VOLUME 4:

SUPPLY-SIDE RESOURCE ANALYSIS

KANSAS CITY POWER & LIGHT COMPANY (KCP&L)

INTEGRATED RESOURCE PLAN

4 CSR 240-22.040

CASE NO. EO-2012-0323

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KCP&L[SM]
energizing *life*

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VOLUME 4: SUPPLY-SIDE RESOURCE ANALYSIS

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.

22.040 (1)

1.1 NEW PLANT RESOURCE OPTIONS

1.1.1 TECHNOLOGY CATEGORIES

The evaluation of potential supply-side resource options began with the identification of forty-one existing or new technology alternatives. The information for these potential supply-side technologies was gathered primarily from the December 2010 Electric Power Research Institute Technical Assessment Guide (EPRI-TAG)®. 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 & FBC	**Integrated Gasification Combined Cycle**	**Nuclear**
SCPC PRB WFGD	IGCC PRB	Nuclear - U.S. EPR
SCPC PRB w/CO2 Capture	IGCC PRB CO2 Capture	Nuclear - G.E. ABWR
SCPC Ill #6 WFGD		Nuclear - Westinghouse AP1000
SCPC Ill #6 w/CO2 Capture		
FBC PRB		
FBC PRB w/CO2 Capture		
	INTERMEDIATE LOAD	
Combined Cycle	**Fuel Cells**	**Energy Storage**
CC w/ GE 7FA.03	Fuel Cell - Molten Carbonate	Compressed Air Energy Storage System
CC w/ GE 7FA.05	Fuel Cell - Solid Oxide	NaS Batteries
	Fuel Cell - PEM	ZnBr Batteries
		Lead-Acid Batteries
		Li-ion Batteries
		Vanadium Redox Batteries
		Flywheel Energy Storage
		Zn Air Batteries
		Fe/Cr Batteries
	PEAKING LOAD	
Combustion Turbines	**Small Scale Alternatives**	
CT LM6000	Internal Combustion Engine - Oil	
CT LMS100	Internal Combustion Engine - Natural Gas/Spark	
CT GE 7EA	Small Scale CT - Natural Gas	
CT GE 7FA.03	Small Scale CT - Oil	
CT GE 7FA.05		
	RENEWABLES	
Solar	**Wind, Biomass**	**Waste to Energy**
Solar Thermal - Parabolic Trough	Wind	Landfill Gas
Solar Thermal - Power Tower	Biomass BFB Boiler	
Solar Central PV Thin-Film		
Solar PV Residential		

Table 2: Technology Development Status **Highly Confidential**

[redacted]

1.2 LIFE EXTENSION & EMISSION CONTROL ENHANCEMENT OPTIONS

In addition to the potential new supply-side resource options identified above, KCP&L evaluated the life extension and refurbishment of existing generating units, 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 potential enhancement of emission controls, the services of the local engineering firm Sega were retained to perform a multi-pollutant emissions control study for the coal-fired units including Montrose Units 1, 2, and 3. The original Sega study for the Montrose Units was completed in November, 2010, and can be found in Appendix 4A. An update to some of the Air Quality Control (AQC) projects for Montrose Units 1, 2, and 3 was provided by Sega in February, 2012, and those updated AQC cost tables can be found in Appendix 4B. The options of retrofitting Montrose Units 1, 2, and 3 were passed on to the integrated resource analysis, with both the LAMP costs and external Sega AQC costs included in the analysis. Detailed discussion of the LAMP process and the Sega Environmental Retrofit Studies can be found in Section 4.1.3.

1.3 CAPACITY & ENERGY MARKET OPTIONS

To identify short-term and long-term market alternatives for the acquisition of capacity and related energy from existing or proposed supply-side facilities, KCP&L considered responses to the Request for Proposal (RFP) issued on August 3, 2011. A copy of the RFP has been provided in Appendix 4C. The responses to the RFP included 5-year, 10-year and 20-year purchased power contracts from existing or proposed generating stations, along with turnkey projects and potential ownership of an existing power plant. The proposal terms and conditions, along with any potential transmission issues, were considered and the Dogwood Energy, LLC, partial ownership alternative was passed on to the integrated resource analysis. See Table 3 below for a listing of the counterparties that responded to the RFP, along with the agreement type (PPA or ownership), the timing (ownership) or duration (PPA), and the capacity amount offered. A summary of the RFP bids and the cost analysis has been provided in the workpapers.

Table 3: Summary of RFP Responses **Highly Confidential**

[redacted]

1.4 PLANT EFFICIENCY IMPROVEMENTS

As part of an overall CO_2 reduction strategy, KCP&L has completed or is currently executing several capital projects that were recommended as part of a Black & Veatch Plant Efficiency Improvement Assessment. This assessment was done by Black & Veatch back in 2008, and indicated eighteen additional capital projects that should be undertaken to improve the fleet plant efficiency.

Following are the projects that have been completed to date:

- Improved monitoring software has been rolled out for Hawthorn Unit 5, Hawthorn Unit 6&9, Iatan Units 1 & 2, LaCygne Units 1 &2, and Montrose Units 1, 2, and 3.

- Yearly Cycle Isolation and Valve Improvement projects have been rolled out at each major coal unit.

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- Performance Engineer positions were created and staffed at each major coal unit.

KCP&L is in the next phase of the recommended Plant Efficiency Improvements, which is primarily the introduction of Combustion and Sootblowing Optimization on the major coal units. Currently, Combustion and Sootblowing Optimization projects are being completed at Hawthorn Unit 5 and LaCygne Units 1 & 2. Combustion Optimization only is being done on Iatan Unit 1.

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 KCP&L 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 4 below:

Table 4: Technologies Excluded From Pre-Screening

TECHNOLOGY TYPE	REASON FOR EXCLUSION
Central Station Geothermal	The region lacks adequate geological resources for this technology.
Pumped Storage	The region lacks adequate geographic features for this technology, and the developmental costs are extremely high.
Hydrokinetic (Run of River)	This is an experimental and unproven technology, and there are wildlife environmental concerns.
Small Modular Nuclear Power Reactors	This is still in the experimental stage, and there is very little cost data available at this time.
Municipal Solid Waste (MSW)	These technologies are largely developmental, they are restricted by the availability and delivery of waste, and there are environmental concerns
Animal Waste	These technologies have transportation issues, are high moisture content, and can cause slagging and boiler shutdowns.

Progress in the 'experimental' hydrokinetic (run of river) and small modular nuclear power 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. Small modular nuclear power reactors, approximately one-third the size of nuclear power plants, could allow for reduction in some of the safety and environmental risks associated with larger nuclear power plants. At this time, the small modular nuclear reactors have limited cost data with high level estimates generally based upon scaled-down costs of large-scale nuclear reactors. KCP&L continues to track the progress of this technology, and will monitor the United States Department of Energy initiative announced in January 2012 for funding the design and licensing of small modular nuclear reactors.

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, combined with the fact that a Montrose 10% biomass co-firing option will be considered in the integrated resource analysis, 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.

22.040 (2)

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).22.040 (2) (A)

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 5 and Table 6.

- 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 7.

- 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 8 and Table 9.

- Any applicable tax credits, including the Production Tax Credit (PTC) and Investment Tax Credit (ITC) available for certain renewable technologies. Currently, the 2.2-cent per kilowatt-hour PTC for wind over the first ten years of operation is set to expire at the end of 2012, while the 30% ITC for solar systems is available through December 31, 2016.

- 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 10.

- 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 11. Further discussion on the development of the probable environmental costs is provided below in Section 2.2.

Table 5: Technology Net Capacities **Highly Confidential**

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Table 6: Technology Capacity Factors **Highly Confidential**

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Table 7: Technology Capital Costs ($/kW) **Highly Confidential**

[redacted]

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Table 8: Technology Fixed O&M Costs ($/kW/Yr) **Highly Confidential**

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Table 9: Technology Variable O&M Costs ($/MWh) **Highly Confidential**

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Table 10: Technoloav Primarv Fuels **Hiahlv Confidential**

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Table 11: Technology Emission Rates **Highly Confidential**

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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.
22.040 (2) (B)

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 4E.

2.2.1 AIR EMISSION IMPACTS

2.2.1.1 National Ambient 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

The EPA is expected to revise the PM standard this year, which could require additional reduction technologies, emission limits, or both on fossil-fueled units.

2.2.1.3 Ozone

On March 12, 2008, the EPA strengthened the NAAQS for ground-level ozone. 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

On August 12, 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. On January 20, 2012, the EPA determined that no area in the country is violating the 2010 national air quality standards for NO_2. On June 2, 2010, the EPA revised the primary NAAQS for SO_2 and it also intends to provide initial guidance on implementing the new 1-hour SO_2 standard within two years of promulgation of the revised SO_2 standard (June 2012). For further discussion, refer to Appendix 4E, Section 1.7.

2.2.1.6 Clean Air Interstate Rule (CAIR)

On March 10, 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 4E, Section 1.8.

2.2.1.7 Cross-State Air Pollution Rule

On July 6, 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 CSAPR is complex and KCP&L is evaluating its impacts. Any shortfall in allocated SO2 or NOx allowances will need to be addressed through a combination of permissible allowance trading, installation of additional emission control equipment, changes in plant processes, or purchasing additional wholesale market power. For further discussion, refer to Appendix 4E, Section 1.9.

2.2.1.8 Regional Haze

For discussion of the regional haze plan, refer to Appendix 4E, 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

On May 13, 2010, the EPA issued a final rule establishing thresholds for greenhouse gas (GHG) emissions that define when permits are required for new and existing facilities, including power plants. For further discussion, refer to Appendix 4E, Section 1.12.

2.2.1.11 Mercury and Air Toxics Standards

On December 16, 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 4E, Section 1.13.

2.2.1.12 Potential Future Regulated Air Pollutants

The Industrial Boiler MACT rule will 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 4E, Section 2.1.

The EPA has not yet issued proposed regulations to address greenhouse gas emissions from certain fossil-fueled EGUs. These New Source Performance Standards (NSPS) are reviewed at least every eight years and, if appropriate, revised. KCP&L will continue to track the status of these emission guidelines. For further discussion, refer to Appendix 4E, Section 2.2.

Future multi-pollutant legislation or regulations could require reduced emissions for criteria pollutants, HAPs, or CO_2. KCP&L 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)

KCP&L'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 4E, Section 3.1.

2.2.2.2 Clean Water Act Section 316(B)

On April 20, 2011, the EPA proposed 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 EPA is anticipated to finalize section 316(B) regulations this year, which could severely restrict cooling water inlet structures and potentially require closed cycle cooling technologies instead. For further discussion, refer to Appendix 4E, Section 3.2.

2.2.2.3 Steam Electric Power Generating Affluent Guidelines

Proposed guidelines regarding settling or holding pond discharges could require compliance with lower standards or elimination of pond usage. For further discussion, refer to Appendix 4E, Section 3.3.

2.2.2.4 Zebra Mussel Infestation

KCP&L monitors for zebra mussels at generation facilities, and a significant infestation could cause operational changes to the stations.

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. The Missouri River is not listed as impaired on the 2010 list. Future TMDL standards could restrict discharges and require equipment to be installed to minimize or control the discharge. For further discussion, refer to Appendix 4E, Section 3.5.

2.2.3 WASTE MATERIAL IMPACTS

2.2.3.1 Polychlorinated biphenyls (PCB's)

Increased regulation of the PCB-containing equipment would require inventorying all PCB containing equipment, which involves a walk down of the KCP&L distribution system and testing of all devices that could contain PCB's. For further discussion, see Appendix 4E, Section 4.1.

2.2.3.2 Coal Combustion Residuals (CCR's)

On June 21, 2010, the EPA proposed to regulate for the first time CCRs to address risks from the disposal of the wastes generated by electric utilities and independent power producers. These future regulations could require existing landfills to be closed and replaced with new landfills designed to more stringent standards. For further discussion, refer to Appendix 4E, Section 4.2.

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 12. In addition to the probable joint environmental cost for new supply-side technologies, KCP&L retained Sega to perform a multi-pollutant emissions control study for the existing coal units of Montrose 1, 2, and 3. These studies identified control technology alternatives, project costs, emission reductions, consumable requirements, etc., for environmental retrofits that would reduce SO_2, NO_x, PM, and Hg to meet potential and/or existing laws or regulations. A discussion of the studies, along with tables showing the expected environmental projects and the related costs to retrofit the existing Montrose station can be found below in Section 4.1.3.1

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 6 above.

2.3.1 <u>POTENTIAL SUPPLY-SIDE RESOURCE OPTION TABLE</u>

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 forty-one 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 forty-one technologies are shown in Table 12 below. The 'utility cost' rankings for all the supply-side resource options are shown below in Table 13. The 'utility cost plus probable environmental' rankings are show below in Table 14. Both the utility cost and probable environmental cost rankings show the lowest-cost alternatives to include supercritical pulverized coal, wind, FBC, combined cycle, and nuclear. 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 forecasted market power prices.

Table 12: Probable Environmental Cost ** Highly Confidential **

Technology	Capacity Factor (%)	Probable Environmental Cost
SCPC PRB WFGD	85%	[redacted]
SCPC PRB CO2 Capture	85%	[redacted]
SCPC ILL #6 WFGD	85%	[redacted]
SCPC ILL #6 CO2 Capture	85%	[redacted]
Fluidized Bed Combustion PRB (FBC)	85%	[redacted]
Fluidized Bed Combustion PRB (FBC) CO2 Capture	85%	[redacted]
IGCC PRB	85%	[redacted]
IGCC PRB CO2 Capture	85%	[redacted]
Nuclear - U.S. EPR	90%	[redacted]
Nuclear - G.E. ABWR	90%	[redacted]
Nuclear - Westinghouse AP1000	90%	[redacted]
CT LM6000 (2X)	10%	[redacted]
CT LMS100 (1X)	10%	[redacted]
CT GE 7EA (4X)	10%	[redacted]
CT GE 7FA.03	10%	[redacted]
CT GE 7FA.05	10%	[redacted]
Combined Cycle w/GE 7FA.03 (2x2x1)	85%	[redacted]
Combined Cycle w/GE 7FA.05 (2x2x1)	85%	[redacted]
Solar Thermal -Parabolic Trough	25%	[redacted]
Solar Thermal - Power Tower	43%	[redacted]
Central Solar PV Thin-Film 25MW	16%	[redacted]
Solar PV Residential - Utility Owned	15%	[redacted]
Wind	41%	[redacted]
Biomass BFB Boiler	85%	[redacted]
Landfill Gas	85%	[redacted]
Compressed Air Energy Storage System (Below Ground)	30%	[redacted]
Fuel Cell - Molten Carbonate	30%	[redacted]
Fuel Cell - Solid Oxide	30%	[redacted]
Fuel Cell - Proton Exch Membrane (PEM)	30%	[redacted]
Na S Batteries	30%	[redacted]
Zn Br Batteries	30%	[redacted]
Lead-Acid Batteries	30%	[redacted]
Li-ion Batteries	30%	[redacted]
Vanadium Redox Batteries	30%	[redacted]
Flywheel Energy Storage	30%	[redacted]
Zn -Air Batteries	30%	[redacted]
Fe/CrBatteries	30%	[redacted]
Internal Combustion Engine -Oil	10%	[redacted]
Internal Combustion Engine - Natural Gas/Spark	10%	[redacted]
Small Scale CT - Natural Gas	10%	[redacted]
Small Scale CT - Oil	10%	[redacted]

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Table 13: Technology Ranking by Nominal Utility Cost **Highly Confidential**

Rank	Technology	Capacity Factor (%)	Nominal Utility Cost ($/MWh)
1	SCPC PRB WFGD	85%	[redacted]
2	Fluidized Bed Combustion (FBC) PRB	85%	
3	Wind	41%	
4	Combined Cycle w/GE 7FA.03	85%	
5	Combined Cycle w/GE 7FA.05	85%	
6	SCPC ILL #6 WFGD	85%	
7	Nuclear - G.E. ABWR	90%	
8	Nuclear - Westinghouse AP1000	90%	
9	Nuclear - U.S. EPR	90%	
10	IGCC PRB	85%	
11	SCPC PRB CO2 Capture	85%	
12	FBC PRB CO2 Capture	85%	
13	IGCC PRB CO2 Capture	85%	
14	SCPC ILL #6 CO2 Capture	85%	
15	Li-ion Batteries	30%	
16	Compressed Air Energy Storage System	30%	
17	Zn -Air Batteries	30%	
18	Zn Br Batteries	30%	
19	Flywheel Energy Storage	30%	
20	Landfill Gas	85%	
21	Fe/CrBatteries	30%	
22	Fuel Cell - Molten Carbonate	30%	
23	CT GE 7FA.05	10%	
24	Na S Batteries	30%	
25	CT GE 7FA.03	10%	
26	Lead-Acid Batteries	30%	
27	Solar Thermal - Power Tower	43%	
28	Vanadium Redox Batteries	30%	
29	CT GE 7EA	10%	
30	Fuel Cell - Solid Oxide	30%	
31	Biomass BFB Boiler	85%	
32	CT LMS100	10%	
33	Fuel Cell - Proton Exch Membrane (PEM)	30%	
34	Int Comb Engine - Natural Gas/Spark	10%	
35	CT LM6000	10%	
36	Solar Thermal -Parabolic Trough	25%	
37	Small Scale CT - Natural Gas	10%	
38	Internal Combustion Engine -Oil	10%	
39	Small Scale CT - Oil	10%	
40	Central Solar PV Thin-Film 25MW	16%	
41	Solar PV Residential - Utility Owned	15%	

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Table 14: Technology Ranking by Nominal Probable Environmental Cost
****Highly Confidential****

Rank	Technology	Capacity Factor (%)	Nominal Utility Cost ($/MWh)
1	SCPC PRB WFGD	85%	[redacted]
2	Wind	41%	
3	Fluidized Bed Combustion (FBC) PRB	85%	
4	Nuclear - G.E. ABWR	90%	
5	Combined Cycle w/GE 7FA.03	85%	
6	Nuclear - Westinghouse AP1000	90%	
7	Combined Cycle w/GE 7FA.05	85%	
8	Nuclear - U.S. EPR	90%	
9	SCPC ILL #6 WFGD	85%	
10	IGCC PRB	85%	
11	SCPC PRB CO2 Capture	85%	
12	FBC PRB CO2 Capture	85%	
13	IGCC PRB CO2 Capture	85%	
14	SCPC ILL #6 CO2 Capture	85%	
15	Li-ion Batteries	30%	
16	Compressed Air Energy Storage System	30%	
17	Zn -Air Batteries	30%	
18	Zn Br Batteries	30%	
19	Flywheel Energy Storage	30%	
20	Landfill Gas	85%	
21	Fe/CrBatteries	30%	
22	Fuel Cell - Molten Carbonate	30%	
23	Na S Batteries	30%	
24	CT GE 7FA.05	10%	
25	Lead-Acid Batteries	30%	
26	CT GE 7FA.03	10%	
27	Solar Thermal - Power Tower	43%	
28	Vanadium Redox Batteries	30%	
29	CT GE 7EA	10%	
30	Biomass BFB Boiler	85%	
31	Fuel Cell - Solid Oxide	30%	
32	CT LMS100	10%	
33	Fuel Cell - Proton Exch Membrane (PEM)	30%	
34	Int Comb Engine - Natural Gas/Spark	10%	
35	CT LM6000	10%	
36	Solar Thermal -Parabolic Trough	25%	
37	Small Scale CT - Natural Gas	10%	
38	Internal Combustion Engine -Oil	10%	
39	Small Scale CT - Oil	10%	
40	Central Solar PV Thin-Film 25MW	16%	
41	Solar PV Residential - Utility Owned	15%	

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 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 Fluidized Bed Combustion (FBC) Technologies

The FBC technologies, FBC and FBC with CO_2 Capture, were not passed on to integrated resource analysis. The most common fluidized bed technology is the circulating fluidized bed combustion (CFBC), which is generally seen as an alternative to pulverized coal (PC) boilers. With no apparent advantage in capital cost or emissions in comparison to the SCPC technologies, the FBC technologies were eliminated from further consideration.

2.3.2.1.2 Integrated Gasification Combined Cycle (IGCC) Technologies

The IGCC technologies, IGCC PRB and IGCC PRB 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.

2.3.2.1.3 Supercritical Pulverized Coal Technologies

The SCPC ILL #6 technology and the SCPC ILL #6 technology with CO_2 Capture were both eliminated from further consideration, in favor of the SCPC technologies that burn PRB coal which is the more commonly used fuel for KCP&L.

2.3.2.1.4 Nuclear Technologies

There were three nuclear technologies considered in the prescreening process, the Westinghouse AP1000, the GE ABWR, and the US EPR. All three have similar costs on a dollar per MWh basis and similar characteristics, so only one technology was needed for the integrated resource analysis. The US EPR was chosen as the nuclear technology to move on to integrated resource analysis, while the AP1000 and ABWR were not passed on. For further discussion of the US EPR technology that did pass on to the integrated resource planning process, see Section 4.1.1.

2.3.2.1.5 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, KCP&L will continue to pursue innovative renewable projects including landfill gas-to-energy projects, such as the recent 1.6 MW landfill power generation project completed by KCP&L GMO in partnership with the City of St. Joseph.

2.3.2.1.6 Combustion Turbine (CT) Technologies

In all, five 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 13 above, their nominal cost rankings on a dollar per MWh basis were relatively similar. The CT technologies of the LM6000, the GE 7FA.03, the LMS100, and the GE 7FA.05 were not passed on to the integrated resource planning process. The GE 7EA combustion turbine technology was passed on to the integrated resource planning process. For further discussion, refer to Section 4.1.1.1

2.3.2.1.7 Combined Cycle (CC) GE 7FA.03 Technology

The GE 7FA.03 technology version was not passed on to integrated resource analysis, but the more current version of the GE 7FA.05 was passed on as a combined cycle technology since it has been available for delivery starting in January 2012.

2.3.2.1.8 Biomass Bubbling Fluidized Bed (BFB) Boiler Technology

This technology was not passed on to integrated resource analysis due to the extremely high capital and fixed O&M costs, and its inability to compete with cheaper renewable alternatives such as wind. The alternative of co-firing Montrose Units 1-3 with 10% biomass was passed on to the integrated resource analysis, and further discussion of this alternative can be found in Section 4.1.2.1

2.3.2.1.9 Energy Storage Technologies

The energy storage technologies included in the prescreening process were compressed air energy storage (CAES), flywheel energy storage, and various batteries (NaS, ZnBr, Lead-Acid, Li-ion, Vanadium, Zn Air, Fe/Cr). Due to their relatively high cost, along with the early development stage and limited utility application of several of these technologies, 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.

2.3.2.1.10 Fuel Cell Technologies

These technologies, including molten carbonate fuel cells, solid oxide fuel cells, and proton exchange membrane (PEM) fuel cells, were 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.

2.3.2.1.11 Solar Thermal Technologies

The solar thermal technologies in the prescreening process– parabolic trough and power tower – 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, KCP&L did pass on a solar technology, solar photovoltaic (PV) fixed flat-plate technology, to the integrated resource analysis.

2.3.2.1.12 Solar PV Residential Technology

This technology was not passed onto the integrated resource analysis due to it being the highest cost (on a dollar per MWh basis) of all the technologies considered in the prescreening process. However, KCP&L continues to offer Missouri customers a $2 per watt solar rebate, up to 25 watts or $50,000, for qualified photovoltaic (PV) solar systems installed on their home or business.

2.3.2.1.13 Small Scale CT Technologies

The small scale CT technologies, one fueled by natural gas and the other by oil, were not passed on to the integrated resource analysis process. Disadvantages of these technologies included high capital cost and fixed O&M for a peaking load technology, leading to being near the bottom of the rankings in terms of all-in cost. The small scale CT technologies provided no tangible benefits over the larger scale CT technologies that were passed on to integrated resource analysis.

2.3.2.1.14 Internal Combustion Engine (ICE) Technologies

Similar to the small scale CT technologies, the internal combustion engine technologies had high fixed O&M costs for a peaking load technology and ranked near the bottom in terms of all-in cost per MWh. These technologies also had relatively high emission rates, and were not passed onto 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). 22.040 (3)

3.1 INTERCONNECTION AND TRANSMISSION CONSTRAINTS ANALYSIS

(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: 22.040 (3) (A)

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 KCP&L transmission upgrade projects are currently made available as public information through either KCP&L'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-Maryville-Sibley project.

As a member of SPP, KCP&L 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. A recent Combined Cycle Plant Siting Study completed by Sega on behalf of KCP&L GMO illustrates the uncertainty of the potential transmission costs. In analyzing six potential sites, the transmission cost estimates ranged from **[redacted]**. For further review of this study, see Volume 7 of the KCP&L GMO Resource Acquisition Strategy, Appendix 7A. The current SPP Aggregate Study process has four active study groups with 195 transmission service requests (TSR), totaling approximately 16,000 MW of TSR.

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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 KCP&L 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. 22.040 (3) (B)

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, an alternative to modify the existing Montrose Units 1, 2, and 3 to burn 10% biomass was also moved into the integration process. This list of supply side technologies passed on to the integrated resource analysis can be found in Table 15 below. For the prescreen, EPRI-TAG® was the primary source utilized for cost and operating data, in order to avoid any potential bias on projections developed by different sources. However, for the technologies that moved on to the integrated resource analysis, KCP&L utilized more recent RFP responses, externally provided estimates, or other market sources when available in developing cost and operating data.

Table 15: Candidate Resource Options

TECHNOLOGY TYPE	DESCRIPTION
Pulverized Coal	SCPC PRB SCPC PRB w/CO2 Capture
Nuclear	Nuclear - U.S. EPR
Combined Cycle	CC w/ GE 7FA.05
Combustion Turbine	CT GE 7EA
Wind	Wind
Solar	Solar Central PV Thin-Film
Existing Resources	Montrose Units 1-3 - 10% Biomass Montrose Units 1-3 - Environmental Retrofits

22.040 (4)

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. 22.040 (4) (A)

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:

4.1.1.1 Combustion Turbine Technologies

The CT technology of the GE 7EA was passed on to the integrated resource analysis process, and is a good representative of the larger group of CT technologies included in the prescreening process. The GE 7EA has more operating flexibility and more familiarity among KCP&L

personnel than the other combustion turbine technologies considered in the prescreening process.

4.1.1.2 Combined Cycle Technologies

The CC technology of the GE 7FA.05 was passed on to the integrated resource analysis process. The local engineering firm Sega assisted in providing CC technology characteristics that were used in the integrated resource analysis. In some cases, these values differed from the EPRI-TAG® values used in the prescreening process, but are more accurate figures for the KCP&L territory.

4.1.1.3 Coal Technology

The SCPC PRB technology and the SCPC PRB technology with CO_2 Capture were both passed on to the integrated resource analysis as representative coal technologies. These were chosen over similar SCPC coal technologies burning Illinois coal, since PRB is a more common fuel type for KCP&L and the cost ranking on a dollar per MWH basis is slightly better.

4.1.1.4 Nuclear Technology

The US EPR nuclear technology was passed on to the integrated resource analysis due to having advanced active safety features and the expectation of having higher fuel burn-up efficiency that will lead to reduced nuclear waste and fuel consumption, when compared to the other nuclear technologies considered in the prescreen, AP1000 and ABWR .

4.1.1.5 Wind Technology

The wind turbine technology was passed on to the integrated resource analysis, due to its ability to help meet the MO 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 MO RES solar carve out requirements, the central solar photovoltaic (PV) thin-film technology was passed on to the integrated resource analysis.

4.1.2 BIOMASS & CONVERSION OPTION

4.1.2.1 Montrose Units 1, 2, and 3 10% Biomass

KCP&L considered the potential of co-firing with 10% biomass at Montrose Units 1, 2, and 3. The services of Black & Veatch were retained to do a study of co-firing with biomass, and following is a list of the biomass cost and operating assumptions used in the analysis of this alternative. This alternative was passed on to the integrated resource analysis.

Table 16: Montrose Station Biomass Assumptions **Highly Confidential**

BIOMASS ASSUMPTIONS	
Capital Cost	[redacted]
FOM	
VOM	
Total Annual OM Increase	
Biomass Fuel ($/mmBtu)	
Heat Rate (Btu/kWh) Impact	
Emission Rate Impacts:	
Hg (lb/Tbtu)	
SO2 (lb/MMBtu)	
Nox (lb/MMBtu)	
CO2	

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4.1.3 ENVIRONMENTAL RETROFIT & LIFE EXTENSION OPTIONS

In evaluating existing generating plants, KCP&L pursued the following options for Montrose Units 1, 2, and 3.

4.1.3.1 Environmental Retrofits

The services of Sega, Inc. were retained to perform a multi-pollutant emissions control study for the coal-fired units of Montrose Units 1, 2, and 3. Included in the scope of the study were conceptual design details to retrofit the units to reduce SO_2, NO_x, PM, and Hg emissions. In addition, Sega performed a Best Available Control Technology (BACT) assessment, along with an intake and cooling tower study for each of the plants. The study provided capital and O&M costs estimations, and the net plant heat rate impacts. In addition to the air quality control (AQC) assessment, Sega investigated other non-AQC such as BOP impacts and plant betterment requirements including auxiliary electric upgrades, circulating/cooling water upgrades, ash handling retrofits, and fan draft modifications. The Environmental Retrofit study performed by Sega can be found in Appendix 4A for Montrose Units 1-3. AQC projects, costs, and operating impacts provided by Sega for Montrose Units 1, 2, and 3 are shown in Table 17 through Table 22 below.

Table 17: AQC Capital Costs Montrose Unit 1 **Highly Confidential**

[redacted]

Table 18: AQC Capital Costs Montrose Unit 2 **Highly Confidential**

[redacted]

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Table 19: AQC Capital Costs Montrose Unit 3 **Highly Confidential**

[redacted]

Table 20: AQC O&M Impacts Montrose Unit 1 **Highly Confidential**

[redacted]

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Table 21: AQC O&M Impacts Montrose Unit 2 **Highly Confidential**

[redacted]

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Table 22: AQC O&M Impacts Montrose Unit 3 **Highly Confidential**

[redacted]

4.1.3.2 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 primary objectives of the LAMP program include:

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

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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 Montrose Units 1, 2, 3, Hawthorne Unit 5, LaCygne (KCP&L Share), and Iatan (KCP&L Share) are shown below in Table 23 through Table 29.

Table 23: Montrose Unit 1 LAMP Capital Plan Years 2017 - 2031 ($000's) ** Highly Confidential **

[redacted]

Table 24: Montrose Unit 2 LAMP Capital Plan Years 2017 - 2031 ($000's) ** Highly Confidential **

[redacted]

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Table 25: Montrose Unit 3 LAMP Capital Plan Years 2017 - 2031 ($000's) ** Highly Confidential **

[redacted]

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Table 26: Hawthorne 5 LAMP Capital Plan Years 2017 - 2024 ($000's) ** Highly Confidential **

[redacted]

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Table 27: Hawthorne Unit 5 LAMP Capital Plan Years 2025 - 2031 ($000's) ** Highly Confidential **

[redacted]

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Table 28: KCP&L SHARE LaCygne Station LAMP Capital Plan Years 2017 - 2031 ($000's) ** Highly Confidential **

[redacted]

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Table 29: KCP&L SHARE Iatan Station LAMP Capital Plan Years 2017 - 2031 ($000's) ** Highly Confidential **

[redacted]

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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. 22.040 (4) (B)

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 KCP&L 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).

22.040 (4) (C)

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 higher interconnection costs for wind projects. This cost adder on a dollar per kW basis is shown below in Table 30. The detail behind this interconnection calculation has been provided in the Volume 4 workpapers.

Table 30: Transmission Interconnection Projection **Highly Confidential**

[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: 22.040 (5)

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;
22.040 (5) (A)

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 4D. 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, Energy Ventures Analysis, Hill & Associates (Wood Mackenzie), and JD Energy. Each source provided the forecast in either nominal or real dollars, and then the forecasts were converted to nominal dollars using Moody's Analytics' GDP implicit price deflator. The forecasts were then

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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 is 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 are base 50%, high 25%, and low 25%.

5.1.2 NATURAL GAS FORECAST

A composite Henry Hub natural gas price forecast was created by combining forecasts from the Energy Information Administration (EIA), Energy Ventures Analysis (EVA), Cambridge Energy Research Associates (CERA), and PIRA Energy Group (PIRA). Each source provided a base forecast in nominal dollars, with the exception of the EIA. The EIA forecast was 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 is 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 are base 50%, high 25%, and low 25%.

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 Energy Information Administration (EIA), Energy Ventures Analysis (EVA), Cambridge Energy Research Associates (CERA), and PIRA Energy Group (PIRA). Each source provided a base forecast in nominal dollars, with the exception of the EIA. The EIA forecast was 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 is 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 are 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, KCP&L 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 'Mid', 'High', and 'Low' fuel price forecasts are shown below in Table 31 and Table 32. The sources used in developing the forecasts are shown below in Table 33.

Table 31: Fuel Price Forecasts – Coal, Natural Gas, Fuel Oil **Highly Confidential **

[redacted]

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Table 32: Fuel Price Forecast – Nuclear ** Highly Confidential **

[redacted]

Table 33: Source Forecasts for Coal, Natural Gas, and Fuel Oil

Forecast Source	Coal	Natural Gas	Fuel Oil	Nuclear
EIA	x	x	x	
Energy Ventures	x	x	x	
Hill & Associates	x			
JD Energy	x			
PIRA		x	x	
CERA		x	x	
Global Energy				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; 22.040 (5) (B)

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 125% 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, the 'High' capital cost range for nuclear was set at 140% of the 'Mid' cost estimate.

5.2.1.3 Central Solar PV

With the uncertainty of what impact a potential elimination of the investment tax credit would have on the cost of solar over the resource planning period, the 'High' capital cost range for the central solar technology was set at 120% of the 'Mid' cost estimate.

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 85% of the 'Mid' cost rather than 90%.

5.2.2.2 Central Solar PV

With a significant reduction in solar PV capital cost over the past few years, the 'Low' capital cost range was set at 85% 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 34 and Table 35.

Table 34: Technology Capital Cost Ranges

TECHNOLOGY DESCRIPTION	Mid Range	High Range	Low Range
SCPC	100%	120%	90%
SCPC w/CO2 Capture	100%	125%	90%
Nuclear	100%	140%	90%
Combined Cycle	100%	115%	90%
Combustion Turbine 7EA	100%	115%	90%
Wind	100%	115%	85%
Solar	100%	120%	80%

Table 35: Capital Cost Estimates Utilized in Integrated Resource Analysis
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[redacted]

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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; 22.040 (5) (C)

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 36 and Table 37. 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 20 through Table 22. Further discussion of the FOM and VOM estimates was provided earlier in Section 1.1.

Table 36: Fixed O&M Estimates Utilized In Integrated Resource Analysis
**** Highly Confidential ****

[redacted]

Table 37: Variable O&M Estimates Utilized in Integrated Resource Analysis
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[redacted]

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5.4 <u>EMISSION ALLOWANCE FORECASTS</u>

(D) Forecasts of the annual cost or value of emission allowances to be used or produced by each generating facility over the planning horizon; 22.040 (5) (D)

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

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

[redacted]

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:

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

[redacted]

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

	Emission Forecast		
Forecast Source	SO2	Nox	CO2
CERA	x	x	
Energy Ventures	x	x	x
JD Energy	x	x	x
PEAR	x	x	x
PIRA	x	x	x
Synapse			x
Wood MacKenzie	x	x	x

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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 22.040 (5) (E) There are no leased or rented facilities included in any of the KCP&L alternative resource plans or in the rate base, so this rule does not apply to this IRP evaluation.

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.
22.040 (5) (F)

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