VOLUME 4:

SUPPLY-SIDE RESOURCE ANALYSIS

KCP&L GREATER MISSOURI OPERATIONS COMPANY (GMO)

INTEGRATED RESOURCE PLAN

4 CSR 240-22.040

APRIL, 2015

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HIGHLIGHTS

- Over twenty generating technologies in various stages of development maturity have been analyzed and screened as potential future supply-side resources
- Candidate generation resources that passed screening included combustion turbines (CT), combined-cycle (CC), coal, nuclear , wind, and solar options and were made available as new generation resources in Integrated Analyses
- Existing power plant efficiency improvements have been an ongoing initiative at GMO generating units
- Future power plant efficiency projects have been identified and expected to be completed in upcoming years
- Existing generation resources have been studied to determine future environmental retrofit requirements and expected maintenance needs

PURPOSE: This rule establishes minimum standards for the scope and level of detail required in supply-side resource analysis.

SECTION 1: SUPPLY-SIDE RESOURCE

(1) The utility shall evaluate all existing supply-side resources and identify a variety of potential supply-side resource options which the utility can reasonably expect to use, develop, implement, or acquire, and, for purposes of integrated resource planning, all such supply-side resources shall be considered as potential supply-side resource options. These potential supply-side resource options include full or partial ownership of new plants using existing generation technologies; full or partial ownership

of new plants using new generation technologies, including technologies expected to become commercially available within the twenty (20)-year planning horizon; renewable energy resources on the utility-side of the meter, including a wide variety of renewable generation technologies; technologies for distributed generation; life extension and refurbishment at existing generating plants; enhancement of the emission controls at existing or new generating plants; purchased power from bi-lateral transactions and from organized capacity and energy markets; generating plant efficiency improvements which reduce the utility's own use of energy; and upgrading of the transmission and distribution systems to reduce power and energy losses. The utility shall collect generic cost and performance information sufficient to fairly analyze and compare each of these potential supply-side resource options, including at least those attributes needed to assess capital cost, fixed and variable operation and maintenance costs, probable environmental costs, and operating characteristics.

1.1 NEW PLANT RESOURCE OPTIONS

1.1.1 TECHNOLOGY CATEGORIES

The evaluation of potential supply-side resource options began with the identification of twenty-three existing or new technology alternatives. The information for these potential supply-side technologies was gathered from multiple sources including the Electric Power Research Institute (EPRI), the Department of Energy (DOE), responses to recent Request for Proposals (RFP), and other internal resources. The supply-side technologies were broken down into the following categories:

- Base load technologies
- Intermediate load technologies
- Peaking load technologies

- Renewable technologies

1.1.2 TECHNOLOGY DEVELOPMENT STATUS

For each technology, the development status was also considered and identified as either mature, commercial, demonstration, pilot, or developmental. Following is a brief description of these different technology stages:

- Mature technologies are proven and well established in the electric power generation industry.
- Commercial technologies are in operation, but efforts to optimize the heat rate and reduce the O&M costs are still on-going.
- Demonstration technologies have designs that are quite advanced, but very few plants exist with actual operating experience.
- Developmental technologies are still emerging.

These technologies and their current development status are shown below in Table 1 and Table 2.

Table 1: Generating Technology Categories

BASE LOAD		
Pulverized Coal	**Integrated Gasification Combined Cycle**	**Nuclear**
SCPC SCPC w CCS	IGCC IGCC w CCS	Large Scale - AP1000 Small Modular Reactors (SMR)
INTERMEDIATE LOAD		
Combined Cycle	**Fuel Cell**	**Energy Storage**
2x1 CC CC w CCS	Solid Oxide	Compressed Air Energy Storage Pumped Hydro Sodium Sulfur Battery
PEAKING LOAD		
Combustion Turbines and Small Scale Alternatives		
GE 7FA.05 GE LMS100 GE LM6000 Reciprocating Engines - Wartsila		
RENEWABLES		
Solar	**Wind, Biomass**	**Waste to Energy**
Photovoltaic (PV) - Fixed Axis PV - Tracking Thermal - Trough Thermal - Dish	Wind Biomass BFB Boiler	Landfill Gas

Table 2: Technology Development Status

Technology Type	Description	Maturity
Combined Cycle	2x1 Combined Cycle Combined Cycle w/CCS	Mature Demonstration
Combustion Turbine	GE 7FA GE LMS100 GE LM6000	Mature Commercial Mature
Energy Storage	Compressed Air Energy Storage Pumped Hydro Sodium Sulfur Battery	Commercial Mature Demonstration
Fuel Cells	Fuel Cell - Solid Oxide	Developmental
Integrated Gasification Comb Cycle	IGCC IGCC w/CCS	Demonstration Demonstration
Nuclear	Large Scale - AP1000 Small Modular Reactors (SMR)	Mature Developmental
Pulverized Coal	SCPC SCPC w/CCS	Mature Demonstration
Small Scale Alternatives	Reciprocating Engines - Wartsila	Mature
Solar	Solar PV - Fixed Axis Solar PV - Tracking Solar Thermal - Trough Solar Thermal - Dish	Commercial Commercial Commercial Commercial
Wind, Biomass, Waste-to-Energy	Wind Biomass BFB Boiler Landfill Gas	Commercial Commercial Mature

1.2 LIFE EXTENSION & EMISSION CONTROL ENHANCEMENT OPTIONS

In addition to the potential new supply-side resource options identified above, GMO evaluated the life extension and refurbishment of existing generating plants, along with the enhancement of the existing emission controls. To evaluate the life extension, an internal review of the long-term plant equipment needs was developed by using the Life Assessment and Management Program (LAMP).

To evaluate the cost and operating characteristics due to potential future environmental equipment, the services of Burns and McDonnell, Inc. were retained to evaluate the GMO coal-fired units including Lake Road Unit 4/6, Sibley Units 1, 2, and 3, and Iatan-1. Further discussion of the LAMP process and the environmental retrofit costs can be found in Section 4.1.2.

1.3 CAPACITY & ENERGY MARKET OPTIONS

In order to consider existing market alternatives, GMO evaluated the option to purchase an ownership interest in the Dogwood Energy Center. Capital cost and operating characteristics were provided by Dogwood Energy, LLC, and the facility was passed on as an alternative in the integrated resource analysis.

1.4 PLANT EFFICIENCY IMPROVEMENTS

In order to minimize the negative impact to plant efficiency from GMO's projects to improve air quality emissions from our major coal units, GMO has proactively engaged on a dual pronged effort to improve the boiler and turbine side efficiency and reduce our own use of energy at our plants. The first half of this effort is to improve performance monitoring and daily attention to operational issues that may be negatively impacting plant efficiency. Below are details on these efforts:

- Issued fleet request for proposal and chose the industry leading EtaPRO© performance monitoring software from GP Strategies in 2009. Software has been implemented on the following units:
    - Sibley-3
    - Lake Road 4/6
- Engineering positions dedicated to Plant Efficiency were staffed as follows:
    - Sibley Performance Engineer
    - Lake Road Performance Engineer
- Beginning in 2013, GMO initiated a remote monitoring contract with GP Strategies. GP Strategies monitors each unit for performance issues and recommends operational improvements on monthly conference calls.

In addition to the daily efforts detailed above, GMO has performed considerable capital improvement projects to maintain or improve plant efficiency. These projects are detailed in Table 3 below:

Table 3: Power Plant Efficiency Projects

Project Description	Unit	Completed	Performance Impact
Sibley Station			
Perf Monitoring/ Optimization s/w	Sibley 3	2009	Moderate
Install boiler nose with replacement waterwall work	Sibley 3	2010	Moderate
Replace R2 & R2 Valves	Sibley 3	2011	Moderate
Combustion Optimization	Sibley 3	2013	Moderate
Lake Road Station			
Perf Monitoring/ Optimization s/w	LR 4/6	2009	Moderate
Boiler 6 Air Heater Upgrade	LR 4/6	2012	Moderate
Estimated Performance Impact: Nominal - Less than 0.1% efficiency improvement; Moderate - 0.1 - 0.5% improvement; Significant - Greater than 0.5% improvement			

GMO's next phase of performance improvement is primarily focused around improving the overall performance of Sibley 3 prior to the further enhancing air quality control equipment as well as Lake Road improvements. The following capital projects are currently budgeted and shown in Table 4 below:

Table 4: Future Performance Improvement Projects

Project Description	Unit	Budget Year	Performance Impact
Sibley Station			
Smart Sooblowing Control	Sibley 3	2015	Moderate
A3 and A4 Valve Replacement	Sibley 3	2016	Moderate
Air Heater Retube	Sibley 3	2016	Moderate
Feedwater Heater #7 East Replacement	Sibley 3	2017	Nominal
Feedwater Heater #7 West Replacement	Sibley 3	2017	Nominal
HP / IP Bucket Replacement	Sibley 3	2017	Moderate
Feedwater Heater #4 Replacement	Sibley 3	2017	Nominal
Feedwater Heater #1 Replacement	Sibley 3	2018	Nominal
West FD Fan Variable Frequency Drive Upgrade	Sibley 3	2018	Moderate
East FD Fan Variable Frequency Drive Upgrade	Sibley 3	2018	Moderate
Lake Road Station			
Install Electric Drive for OFA Ports	LR 4/6	2018	Moderate
VFD for Boiler Feed Pump	LR 4/6	2019	Moderate
Estimated Performance Impact: Nominal - Less than 0.1% efficiency improvement; Moderate - 0.1 - 0.5% improvement; Significant - Greater than 0.5% improvement			

1.5 EXCLUDED TECHNOLOGIES

During the process of identifying potential supply-side alternatives, there were also certain resource alternatives excluded from the pre-screening exercise on the basis of not being viable candidate resource options. The reasons these resource alternatives could not be reasonably developed or implemented by GMO include lack of technology maturity, lack of suitability for this geographic region, and environmental concerns. The resources that were not considered in the pre-screening exercise and the reason for their exclusion is listed in Table 5 below:

Table 5: Technologies Excluded From Pre-Screening

Technology Type	Reason For Exclusion
Central-Station Geothermal	Central US lacks adequate geological resources
Municipal Solid Waste	Developmental phase, environmental concerns concerning delivery of waste
Hydrokinetic (Run-of-River)	Experimental/unproven technology and wildlife concerns
Animal Waste	Delivery issues and high moisture content is problematic

Progress in the 'experimental' hydrokinetic (run of river) and technologies will be tracked going forward, and they will be considered as potential future supply-side technology options if they advance beyond the experimental stage. The hydrokinetic technology is designed to channel and convert current from the river into electricity by the rotation of a turbine from the river flow. Potential issues beyond the economic feasibility include rivers being full of debris and sediment, turbine depths of at least nine feet to avoid collisions with boats, and environmental concerns as it pertains to wildlife that have to be addressed.

Municipal Solid Waste (MSW) technologies were also excluded from the prescreening process for several reasons. Some of the MSW technologies, in particular gasification and plasma arc, are in the developmental stage with limited data to support the capital cost estimates. While MSW incineration is a proven commercially available option, there are significant environmental concerns including air pollution control. Given that, it is doubtful a new MSW incineration plant could be sited or permitted. The potential of limited regional supplies of MSW, along with potential issues on delivery of sufficient supplies to fuel the technologies, are also limiting factors for these technologies. Finally, much of the revenue stream for MSW technologies comes in the form of 'tipping fee' revenues, which is a payment made for diverting the waste from the landfills. This revenue stream is another large unknown that makes it difficult to project the total cost of MSW technologies.

Animal Waste technologies, including anaerobic digestion, direct combustion, co-firing, and gasification, were excluded from the prescreening process. These technologies are viewed as an alternative, renewable fuel for electricity generation, but they have several key barriers. Some of the primary problems inherent with using animal waste as fuel include limited regional availability, prohibitive transportation costs, high moisture content which requires pre-drying of animal waste, and unmanageable ash disposition and slagging that can cause frequent boiler shutdowns. In light of these issues, these technologies were not included in the prescreening process.

SECTION 2: SUPPLY-SIDE ANALYSIS

The utility shall describe and document its analysis of each potential supply-side resource option referred to in section (1). The utility may conduct a preliminary screening analysis to determine a short list of preliminary supply-side candidate resource options, or it may consider all of the potential supply-side resource options to be preliminary supply-side candidate resource options pursuant to subsection (2)(C). All costs shall be expressed in nominal dollars.

2.1 SUPPLY-SIDE RESOURCE COST RANKINGS

(A) Cost rankings of each potential supply-side resource option shall be based on estimates of the installed capital costs plus fixed and variable operation and maintenance costs levelized over the useful life of the potential supply-side resource option using the utility discount rate. The utility shall include the costs of ancillary and/or back-up sources of supply required to achieve necessary reliability levels in connection with intermittent and/or uncontrollable sources of generation (i.e., wind and solar).

Each of the technologies identified in Table 1 above were initially ranked based on their relative annualized utility cost, which was then broken down into an average cost per MWh. In calculating the average cost per MWh, the following characteristics were considered:

- The unit size and capacity factor, which varied depending on the technology's generating unit duty cycle (base load, intermediate, or peaking). Renewable technologies were considered as a separate group due to the requirement that some renewable alternatives would have to be passed on to the integrated resource analysis, irrespective of the cost ranking, in order to meet the MO Renewable Energy Standard (RES). The unit sizes and capacity factors varied widely across all technologies, and the net capacity and capacity factors for each alternative are shown below in Table 6 and Table 7.

- The total capital requirement for building the unit, including the plant capital costs, transmission capital costs, owner costs, and interest during construction. A levelized fixed charge rate (FCR) was applied to these capital requirements to arrive at an annual carrying cost for each technology. The levelized FCR calculation considers the book life, tax life, debt and equity rates to arrive at the annual rate, which is then applied to the total capital requirement. The technology capital costs, including interest during construction, are shown below for each alternative in Table 8.

- The fixed O&M and variable O&M costs. The fixed O&M costs include operating labor, total maintenance costs, and overhead charges. The variable O&M costs include any materials that are consumed in proportion to the energy output, and the calculation of annual variable O&M cost is dependent upon the capacity factor assumption mentioned above. The fixed O&M and variable O&M cost assumptions for each technology are shown below in Table 9 and Table 10.

- The fuel costs based on a projected long-term average cost per MWh, along with the technology heat rate (where applicable). Further discussion of fuel cost projections is provided below in Section 5.1. The primary fuel types for each technology are shown below in Table 11.

- The probable environmental costs, including forecasted allowance prices for SO_2, NO_x, and CO_2, applied using the appropriate emission rates for each technology. The projected emission rates for each technology are shown below in Table 12. Further discussion on the development of the probable environmental costs is provided below in Section 2.2.

Table 6: Technology Net Capacity

Technology Type	Description	Net Capacity (MW)
Combined Cycle	2x1 Combined Cycle	621
	Combined Cycle w CCS	485
Combustion Turbine	GE 7FA	207
	GE LMS100	92
	GE LM6000 (2x)	88
Energy Storage	Compressed Air Energy Storage	441
	Pumped Hydro	280
	Sodium Sulfur Battery	50
Fuel Cells	Fuel Cell - Solid Oxide	1
Integrated Gasification Comb Cycle	IGCC	600
	IGCC w CCS	500
Nuclear	Large Scale - AP1000	1400
	Small Modular Reactors (SMR) (4x)	1340
Pulverized Coal	SCPC	750
	SCPC w CCS	525
Small Scale Alternatives	Reciprocating Engines - Wartsila	99
Solar	Solar PV - Fixed Axis	20
	Solar PV - Tracking	10
	Solar Thermal - Trough	250
	Solar Thermal - Dish	100
Wind, Biomass, Waste-to-Energy	Wind	145
	Biomass BFB Boiler	100
	Landfill Gas	3

Table 7: Technology Capacity Factors

Technology Type	Description	Capacity Factor
Combined Cycle	2x1 Combined Cycle	60%
	Combined Cycle w/CCS	60%
Combustion Turbine	GE 7FA	10%
	GE LMS100	10%
	GE LM6000	10%
Energy Storage	Compressed Air Energy Storage	23%
	Pumped Hydro	27%
	Sodium Sulfur Battery	19%
Fuel Cells	Fuel Cell - Solid Oxide	30%
Integrated Gasification Comb Cycle	IGCC	85%
	IGCC w/CCS	85%
Nuclear	Large Scale	90%
	Small Modular Reactors (SMR)	90%
Pulverized Coal	SCPC	85%
	SCPC w/CCS	85%
Small Scale Alternatives	Reciprocating Engines - Wartsila	10%
Solar	Solar PV - Fixed Axis	17%
	Solar PV - Tracking	20%
	Solar Thermal - Trough	25%
	Solar Thermal - Dish	24%
Wind, Biomass, Waste-to-Energy	Wind	54%
	Biomass BFB Boiler	85%
	Landfill Gas	88%

Table 8: Technology Capital Costs ($/kW) **Highly Confidential**

Technology Type	Description	Capital Cost ($/kW)
Combined Cycle	[redacted]	[redacted]
Combustion Turbine	[redacted]	[redacted]
Energy Storage	[redacted]	[redacted]
Fuel Cells	[redacted]	[redacted]
Integrated Gasification Comb Cycle	[redacted]	[redacted]
Nuclear	[redacted]	[redacted]
Pulverized Coal	[redacted]	[redacted]
Small Scale Alternatives	[redacted]	[redacted]
Solar	[redacted]	[redacted]
Wind, Biomass, Waste-to-Energy	[redacted]	[redacted]

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Table 9: Technology Fixed O&M Costs **Highly Confidential**

Technology Type	Description	Fixed O&M ($/kW)
Combined Cycle	[redacted]	[redacted]
Combustion Turbine	[redacted]	[redacted]
Energy Storage	[redacted]	[redacted]
Fuel Cells	[redacted]	[redacted]
Integrated Gasification Comb Cycle	[redacted]	[redacted]
Nuclear	[redacted]	[redacted]
Pulverized Coal	[redacted]	[redacted]
Small Scale Alternatives	[redacted]	[redacted]
Solar	[redacted]	[redacted]
Wind, Biomass, Waste-to-Energy	[redacted]	[redacted]

Table 10: Technology Variable O&M Costs **Highly Confidential**

Technology Type	Description	Variable O&M ($/MWh)
Combined Cycle	[redacted]	[redacted]
Combustion Turbine	[redacted]	[redacted]
Energy Storage	[redacted]	[redacted]
Fuel Cells	[redacted]	[redacted]
Integrated Gasification Comb Cycle	[redacted]	[redacted]
Nuclear	[redacted]	[redacted]
Pulverized Coal	[redacted]	[redacted]
Small Scale Alternatives	[redacted]	[redacted]
Solar	[redacted]	[redacted]
Wind, Biomass, Waste-to-Energy	[redacted]	[redacted]

Table 11: Technology Primary Fuels

Technology Type	Description	Primary Fuels
Combined Cycle	2x1 Combined Cycle Combined Cycle w/CCS	Natural Gas Natural Gas
Combustion Turbine	GE 7FA GE LMS100 GE LM6000	Natural Gas Natural Gas Natural Gas
Energy Storage	Compressed Air Energy Storage Pumped Hydro Sodium Sulfur Battery	Natural Gas Hydro None
Fuel Cells	Fuel Cell - Solid Oxide	Natural Gas
Integrated Gasification Comb Cycle	IGCC IGCC w/CCS	Coal Coal
Nuclear	Large Scale - AP1000 Small Modular Reactors (SMR)	Uranium Uranium
Pulverized Coal	SCPC SCPC w/CCS	Coal Coal
Small Scale Alternatives	Reciprocating Engines - Wartsila	Natural Gas
Solar	Solar PV - Fixed Axis Solar PV - Tracking Solar Thermal - Trough Solar Thermal - Dish	Solar Solar Solar Solar
Wind, Biomass, Waste-to-Energy	Wind Biomass BFB Boiler Landfill Gas	Wind Biomass - Wood Landfill Gas

Table 12: Technology Emission Rates

Technology Description	NOx (lbs/mmBtu)	SO2 (lbs/mmBtu)	Hg (lbs/TBtu)	CO2 (lbs/mmBtu)	PM10 (lbs/mmBtu)
2x1 Combined Cycle	0.01	-	-	119	0.01
Combined Cycle w/CCS	0.01	-	-	12	0.01
GE 7FA	0.01	-	-	119	0.01
GE LMS100	0.10	0.01	-	113	0.01
GE LM6000	0.03	0.01	-	114	0.01
Compressed Air Energy Storage	0.01	-	-	117	-
Pumped Hydro	-	-	-	-	-
Sodium Sulfur Battery	-	-	-	-	-
Fuel Cell - Solid Oxide	-	-	-	115	-
IGCC	0.01	0.03	1.20	206	0.02
IGCC w/CCS	0.01	0.02	1.20	21	0.02
Large Scale - AP1000	-	-	-	-	-
Small Modular Reactors (SMR)	-	-	-	-	-
SCPC	0.06	0.10	1.20	206	0.02
SCPC w/CCS	0.05	0.06	1.20	21	0.02
Reciprocating Engines - Wartsila	0.02	-	-	122	0.03
Solar PV - Fixed Axis	-	-	-	-	-
Solar PV - Tracking	-	-	-	-	-
Solar Thermal - Trough	-	-	-	-	-
Solar Thermal - Dish	-	-	-	-	-
Wind	-	-	-	-	-
Biomass BFB Boiler	0.10	0.01	-	-	0.02
Landfill Gas	0.20	0.10	-	-	-

2.2 SUPPLY-SIDE RESOURCE PROBABLE ENVIRONMENTAL COSTS

(B) The probable environmental costs of each potential supply-side resource option shall be quantified by estimating the cost to the utility to comply with additional environmental legal mandates that may be imposed at some point within the planning horizon. The utility shall identify a list of environmental pollutants for which, in the judgment of the utility decision-makers, legal mandates may be imposed during the planning horizon which would result in compliance costs that could significantly impact utility rates. The utility shall specify a subjective probability that represents utility decision-maker's judgment of the likelihood that legal mandates requiring additional levels of mitigation will be imposed at some point within the planning horizon. The utility, based on these probabilities, shall calculate an expected mitigation cost for each identified pollutant.

Environmental laws or regulations that may be imposed at some point within the planning horizon may impact air emissions, water discharges, or waste material disposal. Following is a brief discussion of each of these pollutants that could result in compliance costs that may have a significant impact on utility rates. For a more detailed discussion of these potential environmental laws and regulations, refer to Appendix 4A.

2.2.1 AIR EMISSION IMPACTS

2.2.1.1 National Ambient Air Quality Standards

The Clean Air Act (CAA) requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants, including particulate matter (PM), ground-level ozone, carbon monoxide (CO), sulfur oxides (SO_x), Nitrogen Oxides (NO_x), and lead. These air pollutants are regulated by setting human health-based or environmentally-based criteria for permissible levels.

2.2.1.2 Particulate Matter

In 2013, the EPA strengthened the PM standard. The Kansas City area is currently in attainment of the 2013 PM NAAQS. No additional emission control equipment is currently needed to comply with this standard. It is not known whether the Kansas City area will remain in attainment of a future revision of the standard. Future non-attainment of revised standards could require additional reduction technologies, emission limits, or both on fossil-fueled units.

2.2.1.3 Ozone

In 2008, the EPA strengthened the NAAQS for ground-level ozone. Ambient air monitors indicate the Kansas City area could be placed in non-attainment of the 2008 Ozone NAAQS but the EPA has not yet acted. In 2014, the EPA proposed to further strengthen the ozone standard. Until the 2015 Ozone NAAQS is finalized and designations determined, it is unknown if the Kansas City area will be in attainment of the 2015 Ozone NAAQS. Future non-attainment of revised standards could result in regulations requiring additional NO_x reduction technologies, emission limits or both on fossil-fueled units.

2.2.1.4 Carbon Monoxide

In 2011, the EPA issued a decision to retain the existing NAAQS for CO, and the Kansas City area is in attainment of the standard. Future non-attainment could result in requiring additional CO reduction technologies, emission limits or both on fossil-fueled units.

2.2.1.5 Acid Rain Program – Sulfur Dioxide and Nitrogen Oxides

The overall goal of the Acid Rain Program (ARP) is to achieve environmental and public health benefits by reducing emissions of SO_2 and NO_x. In 2012, the EPA determined that no area in the country is violating the 2010 national air quality standards for NO_2. In 2010, the EPA revised the primary NAAQS for SO_2 and in 2014 provided guidance on implementing the new 1-hour SO_2 standard. For further discussion, refer to Appendix 4A, Section 1.5.

2.2.1.6 Clean Air Interstate Rule (CAIR)

In 2005, the EPA issued the CAIR, a rule reducing air pollution that moves across state boundaries. Through the use of a cap-and-trade approach, CAIR provides a Federal framework requiring states to reduce emissions of SO_2 and NO_x. For further discussion, refer to Appendix 4A, Section 1.8.

2.2.1.7 Cross-State Air Pollution Rule

In 2011, the EPA finalized the Cross-State Air Pollution Rule (CSAPR), requiring eastern and central states to significantly reduce power plant emissions that cross state lines and contribute to ground-level ozone and fine particle pollution in other states. The Company will comply through a combination of trading allowances within or outside its system in addition to changes in operations as necessary. For further discussion, refer to Appendix 4A, Section 1.9.

2.2.1.8 Regional Haze

For discussion of regional haze, refer to Appendix 4A, Section 1.10.

2.2.1.9 Lead

The Kansas City area is in attainment of the current NAAQS for lead. Non-attainment of a revised standard could result in regulations requiring additional lead reduction technologies, emission limits or both on coal units.

2.2.1.10 Carbon Dioxide

In 2014, the EPA issued its proposed rule regarding regulation of CO_2 emissions from existing power plants under section 111(d), which the Agency calls the Clean Power Plan. The Clean Power Plan would require each state with fossil fuel-fired generation to meet state-specific emission rate-based CO_2 goals by 2030. Each state's rate is calculated using a basic formula: CO_2 emissions from fossil fuel-fired power plants in pounds divided by state electricity generation from fossil fuel-fired power plants and certain low- or zero-emitting power sources in megawatt hours. State- and regional-specific information (such as the state's fuel mix and its electricity market) is plugged into the formula, and the result of the equation is the state-specific goal that must be met by 2030. In addition to the 2030 final goal, the EPA assigned each state an interim reduction target, which is an average emission rate that must be met over the period 2020 to 2029. For further discussion, refer to Appendix 4A, Section 1.12.

2.2.1.11 Mercury and Air Toxics Standards

In 2011, the EPA signed a rule to reduce emissions of toxic air pollutants from power plants. These mercury and air toxics standards (MATS) for power plants will reduce emissions from new and existing coal and oil-fired electric EGUs. Existing sources will have up to 4 years if they need to comply with MATS, and compliance strategies include wet and dry scrubbers, dry sorbent injection systems, activated carbon injection systems, and fabric filters. For further discussion, refer to Appendix 4A, Section 1.13.

2.2.1.12 Industrial Boiler Maximum Achievable Control Technology Standards

In January 2013, the EPA finalized a revised Industrial Boiler MACT rule to reduce emissions of toxic air pollutants from new and existing industrial, commercial, and institutional boilers and process heaters at major sources facilities. The final rule will reduce emissions of toxic air pollutants including mercury, other metals, and organic air toxics. For further discussion, refer to Appendix 4A, Section 1.14.

2.2.1.13 Potential Future Regulated Air Pollutants

Future multi-pollutant legislation or regulations could require reduced emissions for criteria pollutants, HAPs, or CO_2. GMO will continue to track the status of any future regulations.

2.2.2 WATER EMISSION IMPACTS

2.2.2.1 Clean Water Act Section 316(A)

GMO's river plants comply with the calculated limits defined in the current permits. Future regulations could be issued that would restrict the thermal discharges and require alternative cooling technologies to be installed at coal-fired units using once through cooling. For further discussion, see Appendix 4A, Section 3.1.

2.2.2.2 Clean Water Act Section 316(B)

In May 2014, the EPA finalized standards to reduce the injury and death of fish and other aquatic life caused by cooling water intake structures at power plants and factories. The rule could severely restrict cooling water inlet structures and potentially require closed cycle cooling technologies instead. For further discussion, refer to Appendix 4A, Section 3.2.

2.2.2.3 Steam Electric Power Generating Effluent Limitations Guidelines

In April 2013, the EPA proposed to revise the technology-based effluent limitations guidelines and standards that would strengthen the existing controls on discharges from steam electric power plants. The proposal sets the federal limits on the levels of toxic metals in wastewater that can be discharged from power plants, based on technology improvements in the steam electric power industry over the last three decades, refer to Appendix 4A, Section 3.3.

2.2.2.4 Zebra Mussel Infestation

GMO monitors for zebra mussels at generation facilities, and a significant infestation could cause operational changes to the stations. Refer to Appendix 4A, Section 3.4 for additional information.

2.2.2.5 Total Maximum Daily Loads

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a given pollutant that a body of water can absorb before its quality is impacted. A stream is considered impaired if it fails to meet Water Quality Standards established by the Clean Water Commission. Future TMDL standards could restrict discharges and require equipment to be installed to minimize or control the discharge. For further discussion, refer to Appendix 4A, Section 3.5.

2.2.3 WASTE MATERIAL IMPACTS

2.2.3.1 Coal Combustion Residuals (CCR's)

In December 2014, the EPA finalized regulations to regulate CCRs under the RCRA subtitle D to address the risks from the disposal of CCRs generated from the combustion of coal at electric generating facilities.

The rule requires periodic assessments; groundwater monitoring; location restrictions; design and operating requirements; recordkeeping and notifications; and closure, among other requirements, for CCR units. The regulations could require existing CCR units to be closed and replaced with new landfills designed to more stringent standards. For further discussion, refer to Appendix 4A, Section 4.1.

For the purposes of ranking the supply-side resource options, the subjective probabilities assigned to comply with future environmental laws or regulations are listed as follows:

- Landfills required to provide dry handling of CCPs = 100% probability
- A coal cleaning process to remove HAPs = 100% probability
- A cap and trade program requiring the use of CO_2 allowances for generation technologies that emit CO_2 = 100% probability
- Cooling towers required to comply with Clean Water Act (CWA) Sections 316(a) and (b) = 100% probability

The probable environmental cost for each supply-side resource can be found below in Table 13.

2.3 PRELIMINARY SUPPLY-SIDE CANDIDATE RESOURCE OPTIONS

(C) The utility shall indicate which potential supply-side resource options it considers to be preliminary supply-side candidate resource options. Any utility using the preliminary screening analysis to identify preliminary supply-side candidate resource options shall rank all preliminary supply-side candidate resource options based on estimates of the utility costs and also on utility costs plus probable environmental costs. The utility shall—

Each of the supply-side resource options identified was ranked in terms of a 'utility cost' estimate and a 'utility cost plus probable environmental cost' estimate. The utility cost estimate is expressed in dollars per megawatt-hour, and it is comprised of fixed O&M, variable O&M, fuel cost, and a levelized carrying cost applied to the capital costs incurred for the technology installation and the transmission interconnection (if applicable). In developing the dollar per MWh cost, the technology heat rate and the projected capacity factor also play an important role. In particular, the capacity factor can have a large impact and the base load technologies have the highest capacity factors, followed by the intermediate load and peaking load technologies. The capacity factor of renewable technologies can vary significantly depending on the type of renewable resource. All of the capacity factor assumptions can be found in Table 7 above.

2.3.1 POTENTIAL SUPPLY-SIDE RESOURCE OPTION TABLE

1. Provide a summary table showing each potential supply-side resource option and the utility cost and the probable environmental cost for each potential supply-side resource option and an assessment of whether each potential supply-side resource option qualifies as a utility renewable energy resource; and

The development of the nominal utility costs for each of the twenty-three potential new supply-side resource options was calculated in an Excel workbook, which is attached as a worksheet. Rankings were developed for these technologies for both the 'utility' cost and the 'utility plus probable environmental' cost. The difference between the 2 rankings is driven primarily by the potential of environmental costs for CO_2 emissions in anticipation of legislation being passed to reduce U.S. emissions. The estimated probable environmental costs in nominal dollars for each of the twenty-three technologies are shown in Table 13 below.

The 'utility cost' rankings for all the supply-side resource options are shown below in Table 14. The 'utility cost plus probable environmental' rankings are show below in Table 15. Both the utility cost and probable environmental cost rankings show the lowest-cost alternatives to include wind, combined cycle and supercritical pulverized coal technologies. For both of these cost rankings, it is important to note that the energy storage/battery technologies only store energy and do not produce it, so a cost of energy was added into the dollar per MWh cost based upon projected market power prices.

Table 13: Probable Environmental Cost **Highly Confidential**

Technology Description	Capacity Factor	Probable Environmental Cost
2x1 Combined Cycle	[redacted]	[redacted]
Combined Cycle w/CCS	[redacted]	[redacted]
GE 7FA	[redacted]	[redacted]
GE LMS100	[redacted]	[redacted]
GE LM6000	[redacted]	[redacted]
Compressed Air Energy Storage	[redacted]	[redacted]
Pumped Hydro	[redacted]	[redacted]
Sodium Sulfur Battery	[redacted]	[redacted]
Fuel Cell - Solid Oxide	[redacted]	[redacted]
IGCC	[redacted]	[redacted]
IGCC w/CCS	[redacted]	[redacted]
Large Scale	[redacted]	[redacted]
Small Modular Reactors (SMR)	[redacted]	[redacted]
SCPC	[redacted]	[redacted]
SCPC w/CCS	[redacted]	[redacted]
Reciprocating Engines - Wartsila	[redacted]	[redacted]
Solar PV - Fixed Axis	[redacted]	[redacted]
Solar PV - Tracking	[redacted]	[redacted]
Solar Thermal - Trough	[redacted]	[redacted]
Solar Thermal - Dish	[redacted]	[redacted]
Wind	[redacted]	[redacted]
Biomass BFB Boiler	[redacted]	[redacted]
Landfill Gas	[redacted]	[redacted]

Table 14: Technology Ranking by Nominal Utility Cost **Highly Confidential**

Rank	Technology	Capacity Factor (%)	Nominal Utility Cost ($/MWh)
1	Wind	[redacted]	[redacted]
2	SCPC	[redacted]	[redacted]
3	CC 7FA.05	[redacted]	[redacted]
4	Landfill Gas	[redacted]	[redacted]
5	IGCC	[redacted]	[redacted]
6	Nuclear - Small Modular Reactors	[redacted]	[redacted]
7	Nuclear - Large Scale	[redacted]	[redacted]
8	CC w Carbon Capture	[redacted]	[redacted]
9	SCPC w Carbon Capture	[redacted]	[redacted]
10	IGCC w Carbon Capture	[redacted]	[redacted]
11	Biomass BFB Boiler	[redacted]	[redacted]
12	Compressed Air Energy Storage	[redacted]	[redacted]
13	CT 7FA.05	[redacted]	[redacted]
14	Reciprocating Engines - Wartsila	[redacted]	[redacted]
15	Pumped Hydro Energy Storage	[redacted]	[redacted]
16	CT LMS100	[redacted]	[redacted]
17	Solar Thermal - Parabolic Trough	[redacted]	[redacted]
18	Solar PV - Fixed	[redacted]	[redacted]
19	Solar PV - Single Axis Tracking	[redacted]	[redacted]
20	CT LM6000	[redacted]	[redacted]
21	Sodium Sulfur (NaS) Batteries	[redacted]	[redacted]
22	Solar Thermal - Dish	[redacted]	[redacted]
23	Fuel Cell - Solid Oxide	[redacted]	[redacted]

Table 15: Technology Ranking by Nominal Probable Environmental Cost
****Highly Confidential****

Rank	Technology	Capacity Factor (%)	Prob Enviro Cost ($/MWh)
1	Wind	[redacted]	
2	Landfill Gas		
3	CC 7FA.05		
4	Nuclear - Small Modular Reactors		
5	SCPC		
6	Nuclear - Large Scale		
7	CC w Carbon Capture		
8	IGCC		
9	SCPC w Carbon Capture		
10	IGCC w Carbon Capture		
11	Biomass BFB Boiler		
12	Compressed Air Energy Storage		
13	Pumped Hydro Energy Storage		
14	CT 7FA.05		
15	Reciprocating Engines - Wartsila		
16	Solar Thermal - Parabolic Trough		
17	Solar PV - Fixed		
18	CT LMS100		
19	Solar PV - Single Axis Tracking		
20	Sodium Sulfur (NaS) Batteries		
21	CT LM6000		
22	Solar Thermal - Dish		
23	Fuel Cell - Solid Oxide		

2.3.2 ELIMINATION OF POTENTIAL SUPPLY-SIDE RESOURCE OPTIONS

2. Explain which potential supply-side resource options are eliminated from further consideration and the reasons for their elimination. 22.040 (2) (C) 2.

2.3.2.1 Supply-Side Resource Options Eliminated

The technology options that were eliminated from further consideration on the basis of the pre-screening analysis, along with the reason for their elimination, are addressed in the discussion below. It should be noted that some of the higher-cost options were passed on to integrated resource analysis because the technology was required to help meet the Missouri Renewable Energy

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Standard (RES) Requirements, regardless of its cost ranking. On the other hand, certain low-cost options were not passed on to the integrated resource analysis for a multitude of reasons. Following is a discussion of the supply-side candidate resource options that were not moved on to the integrated resource analysis.

2.3.2.1.1 Integrated Gasification Combined Cycle Technologies

The IGCC technologies, IGCC and IGCC with CO_2 Capture, were not passed on to the integrated resource analysis. These technologies are in the demonstration stage with very little operating experience, and they also have higher projected capital costs and operating expenses relative to the pulverized coal technologies. The development status of IGCC will be monitored and the technology will continue to be considered in future analyses.

2.3.2.1.2 Landfill Gas Technology

The landfill gas technology was not passed on to the integrated resource analysis, due to the limited regional availability of landfill gas opportunities. However, GMO will continue to pursue innovative renewable projects including landfill gas-to-energy projects, such as the existing 1.6 MW landfill power generation facility in partnership with the City of St. Joseph.

2.3.2.1.3 Combustion Turbine (CT) Technologies

Three combustion turbine technologies were identified for the prescreening process and one of those was chosen to move into integrated resource analysis. As shown in Table 14 above, their nominal cost rankings on a dollar per MWh basis were relatively similar. The CT technologies of the LM6000 and the LMS100 were not passed on to the integrated resource planning process. The GE 7FA combustion turbine technology was passed on to the integrated resource planning process. For further discussion, refer to Section 4.1.1.1

2.3.2.1.4 Biomass Bubbling Fluidized Bed (BFB) Boiler Technology

This technology was not passed on to integrated resource analysis due to the high capital and fixed O&M costs, along with potential lack of fuel in this region and its inability to compete with cheaper renewable alternatives such as wind.

2.3.2.1.5 Energy Storage Technologies

The energy storage technologies included in the prescreening process were compressed air energy storage (CAES), pumped hydro, and sodium sulfur batteries. Due to their relatively high cost, along with the early development stage and limited utility application, these energy storage technologies were not passed on to the integrated resource analysis. These technologies will continue to be monitored and will also be considered for their ability to accommodate the impact of hour-by-hour fluctuations from variable wind and solar resources.

2.3.2.1.6 Fuel Cell Technologies

The solid oxide fuel cell technology was not passed on to integrated resource analysis. Fuel cells are still in the technology development stage, and they are high-cost relative to the other technologies in the prescreening process that were moved on to the integrated resource analysis.

2.3.2.1.7 Solar Technologies

The solar thermal technologies in the prescreening process– parabolic trough and dish – were excluded from integrated resource analysis due to high cost and the geographic region requirements. High temperatures and solar concentration systems are required for the thermal technologies to operate with reasonable efficiencies, and the highest quality resources for solar thermal within the United States are located in the Southwest (Nevada, Arizona, California, New Mexico). No solar thermal facilities currently exist in the Midwest, due to these geographic requirements. However, to meet the solar requirements of the MO RES, GMO did pass on the solar photovoltaic (PV) fixed flat-plate technology to the integrated resource analysis given its slight cost advantage over the solar PV tracking technology.

2.3.2.1.8 Small Scale CT Technologies

The Wartsila reciprocating engine small scale CT technology was not passed on to the integrated resource analysis process. The primary disadvantage is the higher cost relative to the larger scale GE 7FA.05 CT that was moved on to the integrated resource analysis.

SECTION 3: INTERCONNECTION AND TRANSMISSION REQUIREMENTS

(3) The utility shall describe and document its analysis of the interconnection and any other transmission requirements associated with the preliminary supply-side candidate resource options identified in subsection (2)(C).

3.1 <u>INTERCONNECTION AND TRANSMISSION CONSTRAINTS ANALYSIS</u>

(A) The analysis shall include the identification of transmission constraints, as estimated pursuant to 4 CSR 240-22.045(3), whether within the Regional Transmission Organization's (RTO's) footprint, on an interconnected RTO, or a transmission system that is not part of an RTO. The purpose of this analysis shall be to ensure that the transmission network is capable of reliably supporting the preliminary supply-side candidate resource options under consideration, that the costs of the transmission system investments associated with preliminary supply-side candidate resource options, as estimated pursuant to 4 CSR 240-22.045(3), are properly considered and to provide an adequate foundation of basic information for decisions to include, but not be limited to, the following:

1. Joint ownership or participation in generation construction projects;

2. Construction of wholly-owned generation facilities;

3. Participation in major refurbishment, life extension, upgrading, or retrofitting of existing generation facilities;

4. Improvements on its transmission and distribution system to increase efficiency and reduce power losses;

5. Acquisition of existing generating facilities; and

6. Opportunities for new long-term power purchases and sales, and short-term power purchases that may be required for bridging the gap between other supply options, both firm and non-firm, that are likely to be available over all or part of the planning horizon.

In general, all major GMO transmission upgrade projects are currently made available as public information through either GMO's public OASIS site or as part of the Southwest Power Pool's (SPP) Transmission Expansion Plan (STEP). In addition, there are also smaller projects of minimal cost and construction time that are not available for public viewing, since they do not result in increases in transmission capacity or transfer capability. These would include projects for replacement of damaged, worn out, or obsolete equipment.

The major regional transmission constraints currently impacting the GMO transmission system are the Iatan-Stranger Creek 345kV line, the St. Joseph-Hawthorn 345kV line, and the Cooper South Flowgate. The first two constraints will be eliminated with the completion of the Iatan-Nashua project, while the Cooper South Flowgate constraint will be eliminated with the completion of the Nebraska City-Mullin Creek-Sibley project.

As a member of SPP, GMO participates in the SPP open access transmission tariff (OATT). All transmission service requests, including generation interconnection requests, must be submitted to the SPP and studied in a non-discriminatory process. Due to the nature of this 'open access' transmission system process, it makes it difficult to predict future transmission constraints. As of November, 2014, the current SPP Aggregate Study process has four active study groups with 83 transmission service requests (TSR), totaling approximately 21,493 MW of TSR.

Due to the iterative nature of the Aggregate Facility Study process, it is not possible to identify specific transmission upgrades needed to delivery energy from a resource in the RTO footprint to GMO until the process for a specific transmission service request has been completed. Any new generation resource requesting interconnection to the transmission system will have to go through the SPP Generator Interconnection process and the Aggregate Study process. These processes are designed to provide adequate transmission capacity for resource interconnection and delivery to load.

3.2 NEW SUPPLY-SIDE RESOURCES OUTPUT LIMITATIONS

(B) This analysis shall include the identification of any output limitations imposed on existing or new supply-side resources due to transmission and/or distribution system capacity constraints, in order to ensure that supply-side candidate resource options are evaluated in accordance with any such constraints.

As discussed in Section 3.1, output limitations are difficult to predict without knowledge of the specific project site. In regards to renewable resources in the southwest Kansas region, it is known that the total current firm transmission service requests to SPP exceed the total transmission service availability which will be provided by transmission construction projects. Until large scale investments in transmission upgrades are made, the timing of future renewable resource additions in that region will be difficult to determine with certainty. This could lead to output and/or delivery limitations on future renewable resource additions in the southwest Kansas region.

SECTION 4: SUPPLY-SIDE CANDIDATE RESOURCE OPTIONS

(4) All preliminary supply-side candidate resource options which are not eliminated shall be identified as supply-side candidate resource options. The supply-side candidate resource options that the utility passes on for further evaluation in the integration process shall represent a wide variety of supply-side resource options with diverse fuel and generation technologies, including a wide range of renewable technologies and technologies suitable for distributed generation.

The supply-side technologies passed on to the integrated resource analysis as candidate resource options represent a wide range of diverse fuel and generation technologies, including natural gas, coal, and nuclear powered options. Renewable technologies for wind and solar were also moved on to the integrated resource analysis. In addition to these new technology options, alternatives to retrofit existing units, burn 100% natural gas at Lake Road 4/6, and purchase an ownership interest in the Dogwood Energy Center were also moved into the integration process. This list of supply side technologies passed on to the integrated resource analysis can be found in Table 16 below. Cost and operating data for the technologies that moved on to the integrated resource analysis came from multiple sources including the Electric Power Research Institute (EPRI), the Department of Energy (DOE), responses to recent Request for Proposals (RFP), and other internal resources.

Table 16: Candidate Resource Options

Technology Type	Description
Combined Cycle	2x1 GE 7FA 2x1 GE 7FA w Carbon Capture
Combustion Turbine	GE 7FA
Nuclear	Large Scale Small Modular Reactors
Pulverized Coal	Super Critical Pulverized Coal (SCPC) SCPC w Carbon Capture
Solar	Photovoltaic - Fixed Axis
Wind	Wind Turbines
Existing Resources	Lake Road 4/6 Gas Conversion Lake Road 4/6 Environmental Retrofit Sibley Units 1-3 Environmental Retrofits Dogwood Energy Center Partial Ownership

4.1 IDENTIFICATION PROCESS FOR POTENTIAL SUPPLY-SIDE RESOURCE OPTIONS

(A) The utility shall describe and document its process for identifying and analyzing potential supply-side resource options and preliminary supply-side candidate resource options and for choosing its supply-side candidate resource options to advance to the integration analysis.

4.1.1 NEW PLANT RESOURCE OPTIONS

Following is a discussion of the supply-side candidate resource options that were advanced to the integration analysis for new generation additions:

4.1.1.1 Combustion Turbine Technologies

The combustion turbine (CT) technology of the GE 7FA was passed on to the integrated resource analysis process as being representative of the larger group of CT technologies that were considered, which included the LMS100 and the LM6000.

4.1.1.2 Combined Cycle Technologies

The combined cycle (CC) technologies of the 2x1 GE 7FA.05 and the CC with CO_2 capture were both passed on to the integrated resource analysis process. The local engineering firm Sega, Inc. assisted in providing CC technology characteristics that were used in the integrated resource analysis and which are more accurate figures for the KCP&L territory.

4.1.1.3 Coal Technology

The super critical pulverized coal (SCPC) technology and the SCPC technology with CO_2 capture were both passed on to the integrated resource analysis as representative coal technologies.

4.1.1.4 Nuclear Technology

Both large-scale and small modular reactor (SMR) nuclear technologies were passed on to the integrated resource analysis. While still in the developmental stages, the SMR technology may represent a more likely long-term alternative and was advanced to the integration analysis for that reason.

4.1.1.5 Wind Technology

Wind generation was passed on to the integrated resource analysis, due to its ability to help meet the Missouri Renewable Energy Standard (RES) requirements and a low cost on a dollar per MWh basis when compared to other prescreened technologies.

4.1.1.6 Solar Technology

As an alternative for meeting the Missouri RES solar carve out requirements, the solar photovoltaic (PV) technology was passed on to the integrated resource analysis.

4.1.2 ENVIRONMENTAL RETROFIT & LIFE EXTENSION OPTIONS

For the 20-year planning period, GMO has evaluated potential environmental retrofits and future capital projects considered necessary to ensure continued reliability of the coal-generation units.

4.1.2.1 Environmental Retrofits

Future potential environmental retrofit equipment costs have been analyzed by Burns and McDonnell and are incorporated into the Sibley Station and Iatan-1 future costs. Future potential environmental regulations are the drivers for the equipment assumed. Budgetary costs, fixed and variable O&M costs determined through the studies are provided in Table 17 through Table 19 below.

Table 17: Environmental Retrofit Capital Costs **Highly Confidential**

Environmental Retrofit Technology Capital Costs (2014 $ x Millions)	Lake Road 4/6	Sibley 1	Sibley 2	Sibley 3	Iatan 1 [1]
Activated Carbon Injection	[redacted]				
ESP Rebuild					
Scrubber/BH					
Fish-Friendly Screens					
Cooling Tower					
Wet-to-Dry Ash Conversion					
Convert to Nat Gas w/ Fuel Oil Backup					

Notes:
NA = Not Applicable
✓ Equipment Installed
R = Retirement expected to occur before retrofit would be required
[1] GMO's Share

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Table 18: Environmental Retrofit Fixed O&M Costs **Highly Confidential**

Environmental Retrofit Technology Fixed O&M ($/kW - 2014 $)	Lake Road 4/6	Sibley 1	Sibley 2	Sibley 3	Iatan 1
Activated Carbon Injectio	[redacted]				
ESP Rebuil					
Scrubber/BH					
Fish-Friendly Screens					
Cooling Towe					
Wet-to-Dry Bottom Ash Conversio					
Convert to Nat Gas w/ Fuel Oil Backup					

Notes:
NA = Not Applicable
✓ Equipment Installed
R=Retirement expected to occur before retrofit would be required

Table 19: Environmental Retrofit Variable O&M Costs **Highly Confidential**

Environmental Retrofit Technology Variable O&M ($/MWh - 2014 $)	Lake Road 4/6	Sibley 1	Sibley 2	Sibley 3	Iatan 1
Activated Carbon Injection	[redacted]				
ESP Rebuild					
Scrubber/BH					
Fish-Friendly Screens					
Cooling Tower					
Wet-to-Dry Bottom Ash Conversion					
Convert to Nat Gas w/ Fuel Oil Backup					

Notes:
NA = Not Applicable
✓ Equipment Installed
R=Retirement expected to occur before retrofit would be required

4.1.2.2 Life Assessment & Management Program

An internal review of long-term plant equipment needs was developed using the Life Assessment and Management Program (LAMP). The program was developed in the late 1980's for the purpose of identifying, evaluating, and recommending improvements and special maintenance requirements necessary for continued reliable operation of KCP&L coal-fired generating units. The program was expanded to now include the GMO coal-fired generating units. The primary objectives of the LAMP program include:

1. Identify and recommend unit requirements associated with future operating plans

2. Identify and recommend areas of improvement and special maintenance requirements necessary to extend the operating life of each unit

3. Identify and recommend areas of improvement to achieve any or all of the following goals:

    a. Capacity

    b. Performance

    c. Reliability/Availability

    d. Safety/ Environmental

    e. Operational Changes

4. Provide a basis for identification and prevention of major component failure, and costly interruptions associated with continued use of existing equipment

5. Provide the tools for managing and protecting remaining life of critical components/assets.

Current schedules of identified LAMP projects and costs for Lake Road Unit 4/6 and Sibley Units 1, 2, 3 are shown below in Table 20 through Table 28.

Table 20: Lake Road 4/6 LAMP Capital Plan Years 2020 - 2027 ($000's) **Highly Confidential**

Project Name	2020	2021	2022	2023	2024	2025	2026	2027
LR 4/6 - Variable Frequency Drive for Forced Draft Fan	[redacted]							
LR 4/6 - Economizer								
LR 4/6 - Primary Superheater								
LR 4/6 - Secondary Superheater								
LR 4/6 - Steam Chest								
LR 4/6 - Intermediate Pressure Steam Casing								
LR 4/6 - Intercept Valves								
LR 4/6 - Turbine Piping								
LR 4/6 - Stator Windings / Generator Bushings								
LR 4/6 - Condenser Tubes								
LR 4/6 - Chimneys and Liners								
LR 4/6 - Cyclone Replacement								
LR 4/6 - Lower Water Walls								
LR STA - Yearly								
LR STA - Additional Spends								

Table 21: Lake Road 4/6 LAMP Capital Plan Years 2028 - 2034 ($000's) **Highly Confidential**

Project Name	2028	2029	2030	2031	2032	2033	2034	Plant Total
LR 4/6 - Variable Frequency Drive for Forced Draft Fan	[redacted]							
LR 4/6 - Economizer	[redacted]							
LR 4/6 - Primary Superheater	[redacted]							
LR 4/6 - Secondary Superheater	[redacted]							
LR 4/6 - Steam Chest	[redacted]							
LR 4/6 - Intermediate Pressure Steam Casing	[redacted]							
LR 4/6 - Intercept Valves	[redacted]							
LR 4/6 - Turbine Piping	[redacted]							
LR 4/6 - Stator Windings / Generator Bushings	[redacted]							
LR 4/6 - Condenser Tubes	[redacted]							
LR 4/6 - Chimneys and Liners	[redacted]							
LR 4/6 - Cyclone Replacement	[redacted]							
LR 4/6 - Lower Water Walls	[redacted]							
LR STA - Yearly	[redacted]							
LR STA - Additional Spends	[redacted]							

Table 22: Sibley-1 LAMP Capital Plan Years 2020 - 2027 ($000's) **Highly Confidential**

Project Name	2020	2021	2022	2023	2024	2025	2026	2027
SIB1 - Replace Generator Step-Up	[redacted]							
SIB1 - Replace #5 High Pressure Feedwater Heater								
SIB1 - Replace #1 Low Pressure Feedwater Heater								
SIB1 - Replace #2 Low Pressure Feedwater Heater								
SIB1 - Replace #3 Low Pressure Feedwater Heater								
SIB1 - Replace #4 Low Pressure Feedwater Heater								
SIB1 - Rewind Generator Stator								
SIB1 - Rewind Generator Rotor								
SIB1 - Replace Air Heater Tubes								
SIB1 - Furnace South Water Wall								
SIB1 - Furnace East Water Wall								
SIB1 - Furnace West Water Wall								
SIB1 - Furnace North Water Wall								
SIB1 - Economizer Replacement								
SIB1 - Secondary Superheater Replacement								
SIB1 - Retube Condenser								
SIB1 - Distributed Control System Replacement								
SIB1 - Cyclone Replacement								
SIB1 - Precipitator Hoppers								
SIB1 - Mud Drum Replacement								
SIB1 - Turbine (capital parts)								
SIB1 - Air Heater Flue Gas Outlet Duct Replacement								
SIB1 - Precipitator Outlet Duct Replacement								
SIB1 - Slag Tank Replacement								
SIB1 - Replace Startup Transformer								
SIB1 - Intake Structure								

Table 23: Sibley-1 LAMP Capital Plan Years 2028 - 2034 ($000's) **Highly Confidential**

Project Name	2028	2029	2030	2031	2032	2033	2034	Plant Total
SIB1 - Replace Generator Step-Up	[redacted]							
SIB1 - Replace #5 High Pressure Feedwater Heater	[redacted]							
SIB1 - Replace #1 Low Pressure Feedwater Heater	[redacted]							
SIB1 - Replace #2 Low Pressure Feedwater Heater	[redacted]							
SIB1 - Replace #3 Low Pressure Feedwater Heater	[redacted]							
SIB1 - Replace #4 Low Pressure Feedwater Heater	[redacted]							
SIB1 - Rewind Generator Stator	[redacted]							
SIB1 - Rewind Generator Rotor	[redacted]							
SIB1 - Replace Air Heater Tubes	[redacted]							
SIB1 - Furnace South Water Wall	[redacted]							
SIB1 - Furnace East Water Wall	[redacted]							
SIB1 - Furnace West Water Wall	[redacted]							
SIB1 - Furnace North Water Wall	[redacted]							
SIB1 - Economizer Replacement	[redacted]							
SIB1 - Secondary Superheater Replacement	[redacted]							
SIB1 - Retube Condenser	[redacted]							
SIB1 - Distributed Control System Replacement	[redacted]							
SIB1 - Cyclone Replacement	[redacted]							
SIB1 - Precipitator Hoppers	[redacted]							
SIB1 - Mud Drum Replacement	[redacted]							
SIB1 - Turbine (capital parts)	[redacted]							
SIB1 - Air Heater Flue Gas Outlet Duct Replacement	[redacted]							
SIB1 - Precipitator Outlet Duct Replacement	[redacted]							
SIB1 - Slag Tank Replacement	[redacted]							
SIB1 - Replace Startup Transformer	[redacted]							
SIB1 - Intake Structure	[redacted]							

Table 24: Sibley-2 LAMP Capital Plan Years 2020 - 2027 ($000's) **Highly Confidential**

Project Name	2020	2021	2022	2023	2024	2025	2026	2027
SIB2 - Replace Generator Step-Up	[redacted]							
SIB2 - Replace #5 High Pressure Feedwater Heater	[redacted]							
SIB2 - Rewind Generator Stator	[redacted]							
SIB2 - Rewind Generator Rotor	[redacted]							
SIB2 - Replace Circ water lines	[redacted]							
SIB2 - Replace Air Heater Tubes	[redacted]							
SIB2 - Furnace South Water Wall	[redacted]							
SIB2 - Furnace East Water Wall	[redacted]							
SIB2 - Furnace West Water Wall	[redacted]							
SIB2 - Furnace North Water Wall	[redacted]							
SIB2 - Economizer Replacement	[redacted]							
SIB2 - Secondary Superheater Replacement	[redacted]							
SIB2 - Retube Condenser	[redacted]							
SIB2 - Cyclone Replacement	[redacted]							
SIB2 - Precipitator Hoppers	[redacted]							
SIB2 - Mud Drum Replacement	[redacted]							
SIB2 - Turbine (capital parts)	[redacted]							
SIB2 - Air Heater Flue Gas Outlet Duct Replacement	[redacted]							
SIB2 - Precipitator Outlet Duct Replacement	[redacted]							
SIB2 - Slag Tank Replacement	[redacted]							

Table 25: Sibley-2 LAMP Capital Plan Years 2028 - 2034 ($000's) **Highly Confidential**

Project Name	2028	2029	2030	2031	2032	2033	2034	Plant Total
SIB2 - Replace Generator Step-Up	[redacted]							
SIB2 - Replace #5 High Pressure Feedwater Heater								
SIB2 - Rewind Generator Stator								
SIB2 - Rewind Generator Rotor								
SIB2 - Replace Circ water lines								
SIB2 - Replace Air Heater Tubes								
SIB2 - Furnace South Water Wall								
SIB2 - Furnace East Water Wall								
SIB2 - Furnace West Water Wall								
SIB2 - Furnace North Water Wall								
SIB2 - Economizer Replacement								
SIB2 - Secondary Superheater Replacement								
SIB2 - Retube Condenser								
SIB2 - Cyclone Replacement								
SIB2 - Precipitator Hoppers								
SIB2 - Mud Drum Replacement								
SIB2 - Turbine (capital parts)								
SIB2 - Air Heater Flue Gas Outlet Duct Replacement								
SIB2 - Precipitator Outlet Duct Replacement								
SIB2 - Slag Tank Replacement								

Table 26: Sibley-3 LAMP Capital Plan Years 2020 - 2027 ($000's) **Highly Confidential**

Project Name	2020	2021	2022	2023	2024	2025	2026	2027
SIB3 - Air Heater Retube	[redacted]							
SIB3 - Coal Feeders								
SIB3 - Circulating Water Pumps and Motors								
SIB3 - Slag Tank Replacement								
SIB3 - Economizer Boiler Tubes								
SIB3 - Remainder of Re-Heater Boiler Tubes								
SIB3 - Secondary Superheat Intermediate Boiler Tubes								
SIB3 - Primary Superheater Boiler Tubes								
SIB3 - Furnace Roof and Tight Casing Seal								
SIB3 - Furnace Floor								
SIB3 - Condenser Retube								
SIB3 - Replace cyclones								
SIB3 - Replace Selective Catalytic Reduction Catalyst (1 layer/ yr, 2 regen & 1 new every 3 yr)								
SIB3 - Dearator Replacement								
SIB3 - Forced Draft Fan Rotors Replacement								
SIB3 - Selective Catalytic Reduction Expansion Joints								
SIB3 - Distributed Control System Upgrade								
SIB3 - Boiler Flue Gas Duct Replacement								
SIB3 - Boiler Comb Air Duct Replacement								
SIB3 - 6 West High Pressure Feed Water Heater Replacement								
SIB3 - 6 East High Pressure Feed Water Heater Replacement								
SIB3 - Circulating Water Piping Replacement								
SIB3 - Precipitator Overhaul								
SIB3 - Precipitator Outlet Dampers								
SIB3 - Generator Exciter Replacement								
SIB3 - Generator Voltage Regulator Replacement								

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Table 27: Sibley-3 LAMP Capital Plan Years 2028 - 2034 ($000's) **Highly Confidential**

Project Name	2028	2029	2030	2031	2032	2033	2034	Plant Total
SIB3 - Air Heater Retube	[redacted]							
SIB3 - Coal Feeders	[redacted]							
SIB3 - Circulating Water Pumps and Motors	[redacted]							
SIB3 - Slag Tank Replacement	[redacted]							
SIB3 - Economizer Boiler Tubes	[redacted]							
SIB3 - Remainder of Re-Heater Boiler Tubes	[redacted]							
SIB3 - Secondary Superheat Intermediate Boiler Tubes	[redacted]							
SIB3 - Primary Superheater Boiler Tubes	[redacted]							
SIB3 - Furnace Roof and Tight Casing Seal	[redacted]							
SIB3 - Furnace Floor	[redacted]							
SIB3 - Condenser Retube	[redacted]							
SIB3 - Replace cyclones	[redacted]							
SIB3 - Replace Selective Catalytic Reduction Catalyst (1 layer/ yr, 2 regen & 1 new every 3 yr)	[redacted]							
SIB3 - Dearator Replacement	[redacted]							
SIB3 - Forced Draft Fan Rotors Replacement	[redacted]							
SIB3 - Selective Catalytic Reduction Expansion Joints	[redacted]							
SIB3 - Distributed Control System Upgrade	[redacted]							
SIB3 - Boiler Flue Gas Duct Replacement	[redacted]							
SIB3 - Boiler Comb Air Duct Replacement	[redacted]							
SIB3 - 6 West High Pressure Feed Water Heater Replacement	[redacted]							
SIB3 - 6 East High Pressure Feed Water Heater Replacement	[redacted]							
SIB3 - Circulating Water Piping Replacement	[redacted]							
SIB3 - Precipitator Overhaul	[redacted]							
SIB3 - Precipitator Outlet Dampers	[redacted]							
SIB3 - Generator Exciter Replacement	[redacted]							
SIB3 - Generator Voltage Regulator Replacement	[redacted]							

Table 28: Sibley Station Common LAMP Capital Plan Years 2020 - 2034 ($000's) **Highly Confidential**

Project Name	2020	2021	2022	2023	2024	2025	2026	2027
SIB STA - Install New Surge Bin for Coal Crushers	[redacted]							
SIB STA - Coal Conveyor Replacement	[redacted]							
SIB STA - Dust Collectors Replacement	[redacted]							
SIB STA - Landfill Expansion (multiple phases)	[redacted]							
SIB STA - Landfill Closure (multiple phases)	[redacted]							
SIB STA - Condensate Polisher Replacement	[redacted]							
SIB STA - Water Treatment Chemical Tank Replacement	[redacted]							
SIB STA - Crushed Coal Storage Silos	[redacted]							
SIB STA - Coal Crushers Replacement	[redacted]							
SIB STA - Condensate Make-up Water Treatment Replacement	[redacted]							
SIB STA - Continuous Emissions Monitoring System upgrade	[redacted]							
SIB STA - Repower Fuel Yard Equipment	[redacted]							
SIB STA - Yearly	[redacted]							
SIB STA - Additional Spends	[redacted]							
Project Name	[redacted]							
SIB STA - Install New Surge Bin for Coal Crushers	[redacted]							
SIB STA - Coal Conveyor Replacement	[redacted]							
SIB STA - Dust Collectors Replacement	[redacted]							
SIB STA - Landfill Expansion (multiple phases)	[redacted]							
SIB STA - Landfill Closure (multiple phases)	[redacted]							
SIB STA - Condensate Polisher Replacement	[redacted]							
SIB STA - Water Treatment Chemical Tank Replacement	[redacted]							
SIB STA - Crushed Coal Storage Silos	[redacted]							
SIB STA - Coal Crushers Replacement	[redacted]							
SIB STA - Condensate Make-up Water Treatment Replacement	[redacted]							
SIB STA - Continuous Emissions Monitoring System upgrade	[redacted]							
SIB STA - Repower Fuel Yard Equipment	[redacted]							
SIB STA - Yearly	[redacted]							
SIB STA - Additional Spends	[redacted]							

4.2 ELIMINATION OF PRELIMINARY SUPPLY-SIDE RESOURCES DUE TO INTERCONNECTION OR TRANSMISSION

(B) The utility shall indicate which, if any, of the preliminary supply-side candidate resource options identified in subsection (2)(C) are eliminated from further consideration on the basis of the interconnection and other transmission analysis and shall explain the reasons for their elimination.

None of the preliminary supply-side candidate resource options were eliminated from consideration based on interconnection or other transmission analysis. For further discussion of the SPP open access transmission tariff (OATI) in which GMO participates, refer above to Section 3.1.

4.3 INTERCONNECTION COST FOR SUPPLY-SIDE RESOURCE OPTIONS

(C) The utility shall include the cost of interconnection and any other transmission requirements, in addition to the utility cost and probable environmental cost, in the cost of supply-side candidate resource options advanced for purposes of developing the alternative resource plans required by 4 CSR 240-22.060(3).

The cost of interconnection was added to the cost of supply-side candidate resource options using a weighted average of recent interconnection requests with the Southwest Power Pool (SPP). There was a separate analysis of the cost for interconnection requests related to wind projects versus other non-wind projects, with the results showing higher interconnection costs for wind projects. This cost adder on a dollar per kW basis is shown below in Table 29. The detailed analysis of the interconnection calculations has been provided in the Volume 4 workpapers.

Table 29: Transmission Interconnect Cost Projection

Capital Cost Adder (w/ Substation)	Wind Technology	All Other Supply-Side Options
$/kW ($ 2014)	[redacted]	

SECTION 5: SUPPLY-SIDE UNCERTAIN FACTORS

(5) The utility shall develop, and describe and document, ranges of values and probabilities for several important uncertain factors related to supply-side candidate resource options identified in section (4). These cost estimates shall include at least the following elements, as applicable to the supply-side candidate resource option:

5.1 FUEL FORECASTS

(A) Fuel price forecasts, including fuel delivery costs, over the planning horizon for the appropriate type and grade of primary fuel and for any alternative fuel that may be practical as a contingency option;

Fuel price forecasts were developed for coal, natural gas, fuel oil, and uranium. KCP&L performed an investigation to determine the best possible commodity forecasts for use in the supply-side resource analysis and modeling, and that investigation showed that using an average of forecasts proves to be most reliable. The result of the averaging process is that random errors cancel each other out, when forecasts from multiple sources are utilized. Several assumptions apply when averaging multiple forecasts, including the belief that all expert forecasts are interchangeable and the closer to the time period being forecast, the lower the expected error to actual. A detailed description of the fuel price forecasting methodology can be found in Appendix 4B, "Fuel Price Forecasting". Following is an overview of the forecasting process applied for coal, natural gas, fuel oil, and uranium.

5.1.1 COAL FORECAST

A composite coal price forecast was created by combining the forecasts of the Energy Information Administration (EIA), Energy Ventures Analysis (EVA), IHS Energy (IHS), JD Energy (JDE), and Hanou Energy Consulting (HEC). Each source provided their forecast in either nominal or real dollars. The forecasts that were provided in real dollars were converted to nominal dollars using Moody's Analytics' GDP implicit price deflator. The forecasts were then combined and weighted equally to create a composite price forecast that represents the base case consensus of the major forecast sources. The variation of individual forecasts within the composite was then used within a t-distribution to mathematically calculate high and low forecast price curves. The three resultant price curves with their probability of occurrence were base 50%, high 25%, and low 25%. To ensure the early part of the forecast reflects expected cost, to the extent contracts are in place, actual contract prices or projections of those contract prices are used for the duration of the contract, which is typically less than six years.

5.1.2 NATURAL GAS FORECAST

A composite Henry Hub natural gas price forecast was created by combining forecasts from the EIA, EVA, IHS, and PIRA Energy Group (PIRA). Like with our coal forecast, each source provided their forecast in either nominal or real dollars. The forecasts that were provided in real dollars were converted to nominal dollars using Moody's Analytics' GDP implicit price deflator. The forecasts were then all combined in equal weight to create a composite price forecast representing the expected or base case consensus of the forecast sources. The variation of individual forecasts within the composite was then used within a t-distribution to mathematically calculate high and low forecast price curves. The three resultant price curves with their probability of occurrence were base 50%, high 25%, and low 25%. To better synchronize the early part of the forecast with current market data, the first few years of the forecast are overwritten by the NYMEX strip and a "bridge" is constructed from the NYMEX strip to the long-term forecast described above.

5.1.3 FUEL OIL FORECAST

Oil fired power generation is not a major source of electricity generation, and there are presently no price forecast scenarios in which oil would become the lowest cost fuel option for generating electricity when compared to other fossil fuels. A composite crude oil price forecast was created by combining forecasts from the EIA, EVA, and IHS. Like with our coal and natural gas forecasts, each source provided their forecast in either nominal or real dollars. The forecasts that were provided in real dollars were converted to nominal dollars using Moody's Analytics' GDP implicit price deflator. The forecasts were then all combined in equal weight to create a composite price forecast representing the expected or base case consensus of the major forecast sources. The variation of individual forecasts within the composite was then used within a t-distribution to mathematically calculate high and low forecast price curves. The three resultant price curves with their probability of occurrence were base 50%, high 25%, and low 25%.

5.1.4 URANIUM FORECAST

There are not nearly as many economic consulting organizations that regularly produce long-term forecasts for uranium as there are for natural gas, crude oil, or coal. With few sources, it is difficult to construct long-term consensus forecasts similar to the coal, gas, and oil forecasts. For the uranium forecast, GMO utilized the most recent Global Energy Velocity Suite database long-term price forecast. The 'High' and 'Low' forecasts were set at plus or minus 20%.

The 'Base', 'High', and 'Low' fuel price forecasts are shown below in Table 30 and Table 31. The sources used in developing the forecasts are shown below in Table 32.

Table 30: Fuel Price Forecasts – Coal, Natural Gas, Fuel Oil **Highly Confidential**

[redacted]

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Table 31: Fuel Price Forecast – Nuclear **Highly Confidential**

Fuel Price Forecast	2015	2016	2017	2018	2019
[redacted]					

Table 32: Source Forecasts for Coal, Natural Gas, and Fuel Oil

Forecast Source	Coal	Natural Gas	Fuel Oil	Nuclear
IHS	x	x	x	
EIA	x	x	x	
PIRA		x		
Energy Ventures Analysis	x	x	x	
Wood Mac				
JD Energy	x			
Synapse				
SNL Financial				
Hanou Energy Consulting	x			

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5.2 NEW FACILITY CAPITAL COSTS, EXISTING FACILITIES CAPITAL EXPENDITURES

(B) Estimated capital costs including engineering design, construction, testing, startup, and certification of new facilities or major upgrades, refurbishment, or rehabilitation of existing facilities;

Capital cost estimates for the technologies that moved on to integrated resource analysis were developed for both 'High' and 'Low' capital cost scenarios. As a starting point for all technologies, the 'High' capital cost estimate was set at 115% of the 'Mid' cost and the 'Low' capital cost estimate was set at 90% of the 'Mid' cost. From there, some of the technologies were assigned 'High' or 'Low' estimates that varied from these amounts, and following is a discussion on those decisions.

5.2.1 TECHNOLOGIES WITH 'HIGH' CAPITAL COST ABOVE 115%

5.2.1.1 Supercritical Pulverized Coal & SCPC w Carbon Capture

Given the uncertainty surrounding potential environmental requirements for SCPC, this technology's 'High' capital cost range was set at 120% of the 'Mid' cost rather than 115%. The 'High' capital cost for SCPC w Carbon Capture was set even higher at 140% of the 'Mid' cost, since it has the added uncertainty of very few plants having been built.

5.2.1.2 Nuclear

Given the current challenging environment for building a nuclear facility, along with no recent construction activity for nuclear plants and uncertainty for the pricing of SMR technology, the 'High' capital cost range for nuclear technologies was set at 140% of the 'Mid' cost estimate.

5.2.1.3 Combined Cycle w Carbon Capture

The 'High' capital cost for Combined Cycle w Carbon Capture was set at 140% of the 'Mid' cost, since it has the uncertainty of very few plants having been built.

5.2.2 TECHNOLOGIES WITH 'LOW' CAPITAL COSTS BELOW 90%

5.2.2.1 Wind

With the reduction in wind capital costs over the past several years, this technology's 'Low' capital cost range was set at 80% of the 'Mid' cost rather than 90%.

5.2.2.2 Solar PV

With a continuous and significant reduction in solar PV capital costs over the past few years, the 'Low' capital cost range was set at 60% of the 'Mid' cost to account for the potential of continued reductions in solar capital costs.

The 'Mid', 'High', and 'Low' capital cost ranges and the resulting capital cost estimates on a $/kW basis are shown below in Table 33 and Table 34.

Table 33: Technology Capital Cost Ranges

Technology Description	Mid Range	High Range	Low Range
2x1 Combined Cycle	100%	115%	90%
CC w Carbon Capture	100%	140%	90%
Combustion Turbine 7FA	100%	115%	90%
Nuclear - Large Scale	100%	140%	90%
Nuclear - SMR	100%	140%	90%
SCPC	100%	120%	90%
SCPC w Carbon Capture	100%	140%	90%
Solar PV	100%	115%	60%
Wind	100%	115%	80%

Table 34: Capital Cost Estimates Utilized in Integrated Resource Analysis
****Highly Confidential****

Technology Description	Mid Range	High Range	Low Range
2x1 Combined Cycle	[redacted]	[redacted]	[redacted]
CC w Carbon Capture	[redacted]	[redacted]	[redacted]
Combustion Turbine 7FA	[redacted]	[redacted]	[redacted]
Nuclear - Large Scale	[redacted]	[redacted]	[redacted]
Nuclear - SMR	[redacted]	[redacted]	[redacted]
SCPC	[redacted]	[redacted]	[redacted]
SCPC w Carbon Capture	[redacted]	[redacted]	[redacted]
Solar PV	[redacted]	[redacted]	[redacted]
Wind	[redacted]	[redacted]	[redacted]

5.3 NEW FACILITY AND EXISTING FACILITY FIXED AND VARIABLE O&M

(C) Estimated annual fixed and variable operation and maintenance costs over the planning horizon for new facilities or for existing facilities that are being upgraded, refurbished, or rehabilitated;

The range of values for estimated annual fixed and variable operation and maintenance costs for new facilities considered in integrated analysis are shown below in Table 35 and Table 36. The 'High' O&M cost estimates were set at 110% of the 'Mid' cost estimate and the 'Low' O&M cost estimates were set at 90% of the 'Mid' cost. The projected increase in fixed and variable operation and maintenance costs due to the potential environmental retrofits of existing facilities is shown above in Table 18 through Table 19. Further discussion of the FOM and VOM estimates was provided earlier in Section 1.1.

Table 35: Fixed O&M Estimates Utilized In Integrated Resource Analysis
****Highly Confidential****

Technology Description	Mid FOM ($/kW-Yr)	High FOM ($/kW-Yr)	Low FOM ($/kW-Yr)
2x1 Combined Cycle	[redacted]		
CC w Carbon Capture			
Combustion Turbine 7FA			
Nuclear - Large Scale			
Nuclear - SMR			
SCPC			
SCPC w Carbon Capture			
Solar PV			
Wind			

Table 36: Variable O&M Estimates Utilized in Integrated Resource Analysis
****Highly Confidential****

Technology Description	Mid VOM ($/MWh)	High VOM ($/MWh)	Low VOM ($/MWh)
2x1 Combined Cycle	[redacted]		
CC w Carbon Capture			
Combustion Turbine 7FA			
Nuclear - Large Scale			
Nuclear - SMR			
SCPC			
SCPC w Carbon Capture			
Solar PV			
Wind			

5.4 EMISSION ALLOWANCE FORECASTS

(D) Forecasts of the annual cost or value of emission allowances to be used or produced by each generating facility over the planning horizon;

The CO2 emission allowance price forecast was modified to reflect the paradigm shift caused by EPA's proposed Clean Power Plan (CPP). The CPP used four "building blocks" to construct state specific emissions rates. It did not develop a national CO2 emission allowance program. On the other hand, the CPP did leave room for states to join together and develop regional programs. Given the view that the CPP is focused on reducing CO2 emissions through means other than a trading program such as adopted under the CSAPR, the Company assigned a probability of 0.6 to the scenario there would be no CO2 emission allowance trading program. Given the CPP would allow states to form a regional trading program and that the CPP may ultimately be changed to include a national trading program, the Company assigned a probability of 0.4 to the implementation of a CO2 trading program that would apply to units in Kansas or Missouri. Under that scenario, CO2 allowance prices were forecast as the composite of the individual price forecasts.

The forecasted cost of sulfur dioxide emission allowances over the planning horizon is shown in Table 37 and Table 38 below:

Table 37: SO_2 Group 1 Price Forecast **Highly Confidential**

[redacted]

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Table 38: SO_2 Group 2 Price Forecast **Highly Confidential**

[redacted]

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Also provided in this section are the forecasts for Annual NO_x, Seasonal NO_x, and CO_2 in Table 39, Table 40, and Table 41 below:

Table 39: NO_x Annual Price Forecast **Highly Confidential**

[redacted]

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Table 40: NO_x Seasonal Price Forecast **Highly Confidential**

[redacted]

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Table 41: CO_2 Price Forecast **Highly Confidential**

[redacted]

The source forecasts utilized to develop the emission allowance forecasts are shown in Table 42 below:

Table 42: Source Forecasts for Emission Allowances

Forecast Source	SO_2	NO_x	CO_2
IHS	x	x	x
EIA			
PIRA			x
Energy Ventures Analysis	x	x	x
Wood Mac			
JD Energy	x	x	x
Synapse			x
SNL Financial			
Hanou Energy Consulting			

5.5 LEASED OR RENTED FACILITIES FIXED CHARGES

(E) Annual fixed charges for any facility to be included in the rate base, or annual payment schedule for leased or rented facilities; and

There are no leased or rented facilities included in any of the GMO alternative resource plans or in the rate base, so this rule does not apply to this IRP evaluations.

5.6 INTERCONNECTION OR TRANSMISSION COSTS FOR SUPPLY-SIDE CANDIDATES

(F) Estimated costs of interconnection or other transmission requirements associated with each supply-side candidate resource option.

The estimated cost of interconnection associated with the supply-side candidate resource options is shown above in Section 4.3.