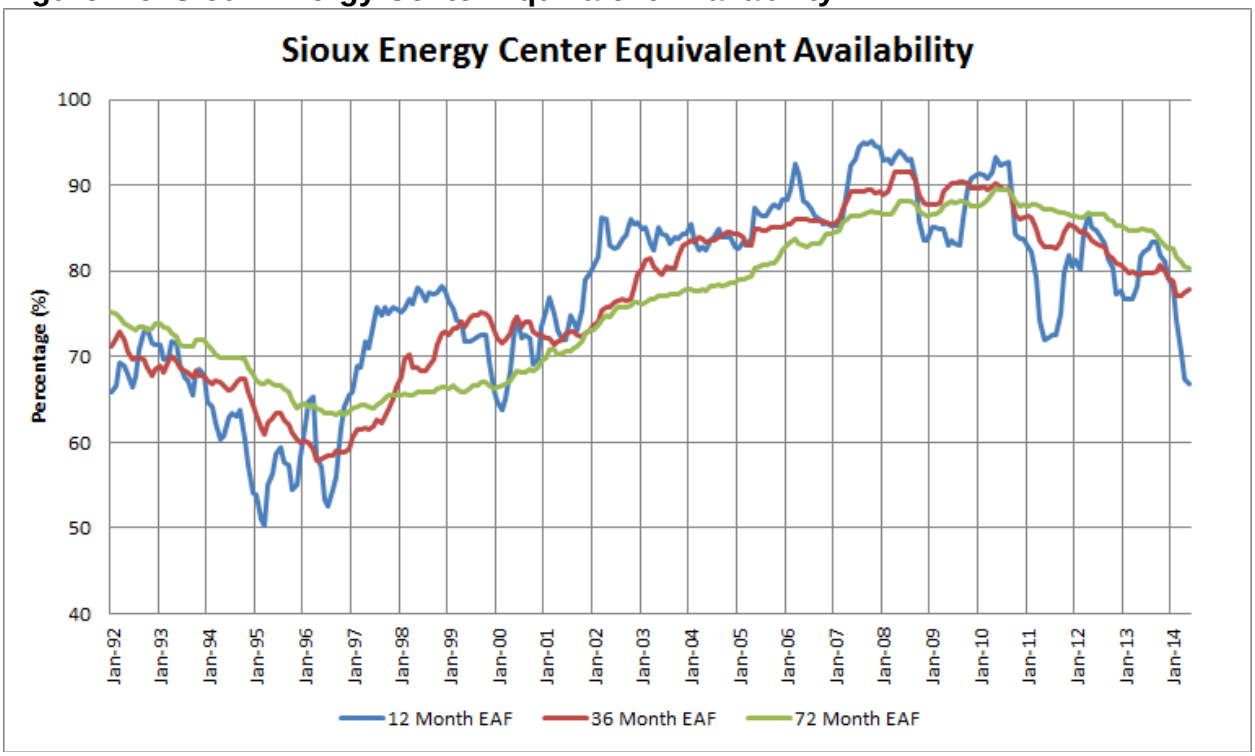


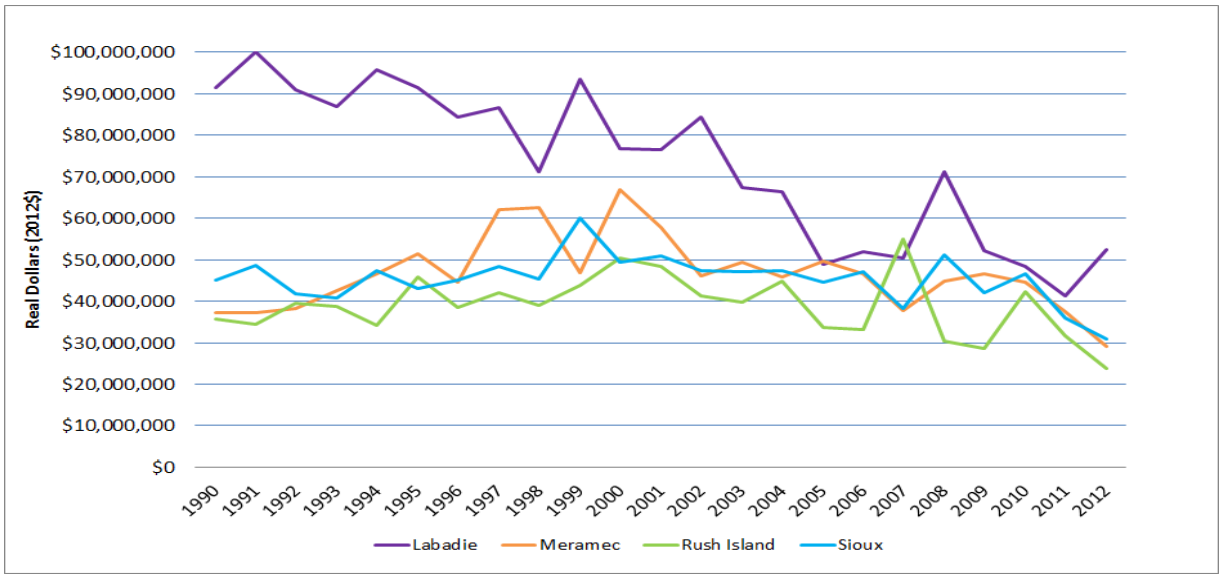
Figure 4.6 Sioux Energy Center Equivalent Availability



4.2.2 Operations and Maintenance Costs

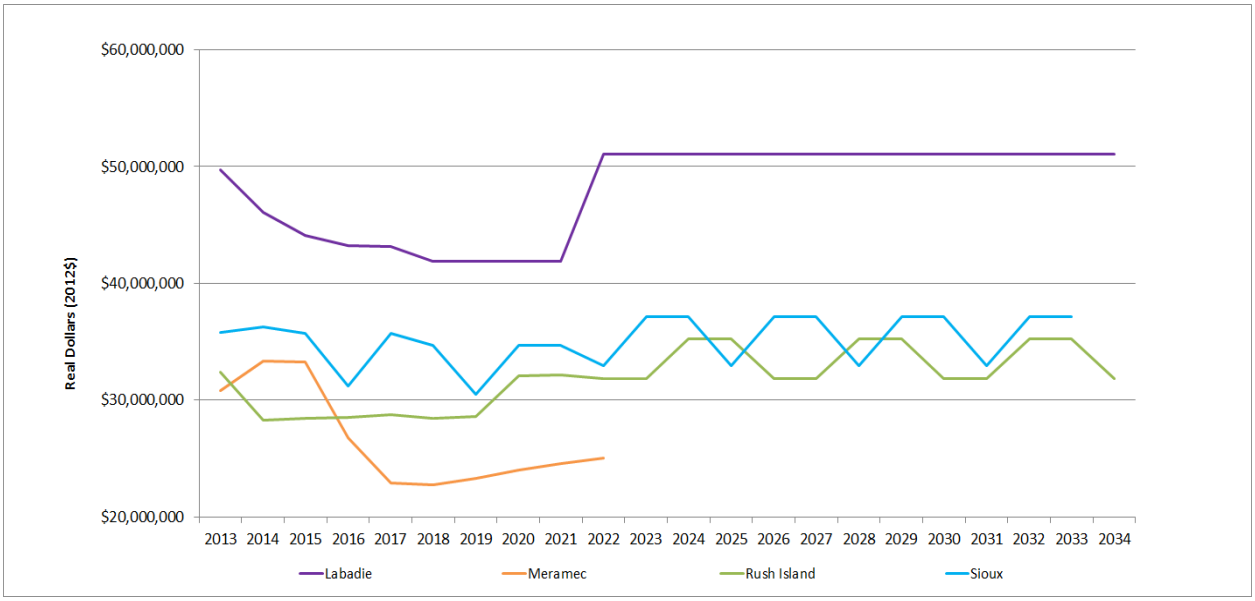
Figure 4.7 shows the historical operations and maintenance (O&M) costs for Ameren Missouri's four coal-fired energy centers from 1990 to 2012. The plant O&M costs were taken from the annual plant operating reports and then normalized to 2012 dollars using the Handy Whitman Index for Total Steam Production Plant. The average annual escalation for the period 1990 to 2012 was 3.3%. These costs are non-fuel O&M expenses. Labadie's O&M decreased and the other energy centers' O&M has remained relatively flat in real terms over the time period with a moderate downward trend in the last 10-15 years. Although the O&M costs were declining or relatively flat, the reliability of the energy centers has remained constant or improved as illustrated in the previous section.

Figure 4.7 Historical Annual O&M for Ameren Missouri Coal Energy Centers (2012$)



The plant O&M costs are anticipated to remain relatively flat to slightly increasing in real terms in the future. Figure 4.8 shows the future O&M costs from 2013 to 2034 in 2012 dollars. The labor portion of the O&M assumes a 50% pension and benefit loading factor. In addition, the O&M forecasts assume annual revenues from refined coal operations at Labadie, Rush Island, and Sioux from 2014 through 2021. A 12 year outage cycle for Labadie and Rush Island and a three year outage cycle for Sioux are assumed in the O&M forecast. In the retirement year of each plant, what would otherwise be capital expenditures are included in O&M costs for modeling purposes.

Figure 4.8 Future Annual O&M for Ameren Missouri Coal Energy Centers (2012$)



4.2.3 Capital Expenditures

Figure 4.9 shows the historical capital expenditures (environmental and non-environmental) from 2001 to 2012. The plant capital expenditures were taken from the Ameren Missouri accounting system and normalized to 2012 dollars using a 2% escalation rate. Labadie's capital expenditures were relatively flat with the exception of 2012. In 2012, the capital expenditures increased mainly due to a turbine retrofit and electrostatic precipitator (ESP) projects at Labadie to comply with MATS. Meramec's capital expenditures decreased over the time period. Rush Island's capital expenditures remained relatively flat over the time period. Sioux's capital expenditures increased from 2006 to 2010 mainly due to the installation of the WFGD system for SO_2 control.

Figure 4.9 Historic Capital Expenditures Ameren Missouri Coal Energy Centers (2012$)

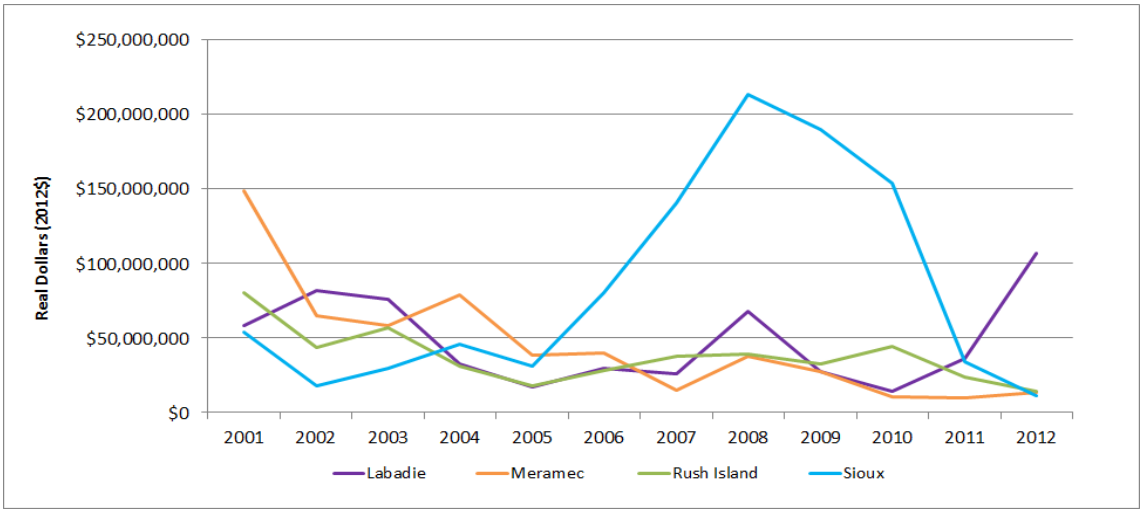
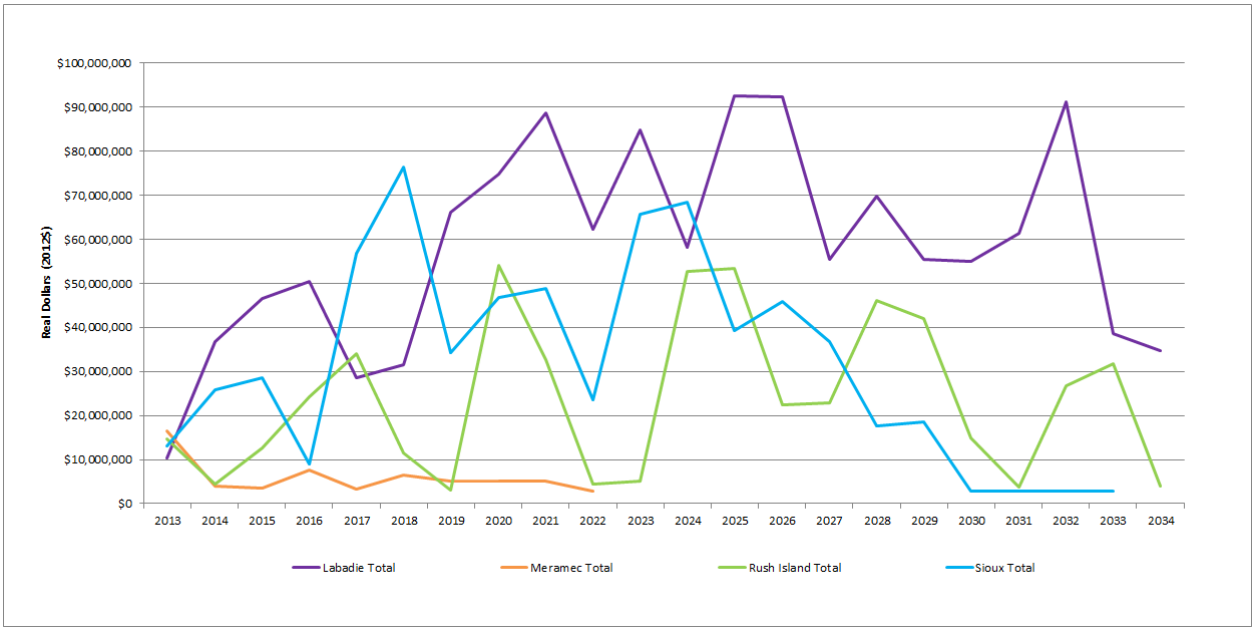


Figure 4.10 shows the future non-environmental capital expenditures for 2013 to 2034. The future environmental capital expenditures are discussed in Chapter 5. The future non-environmental plant capital expenditures were provided by Ameren Missouri Power Operations Services and normalized to 2012 dollars using a 2% escalation rate. Labadie's capital expenditures show a slight increasing trend over time due to boiler and landfill projects. Meramec and Sioux energy centers show a decreasing trend in non-environmental capital expenditures over the time period. Rush Island capital expenditures are expected to remain relatively flat over the time period.

Figure 4.10 Future Non-Environmental Capital Expenditures Ameren Missouri Coal Energy Centers (2012$)



4.2.4 Potential Conversion of Meramec Units to Natural Gas-Fired Operation

Ameren Missouri conducted an internal preliminary evaluation for the potential conversion of the Meramec Energy Center Units 1-4 from coal to natural gas-fired operations. Units 1&2 were designed with the capability to operate on natural gas; however, these units have not operated at full load on natural gas since 1993. Therefore, restoration of devices and equipment is needed for Units 1&2 to operate fully on natural gas. The expected cost to restore Units 1&2 to natural-gas operations is estimated to be less than $2 million. Units 3&4 are currently capable of coal-fired operations only. The expected cost to convert Units 3&4 to natural-gas operations is expected to be over $40 million.

In 2014, Burns & McDonnell completed a Condition Assessment for the Meramec Energy Center to determine ongoing costs to keep the plant operating safely and reliably through the planning horizon. The Condition Assessment was used to develop the Meramec Options that were evaluated in the alternative resource plans discussed in Chapter 9. Three different Meramec retirement options were considered: 1) retirement by December 31, 2015, 2) retirement by December 31, 2022, and 3) conversion of Units 1&2 to Natural Gas as of December 31, 2015 with Units 3&4 continuing on coal and retirement of all four units by December 31, 2022.

4.3 Potential Expansion of Existing Hydroelectric Resources

4.3.1 Keokuk Hydroelectric Expansion Opportunities

Ameren Missouri retained HDR Engineering, Inc. (HDR|DTA) to evaluate potential expansion options for increasing generation at the Keokuk Hydroelectric Energy Center located on the Mississippi River in Keokuk, Iowa. This included identifying opportunities for increasing performance of the existing generating units, adding generation at the existing powerhouse and/or Lock No. 19 (a navigation lock that is owned and operated by the U.S. Army Corps of Engineers), and possibly adding generating units in the spillway or from a separate powerhouse adjacent to the eastern side of the Keokuk Dam. In 2011, HDR|DTA prepared a report entitled *Keokuk Hydroelectric Project Expansion Study Concept Report* that summarizes the 14 potential expansion options that were evaluated, results, and conclusions.

Seven of the 14 potential expansion options, listed below and retaining the option designations from the HDR|DTA study, were evaluated further with approximate additional generating capacity ranging from 4.5 to 162 MW.

- **Option 1**: Restore/upgrade the two House Units that are currently not operational.
- **Option 2**: Implement draft tube modifications that will increase performance for all fifteen main unit turbines.
- **Option 2a**: Restore/upgrade the two House Units that are currently not operational and implement draft tube modifications that will increase performance for all fifteen main unit turbines.
- **Option 3 (3-5K)**: Use the five spare bays to add generating units (10 MW Kaplan Units).
- **Option 3a-5K**: Restore/upgrade the two House Units that are currently not operational and use the five spare bays to add generating units (10 MW Kaplan Units).
- **Option 3a-15K**: Restore/upgrade the two House Units that are currently not operational and use the 15 spare bays to add generating units (10 MW Kaplan Units).

- **Option 3c-15K**: Restore/upgrade the two House Units that are currently not operational; implement draft tube modifications that will increase performance for all fifteen main unit turbines; and use the 15 spare bays to add generating units (10 MW Kaplan Units).

Table 4.5 provides a summary of the operating and cost characteristics that were evaluated in a levelized cost of energy analysis (LCOE). Cost assumptions from the original HDR|DTA evaluation were reviewed with internal subject matter experts and revised as appropriate.

Table 4.5 Summary of Operating and Cost Characteristics (2013$)

	Option	Additional Capacity (MW)	Additional Average Annual Energy (MWh)	Project Cost ($1,000)	Annual Fixed O&M ($/yr), ($1,000)	Annual Variable O&M ($/yr), ($1,000)	LCOE (¢/kWh)
1	Restore/Upgrade Non-Operational House Units	4.5	18,271	27,151	56	37	15.66
2	Implement Draft Tube Modifications	7.5	5,974	45,554	38	5	77.79
2a	Restore House Units, Implement Draft Tube Modifications	12	22,486	63,359	90	42	28.37
3 (3-5K)	New Units to Spare Bays (Add 5 Kaplan Units)	50	170,408	255,884	255	74	14.96
3a-5K	Restore House Units, Add 5 Kaplan Units	54.5	175,202	272,412	497	111	15.68
3a-15K	Restore House Units, Add 15 Kaplan Units	154.5	372,168	731,491	791	260	19.61
3c-15K	Restore House Units, Implement Draft Tube Modifications, Add 15 Kaplan Units	162	376,104	767,837	554	223	20.84

Based on the *Keokuk Hydroelectric Project Expansion Study Concept Report*, two projects were identified as viable options for further consideration: Option 1 and Option 3. Table 4.5 shows that Option 3 (3-5K) is the least cost option. Therefore, Option 3 (3-5k) was selected for further evaluation in the integration analysis, discussed in Chapter 9.

4.4 Efficiency Improvements[5]

4.4.1 Existing Facility Efficiency Options

Ameren Missouri has implemented various initiatives to improve efficiency and reduce greenhouse gas (GHG) emissions at its existing facilities. These initiatives include replacement of incandescent light bulbs with compact fluorescent light bulbs, and standardization on low-energy usage light fixtures during system replacements. Another initiative to improve efficiency and reduce GHG emissions in the operation of

[5] 4 CSR 240-22.040(1)

heating, ventilation, and air conditioning (HVAC) equipment through the installation of programmable thermostats for control of HVAC systems is expected to reduce energy consumption during off-hours. In 2011 and 2012, Ameren Missouri completed several energy efficiency projects that will reduce energy consumption by more than 1,000 MWh annually and reduced carbon dioxide (CO_2) emissions by more than 870 metric tons annually (assuming 0.73 metric tons of CO_2 per 1 MWh). Ameren Missouri will continue assessing and implementing the projects that prove to be feasible on an ongoing basis.

Ameren Missouri has been proactive in monitoring the status of light-emitting diode (LED) technology. The company engaged EPRI to conduct a pilot program, testing 11 street lights in the city of Ballwin, Missouri beginning in 2009 and lasting approximately 36 months. This pilot, part of a larger, national effort, provided key insights into the performance of LED street and area lighting (SAL) technology. While there were multiple findings from the EPRI study, there are a few important observations to note:

- **Reliability** – EPRI uncovered multiple issues with the products submitted in the demonstration project including failures directly "out of the box" from the manufacturer, failures caused by faulty circuitry, LED driver failure, and manufacturer recalls.
- **Varying Power Draw Compared to Specifications** – EPRI discovered that many of the manufacturers' claims on power draw were optimistic and inconsistent with their field testing results.
- **Good light distribution** – LEDs were able to produce lighting patterns more uniformly than existing lighting technologies.

EPRI's study indicated that the LED SAL technology was "ready for energy efficiency programs for utilities." Given EPRI's findings, Ameren Missouri undertook a study of the economics of replacing its existing street lighting system with LEDs (Company owned street lights which represent greater than 90% of the street lights on Ameren Missouri's system). Ameren Missouri conducted multiple analyses to evaluate the economics of LED street lighting facilities and also conducted multiple risk analyses to provide more insight into the results. The overall conclusion is that while LEDs appear to be a viable technology, current economics and associated uncertainty do not support near-term adoption. Ameren Missouri will continue to monitor the various critical assumptions identified through this analysis, and will update the analysis as needed.

4.4.2 Existing Energy Center Efficiency Options[6]

In 2009, Ameren Missouri recognized the potential for end-to-end energy efficiency improvements, and engaged EPRI to undertake a study to identify, quantify, and prioritize energy efficiency project opportunities across its operations in electricity generation, transmission, distribution, and utilization at Ameren Missouri facilities. A team developed profiles of 37 candidate generation project types, which were screened on a unit-by-unit basis on technical applicability. The LCOE was calculated for the remaining 28 project types after the first screening.

In 2010, a team composed of Power Operations Support personnel further reviewed the 28 potential project types at Ameren Missouri's coal-fired energy centers and selected several for implementation. These projects included:

- Operation of both Sioux Energy Center units in partial arc operation
- Precipitator power optimization at Labadie Units 3&4
- Circulating water system improvements at Meramec Energy Center
- Circulating water debris filters and ball cleaning system installation on Labadie Unit 4
- Turbine spill strip restoration on Rush Island Unit 1

All of the above projects have been implemented successfully and each has contributed to improved efficiency on the respective units. These plant energy efficiency projects allow for a potential reduction in CO_2 emissions at the energy centers. For example, high pressure turbine efficiency improved by over 4% on Rush Island Unit 1 following the outage in which the turbine spill strips were restored. Operation of the Sioux units in partial arc operation is expected to increase efficiency by approximately 0.4% on each unit. The circulating water debris filters and ball cleaning system on Labadie Unit 4 has led to the highest condenser cleanliness factors at the energy center without the need to perform labor-intensive mechanical cleaning on the unit.

Ameren Missouri is in the process of replacing aging feedwater heaters at several energy centers. In 2012, Labadie replaced 10 feedwater heaters. Additional feedwater heater replacements are scheduled at several coal-fired energy centers over the next several years. Issues with aging feedwater heaters, such as tube leaks and excessive tube plugging, can cause large efficiency reductions. In addition, Ameren Missouri monitors and reports on efficiency at each coal-fired energy center on a periodic basis in an effort to maintain acceptable heat rate performance.

[6] 4 CSR 240-22.040(1)

As of 2012, the successful implementation of the above-mentioned projects, as well as other efforts, helped Ameren Missouri reduce heat rate by over 0.8% from a 2009 baseline. Ameren Missouri will continue assessing and implementing projects that look feasible on an ongoing basis.

4.5 Compliance References