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# VOLUME 1

# EXECUTIVE SUMMARY

# THE EMPIRE DISTRICT ELECTRIC COMPANY – A LIBERTY UTILITIES COMPANY (LIBERTY-EMPIRE)

## 4 CSR 240-22.080

## FILE NO. EO-2019-0049

## June 2019

**Denotes Confidential**

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# EXECUTIVE SUMMARY

**4 CSR 240-22.080 Executive Summary**

*(2) The utility's triennial compliance filings shall demonstrate compliance with the provisions of this chapter and shall include at least the following items:*

*(E) An executive summary, separately bound and suitable for distribution to the public in paper and electronic formats. The executive summary shall be an informative non-technical description of the preferred resource plan and resource acquisition strategy. This document shall summarize the contents of the technical volume(s) and shall be organized by chapters corresponding to 4 CSR 240-22.030–4 CSR 240-22.070. The executive summary shall include:*

## SECTION 1 INTRODUCTION

*1. A brief introduction describing the utility, its existing facilities, existing purchase power arrangements, existing demand-side programs, existing demand-side rates, and the purpose of the resource acquisition strategy;*

### 1.1 Purpose of This Document

Liberty-Empire's Integrated Resource Plan ("IRP") and its associated Preferred Resource Plan ("Preferred Plan") recommendation have been guided by both a careful attention to underlying resource planning and evaluation requirements *and* overarching mandates that require Liberty-Empire to provide customers with energy services that are safe, reliable, and efficient, at just and reasonable rates. The Preferred Plan carries carry out both areas of these responsibilities in a manner that serves the public interest, is in compliance with all legal mandates, and is consistent with state energy and environmental policies.

**Liberty-Empire's Preferred Resource Plan**

Continued commitment to acquiring 600MW of new wind generation

Potential near-term retirement of the Asbury coal-fired plant due to economic challenges

Investment in solar and storage to take advantage of tax credits and declining capital costs

Investment in distributed energy resources where significant T&D avoided costs are identified

Pursuit of demand-side resources and commitment to a MEEIA filing

Importantly, the Liberty-Empire Preferred Plan both maintains a consistency with and builds upon its prior Preferred Plan, which was filed with the Commission in 2018.[1] Like the prior filing, it incorporates 600 MW of new renewable wind generation as a core part of a reconfigured generation portfolio. However, unlike the 2016 IRP, the Preferred Plan proposes the retirement of the Asbury coal-fired plant, the advancement of utility-scale and distributed solar and storage resource investments, and the adoption of an energy efficiency plan.

[1] Note that this reflected a change in Preferred Plan from Liberty-Empire's 2016 IRP filing. See Empire's Notice of Change in Preferred Plan. In the Matter of the Empire District Electric Company's Change to its 2016 Utility Resource Filing Pursuant to 4 CSR 240 – Chapter 22. (October 17, 2018).

The Preferred Plan that has resulted from this analysis effort is technically rigorous, balanced, and innovative. It strikes a balance between demand-side and supply-side resources as well as utility-scale and distributed resources, while also meeting long-run utility cost minimization objectives.[2] The Preferred Plan also identifies, analyzes, and documents key considerations that go into its selection, including uncertain factors (such as technology changes, market forces, and more stringent legal mandates than those existing today) that shape the plan's conclusions. Identifying these factors help customers and other stakeholders appreciate how Liberty-Empire has been reasonable and prudent in recommending the Preferred Plan.

## 1.2 Highlights of Liberty-Empire's IRP and its Preferred Resource Plan

Liberty-Empire has engaged in an extensive eleven-month effort to assess, with great care and diligence, how it can best meet its customers' needs for low-cost energy that is highly reliable, safe, resilient, and environmentally sustainable. This is not an easy or straightforward task and has required significant evaluation and estimation of customer load requirements, market and technology trends, and existing and potential environmental policy. In short, this exercise requires careful consideration of those assumptions in which the Company can be confident, and other assumptions that are less certain. To create this IRP, and the Preferred Plan that forms its core conclusions, Liberty-Empire has deployed state-of-the-art tools and techniques to help delineate and clarify choices and tradeoffs. It has also listened to its customers about their priorities and interests.

With this IRP, Liberty-Empire has built upon and confirmed the soundness of the direction laid out in its prior Preferred Plan, creating and extending specific commitments as part of a new, near-term, three-year implementation plan.

[2] Formally, the minimization of present value revenue requirement, or PVRR, is the primary criterion for the selection of the Preferred Plan.

**Asbury Plant**

Although no definitive decision has been made, one component of Liberty-Empire's Preferred Plan is the potential retirement of the Asbury power plant. Asbury is a 200 MW coal-fired power plant located north of Joplin in the Company's service territory. While the plant is partially controlled for $SO_2$, $NO_x$, and mercury emissions, lower-cost competing technologies in the market have reduced the value of the plant. In 2018, Asbury had a 48% average capacity factor.

The IRP modeling demonstrates that because of the additional capital investment that would be necessary to meet environmental regulations relating to Asbury's coal ash handling system and the energy market created by the Southwest Power Pool's (SPP) integrated marketplace (IM), which are factors that are generally outside the control of Liberty-Empire, the Asbury plant is not a cost-effective resource for customers going forward. Asbury generates limited energy margin selling into SPP in the hours when it operates. This trend is not expected to materially improve. Asbury has significant non-fuel operations and maintenance costs that currently overwhelm the plant's energy margin. In addition to ongoing maintenance and operations costs, maintaining Asbury beyond 2020 would require a significant incremental capital investment of approximately $20 million. These costs are associated with converting the existing bottom ash handling system at Asbury from a wet to a dry system. Even assuming some value for Asbury's capacity, lower-cost alternatives exist for meeting Liberty-Empire's requirements. In the Preferred Plan, future capacity and energy needs are met by solar, wind, and storage technologies, which are lower-cost than retaining Asbury.

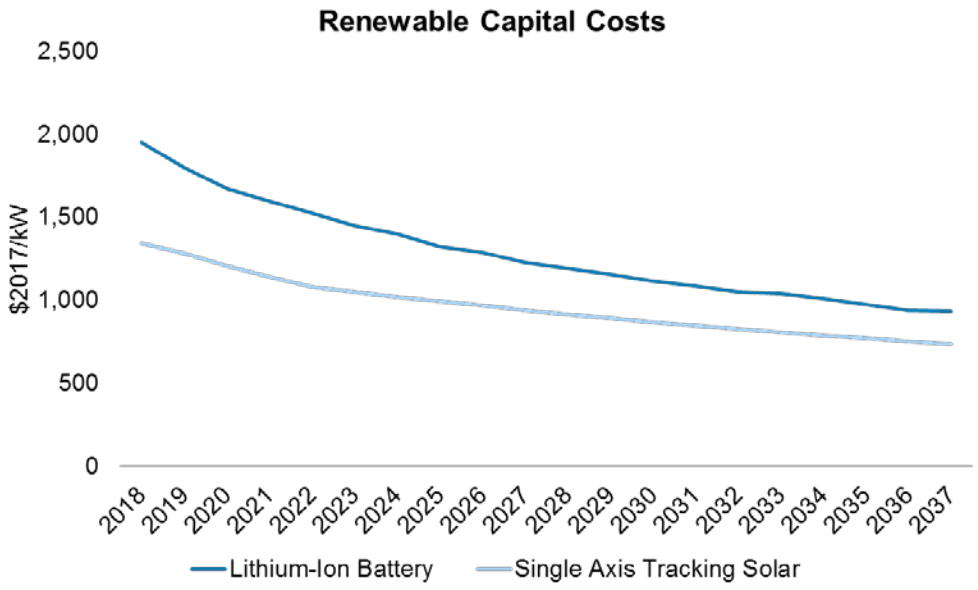
**Drivers of a Potential Asbury Plant Retirement**

- Challenging market conditions
- In 2018, Asbury had a 48% average capacity factor
- Lower cost alternatives to Asbury exist for meeting Liberty-Empire's requirements

**Investment in Solar and Storage**

This IRP calls for investment in solar and storage as the primary near- and long-term capacity and energy options. In the near term, Liberty-Empire expects to take advantage of investment tax credits to lower the overall cost of solar and storage significantly. Over the long term, Liberty-Empire expects the cost of solar development to continue to decline, improving the relative economics of the technology, even without tax credit availability. Figure 1-1 illustrates the expected capital costs for solar and storage over the planning period, in real dollars.

**Figure 1-1 – Solar and Storage Capital Costs**




Liberty-Empire plans to add solar and storage in combination in 2022, 2027, 2028, 2032, 2034, and 2036. Liberty-Empire plans to add solar as a stand-alone resource in 2021 and 2023.

**Investment in Distributed Energy Resources**

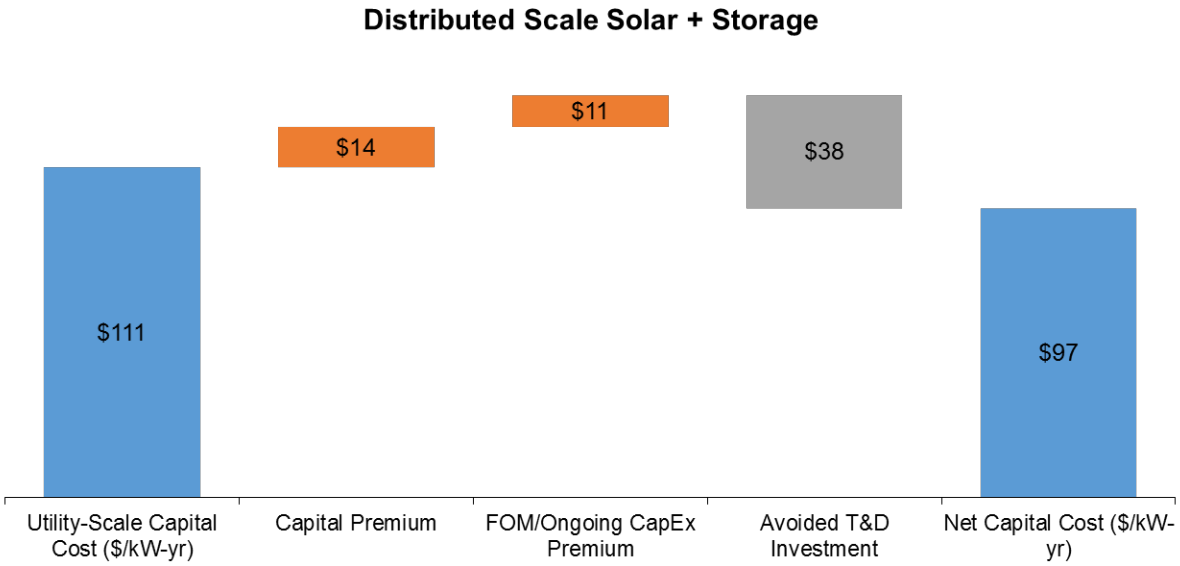
For the first time, Liberty-Empire's IRP includes investment in distribution-level resources to meet future resource requirements. The distributed solar + storage[3] investments planned in the IRP

[3] The terminology "solar + storage" refers to storage built in conjunction with solar to at least partly firm the capacity.

are in addition to Liberty-Empire's plans for up to 10 MW of community solar by 2021.[4] In addition, Liberty-Empire is proposing to add 19.5 MW of distributed solar + storage in 2022 and 2028, and 13.5 MW of distributed solar + storage in 2032 and 2036.

Distributed solar + storage is advantageous to Liberty-Empire customers because of the transmission and distribution system savings it creates at a relatively low incremental cost to utility-scale systems. Liberty-Empire estimates that distributed solar + storage is only 12 to 14% more expensive than comparable utility-scale configurations, but with the benefit of potentially significant deferred substation upgrades and avoided transmission line losses. Figure 1-2 illustrates the potential incremental costs and benefits of distributed resources.

**Figure 1-2 – Potential DER Benefits[5]**




**Investment in Grid Modernization**

[4] Note, Liberty-Empire is planning to propose a community solar tariff with expansion in 5 MW increments up to 30 MW. However, for purposes of the IRP, Liberty-Empire assumed 10 MW by 2021.

[5] In addition to avoided T&D benefits, distributed solar + storage also benefits from SPP energy market revenues.

Liberty-Empire's 2019 IRP affirms the Company's specific intentions to support the evolution in grid needs with the implementation of distribution grid modernizing technology. This includes advanced meters to help Liberty-Empire's customers interact more effectively with the Company in their energy use. Over the next several years, Liberty-Empire also expects to implement grid monitoring and control technologies to enable greater levels of Distributed Energy Resource ("DER") participation on the grid.

**Investment in Demand-side Management**

Finally, Liberty-Empire remains committed to achieving pathways for its customers to use electricity wisely. The Preferred Plan includes a continuing role for Demand Side Management ("DSM") programs.

## 1.3 Liberty-Empire Utility Overview

Liberty-Empire is a regulated utility based in Joplin, Missouri that provides electric and water service to approximately 173,000 customers. In 2017 The Empire District Electric Company was acquired by Liberty Utilities (Central) Corp., a subsidiary of Liberty Utilities Co., itself a U.S. subsidiary of Algonquin Power & Utilities Corp. The Liberty-Empire relationship provides many benefits to the Company, including opportunities to share corporate resources and engage in multi-company research efforts.

The 2019 IRP applies to the Liberty-Empire electric business. The electric operation generates, purchases, and distributes electricity to approximately 173,000 electric customers in parts of Missouri, Kansas, Oklahoma, and Arkansas. Liberty-Empire is subject to the regulatory authority of the Missouri Public Service Commission ("MPSC"), the Arkansas Public Service Commission ("APSC"), the Kansas Corporation Commission ("KCC"), the Oklahoma Corporation Commission ("OCC"), and the Federal Energy Regulatory Commission ("FERC"). Additionally, Liberty-Empire is

a member of, and participates in, the electricity market managed by the Southwest Power Pool ("SPP").

Liberty-Empire's electric service territory encompasses approximately 10,000 square miles. Liberty-Empire serves twelve counties in Missouri, three counties in Oklahoma, one county in Kansas, and one county in Arkansas. Most of Liberty-Empire's load and territory is located in southwestern Missouri. The largest urban area it serves is the city of Joplin, Missouri, which has a population of over 50,000.[6] Principal commercial activities for its service territory are light industry, agriculture and tourism. In addition to supplying retail electric service, Liberty-Empire also provides wholesale service to municipally owned distribution systems.

Liberty-Empire's 2018 system maximum hourly electricity demand was 1,211 MW and Liberty-Empire's 2018 retail customer load was 5,231,113 MWh. Liberty-Empire meets its load requirements through a combination of owned and contracted resources and demand-side programs. In addition to the resources listed in Table 1-1, Liberty-Empire is in the process of acquiring wind projects located in Missouri and Kansas with a total capacity of approximately 600 MW. An order approving Liberty-Empire's request for a CCN for three wind projects was received on June 19, 2019.

**Table 1-1 – Summary of Liberty-Empire's Existing Supply-Side Resources (Winter Accredited Capacity)**

| | Owned Capacity | Contracted Capacity |
|---|---|---|
| **Coal** | 441 MW | 50 MW |
| **Natural Gas** | 1045 MW | |
| **Hydroelectric** | 16 MW | |
| **Wind** | | 61 MW |
| **TOTAL** | 1502 MW | 111 MW |

[6] https://www.census.gov/quickfacts/fact/table/joplincitymissouri/PST045218

Liberty-Empire serves its customers through an interconnected grid of transmission and distribution ("T&D") circuits and substations, which are diverse, and which must serve the needs of both its urban customers (located in areas of high service density like Joplin) as well as customers located along rural "feeder" circuits, where loads are low and circuits are long. This is an important physical characteristic of the Company's service area.

## SECTION 2 LIBERTY-EMPIRE'S LOAD FORECAST

*2. For each major class and for the total of all major classes, the base load forecasts for peak demand and for energy for the planning horizon, with and without utility demand-side resources, and a listing of the economic and demographic assumptions associated with each base load forecast;*

Liberty-Empire must perform extensive load analysis and forecasting as part of its IRP. The manner in which it performs this must also conform to Missouri 4 CSR 240-22 ("IRP Rule"). The load analysis and forecasting involves careful treatment and storage of historical electricity use data (at least 10 years), estimation of the effects of demand-side management programs and rates on loads, and economic, weather, and market trends affecting customer use patterns. Liberty-Empire also factors in the expected effects of electric vehicles and customer-owned solar PV. Liberty-Empire uses rigorous statistical techniques to adjust the load data to consider the effect of weather in a process known as "weather normalization."

Liberty-Empire forecasts loads using revenue class energy models, revenue class load profiles, and a system peak model. Load profiles are calibrated to both class energy and system peak forecasts, resulting in both energy and coincident peak forecasts for all classes and the system. The forecast method employs at least ten years of historic load data and thirty years of historical weather data. Combined with economic and end-use data, these data are used to develop econometric models which forecast load through 2048. The forecasts have been developed by Itron with the MetrixND software, and in consultation with the Company.

Liberty-Empire forecasts its energy sales to remain relatively flat through the planning period. Energy sales are forecast to rise from 5,135,379 MWh in 2019 to 5,137,276 MWh in 2038. Net energy for load is forecast to rise from 5,484,665 MWh in 2019 to 5,486,734 MWh in 2038. Liberty-Empire expects to experience a reduction in load in 2020 as a result of four municipalities no longer being served as full requirements customers. However, Liberty-Empire has executed

wholesale contracts with two of the four municipalities to serve their load from designated resources.

Residential and industrial class load is expected to be relatively flat during the 20-year period, while commercial requirements are expected to grow at a 0.6% per annum. Liberty-Empire forecasts its peak requirements to grow modestly through the planning period. Winter peak is forecast to rise from 1,185 MW in 2019 to 1,213 MW in 2038.

**Figure 1-3 – Net Energy for Load Forecast 2019-2038 (MWh)**

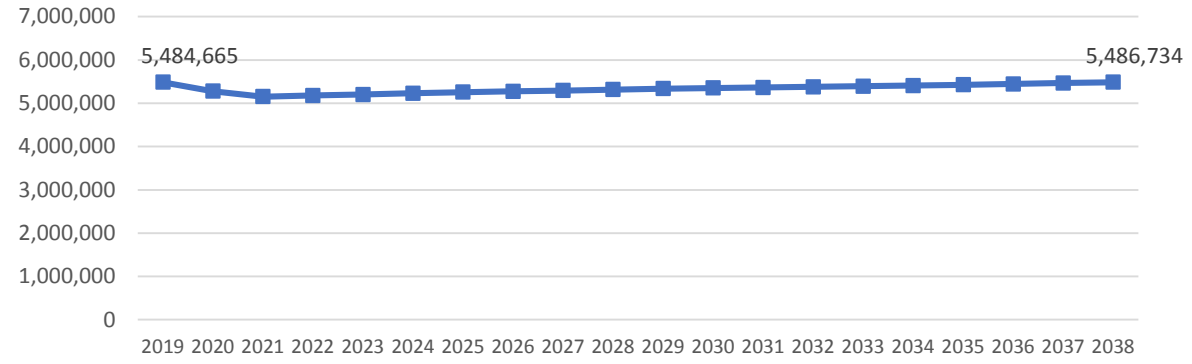
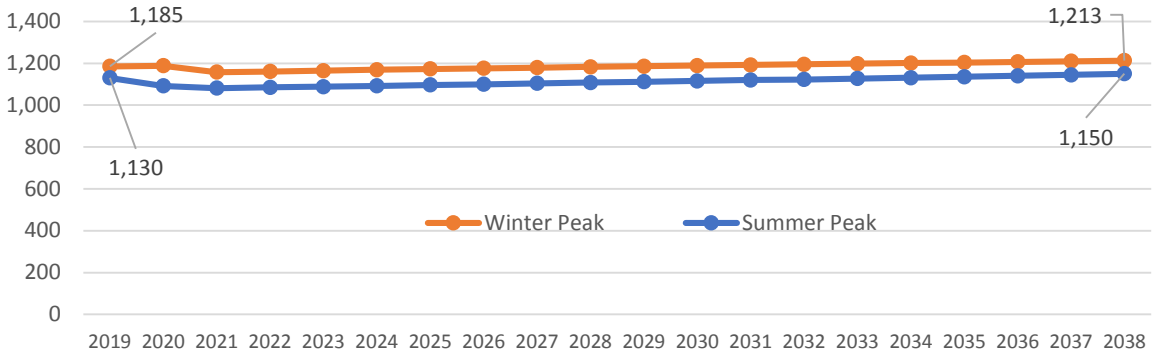



**Figure 1-4 – Peak Forecast 2019-2038 (MW)**

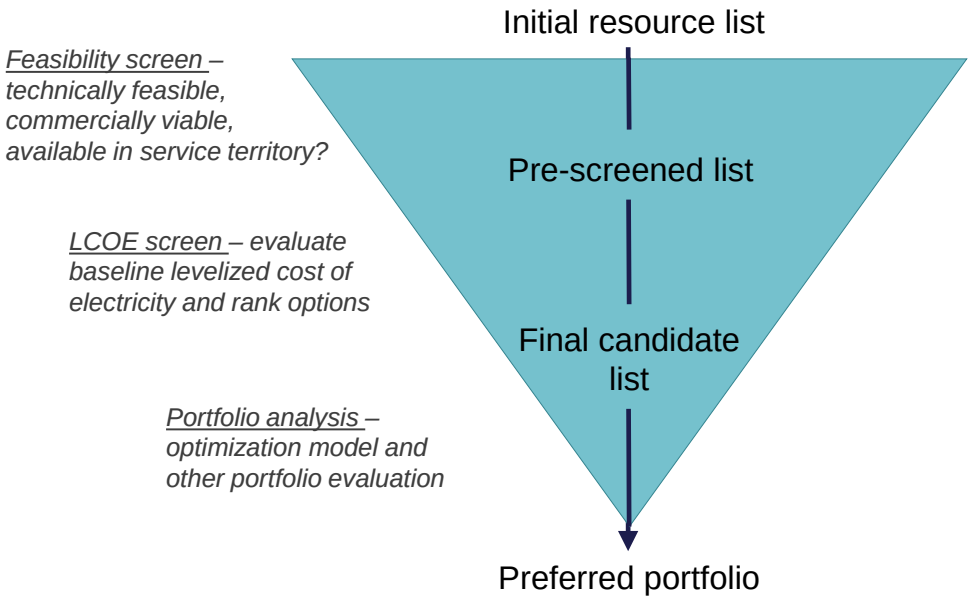


## SECTION 3 SUPPLY SIDE OPTIONS

*3. A summary of the preferred resource plan to meet expected energy service needs for the planning horizon, clearly showing the demand-side resources and supply-side resources (both renewable and non-renewable resources), including additions and retirements for each resource type;*

Liberty-Empire performed two rounds of preliminary screening to determine a short-list of supply-side candidate resource options prior to the full portfolio analysis. The first screening evaluated feasibility of the resource option within the Company's service territory or surrounding SPP region. The second screening compared the levelized cost of electricity ("LCOE") associated with installed capital costs plus fixed and variable operation and maintenance costs for the potential resource options. The screening process is illustrated in Figure 1-5.

**Figure 1-5 – Supply-Side Resource Screening Approach**



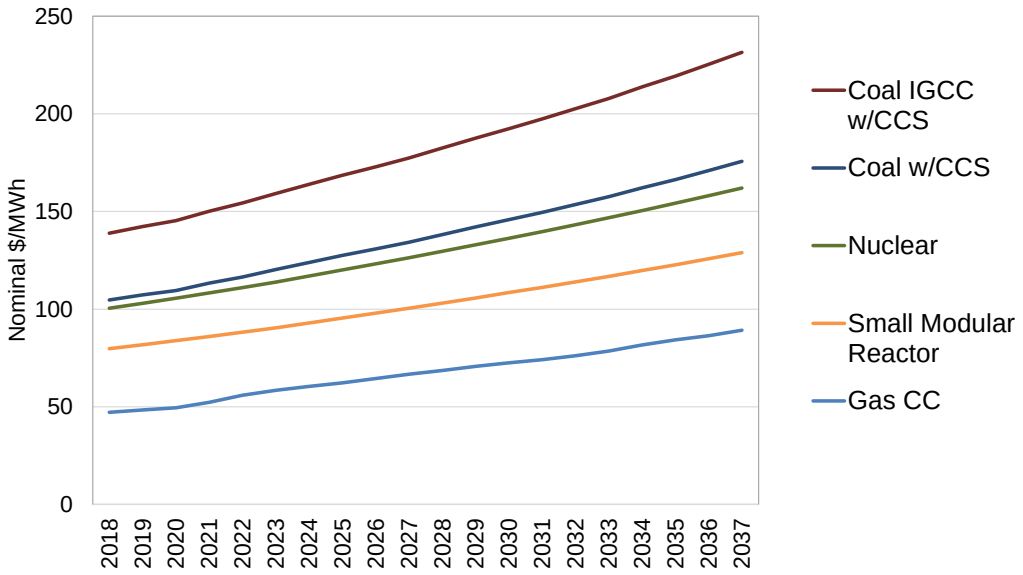
### 3.1 Utility Scale Resource Option Screening

In the LCOE screening stage, Liberty-Empire divided the pre-screened resources into four types due to their unique attributes: (1) non-renewable, baseload or intermediate load resources; (2) non-renewable, peaking load resources; (3) renewables resources, and; (4) storage resources.

#### 3.1.1 Baseload and Intermediate Load Resource Screening – Non-Renewable

As shown in Figure 1-6, a new natural gas combined cycle was found to be significantly lower-cost on an LCOE basis than the other resources evaluated in the non-renewable, baseload or intermediate category. Note that each year represents the projected LCOE for the resource that would enter service in that year. The natural gas combined cycle was the only option selected as a final candidate in the portfolio analysis.

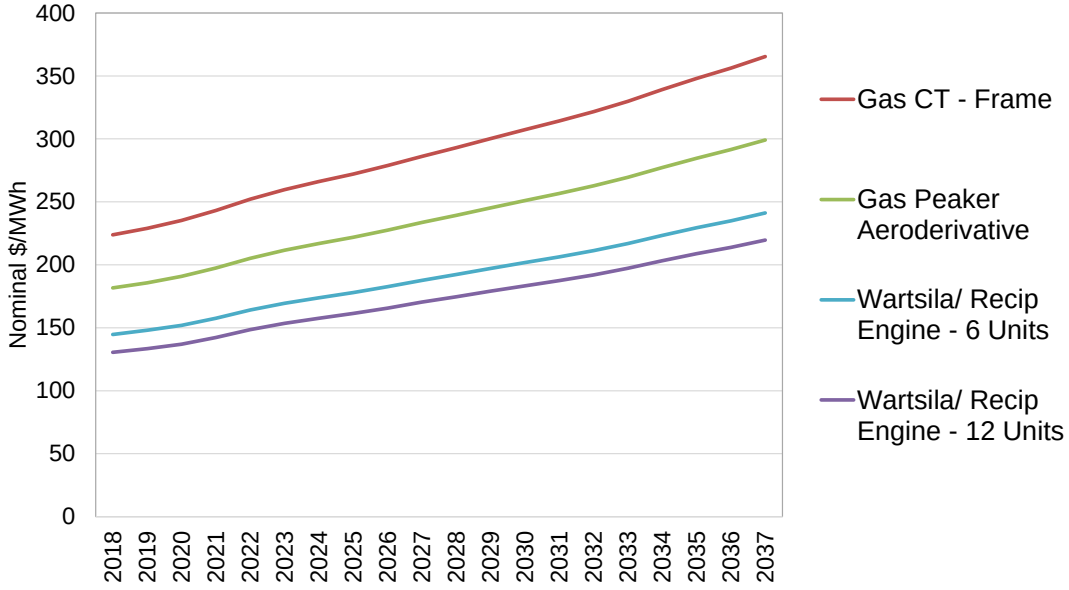
**Figure 1-6 – LCOE of Non-Renewable, Baseload or Intermediate Load Resources**



### 3.1.2 Peak Load Resource Screening – Non-Renewable

Four resources were evaluated in the non-renewable, peaking load category, as shown in Figure 1-7. Given lower LCOEs and the additional flexibility of aeroderivatives and reciprocating engines versus frame machines (smaller and more modular sizes to fit with Liberty-Empire's load requirements and faster ramp rates that can take advantage of the growing intermittency in the SPP energy market), Liberty-Empire determined that the aeroderivatives and reciprocating engines are likely to provide higher value than frame machines. Therefore, the gas frame machines were not included as final candidates in the portfolio analysis.

**Figure 1-7 – LCOE of Non-Renewable, Peaking Load Resources**

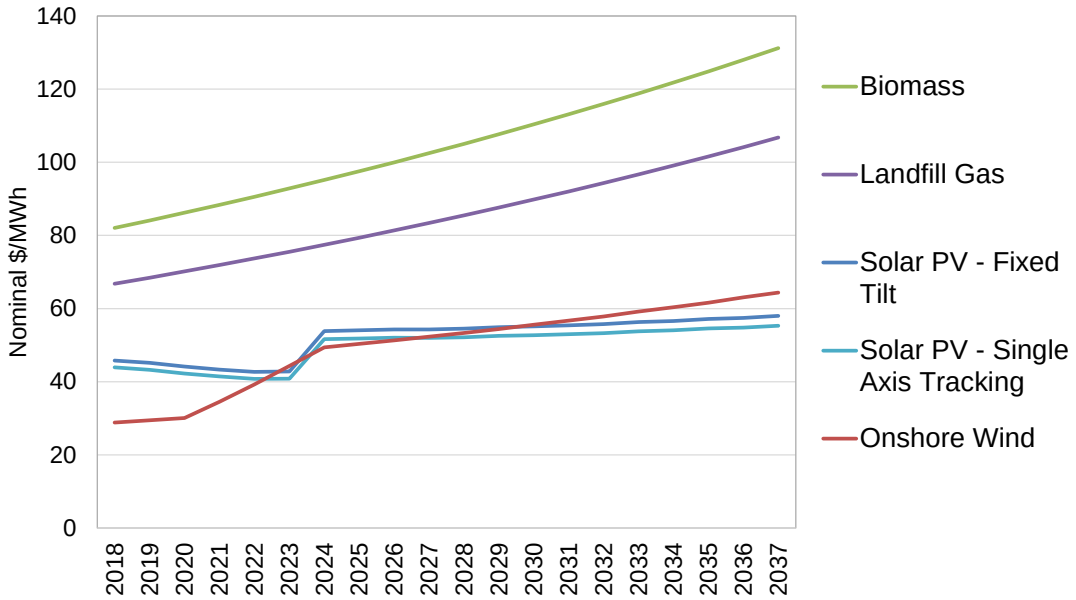



### 3.1.3 Renewable Resource Screening

Five renewable technologies were evaluated in the LCOE screening stage, as shown in Figure 1-8. Wind and solar are significantly lower-cost than the biomass and landfill gas due to tax incentives and declining cost curves. The solar cost projections are close to wind costs over time and have more potential to decline in real dollar terms in future years. Furthermore, solar resources may offer more capacity value to Liberty-Empire than wind resources in the summer

months, given their higher availability during summer days when the SPP system realizes its system peak. Within the solar resource category, the small capital cost premium associated with single axis tracking is more than offset by the increase in expected capacity factor, which lowers its cost on an LCOE basis.

**Figure 1-8 – LCOE of Renewable Load Resources**




### 3.1.4 Storage Resource Screening

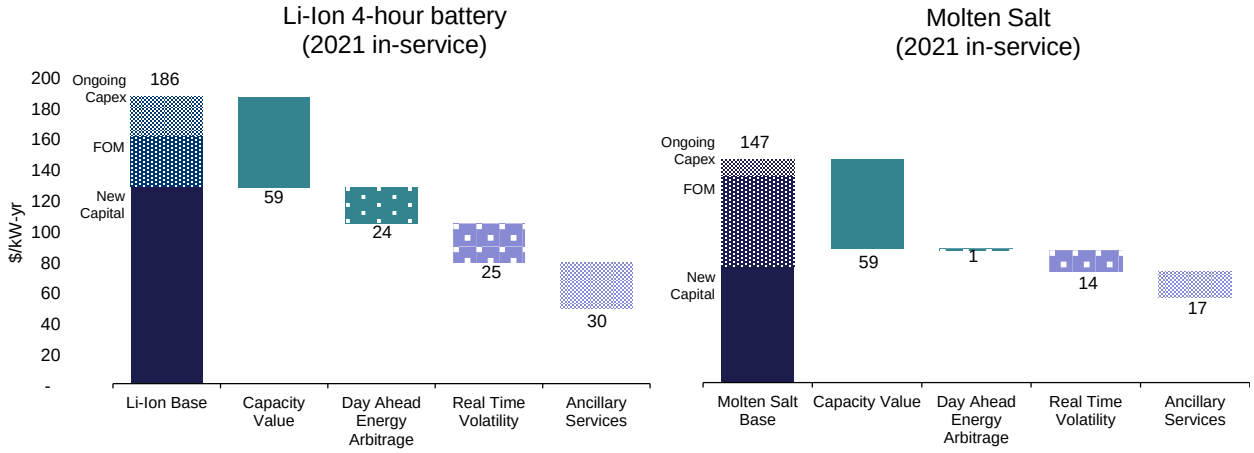
Liberty-Empire evaluated two storage technologies for consideration as final candidate supply-side options, as shown in Figure 9. The Company is of the view that given the observed rapid cost reductions and a growing availability of commercially viable options, storage is an important asset class to be considered as part of the 2019 IRP. Unlike conventional generation resources, however, storage resources do not provide net energy to the grid, but instead shift energy during a day or across a week. Hence, they cannot be appropriately evaluated in the traditional LCOE framework. In addition to energy shifting value, they also have the potential to provide capacity value and offer a host of ancillary services like frequency regulation and spinning reserves. As a result, Liberty-Empire has performed a "value stacking" exercise to evaluate the costs and comparative value of different storage options in providing benefits associated with capacity,

day-ahead market energy arbitrage, real-time volatility value, and ancillary services value.

At this point in time, Liberty-Empire has not definitively eliminated any storage technologies from future consideration, as technologies are rapidly evolving and use cases are developing. However, for planning purposes in this 2019 IRP, Liberty-Empire has reviewed four distinct storage technologies (mechanical concrete block, lead acid battery, lithium ion battery, and molten salt) and identified only two – lithium ion and molten salt – as having sufficient data to perform analysis. Liberty-Empire found that the higher levels of flexibility and efficiency associated with lithium ion batteries offer significant value opportunities across multiple SPP markets, with additional long-term value potential associated with expected capital cost declines and expected growth of intermittent resource capacity in the market. While the screening analysis does indicate that other technologies may also be competitive depending on specific cost assumptions and operational parameters, Liberty-Empire has determined that lithium ion battery technology is the appropriate benchmark for all storage options in the IRP.

Figure 1-9 illustrates the value stack for each of the storage resources that result from Liberty-Empire's analysis.

**Figure 1-9 – Storage Screening Results**



## 3.2 Distributed Resource Option Screening

Distributed resource options for solar and battery storage have generally been found to be at a cost premium of about 12 to 14% to their utility-scale counterparts, with a distributed reciprocating engine option being comparable or even lower-cost than the utility-scale alternative. Given the relatively similar fixed cost structure, Liberty-Empire determined that it is not appropriate to eliminate the feasible distributed resource options through an LCOE approach, since they can also provide benefits to the system associated with avoided distribution-level expenditures. Therefore, the distributed resource options for solar, battery storage, and reciprocating engines were preserved as candidate resource options.

## SECTION 4 GRID MODERNIZATION INVESTMENT

Liberty-Empire is pursuing several areas of advanced transmission and distribution network technology ("ATDNT") investment that will support its customers well over time, and that advance capabilities which will: (a) sustain and improve system reliability through such means as recloser and smart fusing operations; (b) improve system resilience through rebuilding core infrastructure such as substations; (c) improve day-to-day operations and customer care functions related to billing and other common customer energy account services; (d) reduce distribution system operational inefficiencies related to metering, billing accuracy, tamper and energy theft; (e) deliver energy efficiencies and power quality enhancements on the distribution system through the pursuit of voltage control capabilities; (f) improve the quality of information Liberty-Empire is able to provide customers about their energy use, therefore empowering customers to be better energy consumers; and (g) support new and expanded customer energy service choices through metering, rate programs and Liberty-Empire's situational awareness of grid performance.

Not all of these improvements will be readily visible to customers, nor are they limited to the installation of physical devices. The ATDNT plans, for example, will lead to more grid self-healing through distribution automation, expanded and improved communication to substations and field devices, and improvements to day-to-day engineering functions due to improved circuit models and maps. Process improvements of these kinds are needed if Liberty-Empire is going to be able to operate and maintain the grid reliably and resiliently, supporting the delivery of the right energy product in the right place and time as demanded by the Liberty-Empire customers over time. In this way, the ATDNT aspirations are best viewed from a systems point of view, involving by necessity field-located hardware, communications, integrated back office systems, and process improvements that apply the new functional capabilities in order to secure benefit achievement.

As a next phase of Liberty-Empire's ATDNT efforts, the Company intends to improve customer

care functions and improve related operational performance through the implementation of an AMI system covering Liberty-Empire's approximately 173,000 residential and commercial electric customers. Liberty-Empire intends to continue its detailed implementation planning of its AMI initiative during 2019, followed by the network and meter installation sometime during the 2020-2021 timeframe. This AMI initiative is part of Liberty-Empire's 5-year capital plan and is coordinated with the Liberty Utilities' company-wide rollout of AMI. Liberty-Empire's AMI initiative is designed to occur in specific stages that are tied to integrations to billing, outage management and other essential "back office" systems, which rely in part on advanced metering data. These stages occur over time, and in a methodical and prudent step-wise fashion.

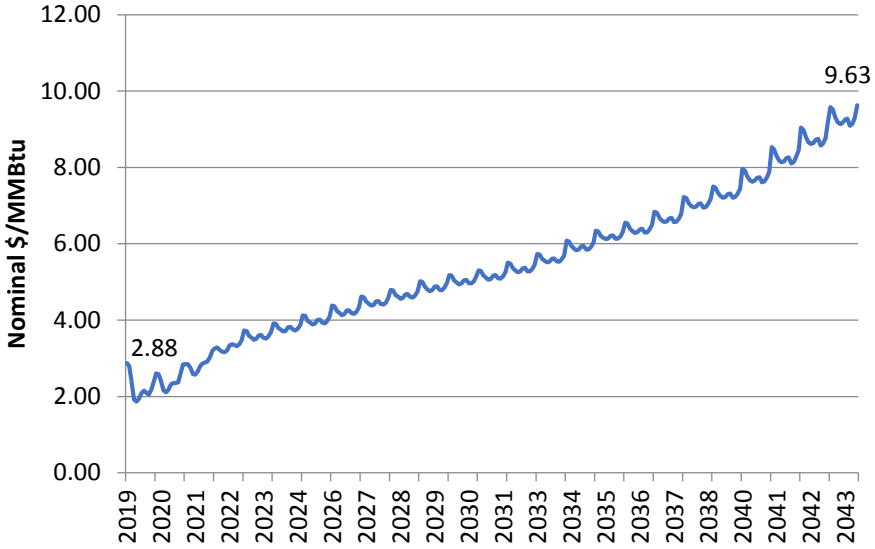
## SECTION 5 BASE CASE PRICE FORECASTS

Fuel, electricity, and emission allowance prices are key value drivers for Liberty-Empire's resource portfolios. These prices can dictate the competitiveness of different resource types and thus must be carefully evaluated in the IRP. Liberty-Empire's base case price forecasts were developed primarily by third-party consultants.

### 5.1 Natural Gas Price Forecast

For forecasting natural gas prices, Liberty-Empire relied on ABB's long-term natural gas price forecast. ABB publishes its forecast semi-annually, in the spring and in the fall. ABB's model combines futures prices in the near term with fundamental modeling of supply and demand to develop natural gas prices over the long term. The base case natural gas price is shown in Figure 1-10. The Company's base case natural gas forecast is characterized by relatively flat prices (in real dollars) in the first five years, followed by a steady, gradual increase in nominal prices through 2040. The forecast assumes that there will be a modest long-term resource increase for natural gas reserves. Demand for natural gas is also expected to increase over time, driven by power sector demand and export demand, partially offset by lower long-term industrial demand.

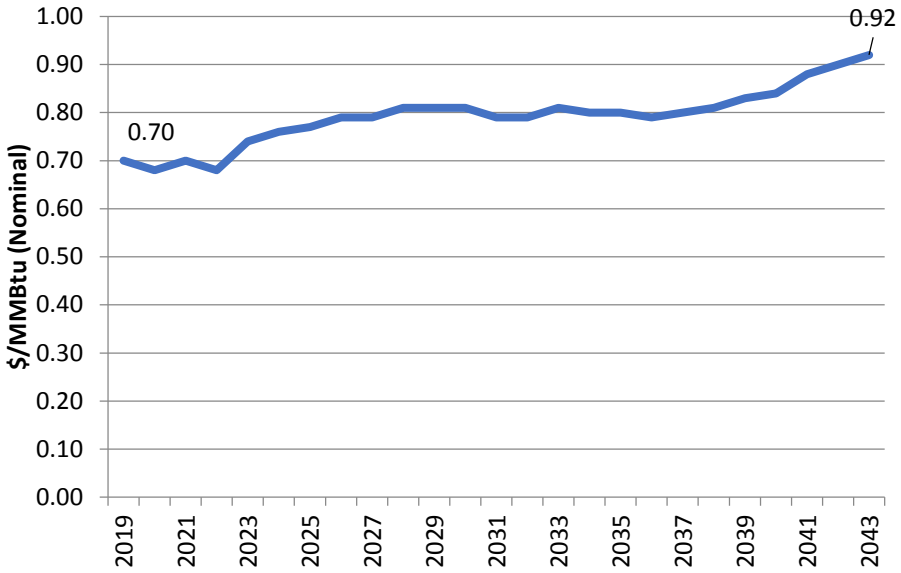
**Figure 1-10 – Base Case Natural Gas Price Forecast – Southern Star Delivered Price**




## 5.2 Coal Price Forecast

For forecasting coal prices, Liberty-Empire relied on several different sources. The first four to five years of the coal price forecasts used for the Asbury, Iatan, and Plum Point facilities were derived by the Company's fuels personnel and reflect contracts in place. The values for subsequent years use ABB's fundamentally-derived coal price forecast, combined with transportation adders for Liberty-Empire's coal units. Liberty-Empire's coal price forecast is relatively flat over the short term, with modest nominal price increases over the duration of the forecast. Coal demand is expected to be flat to declining over the period as demand from the power sector continues to decline.

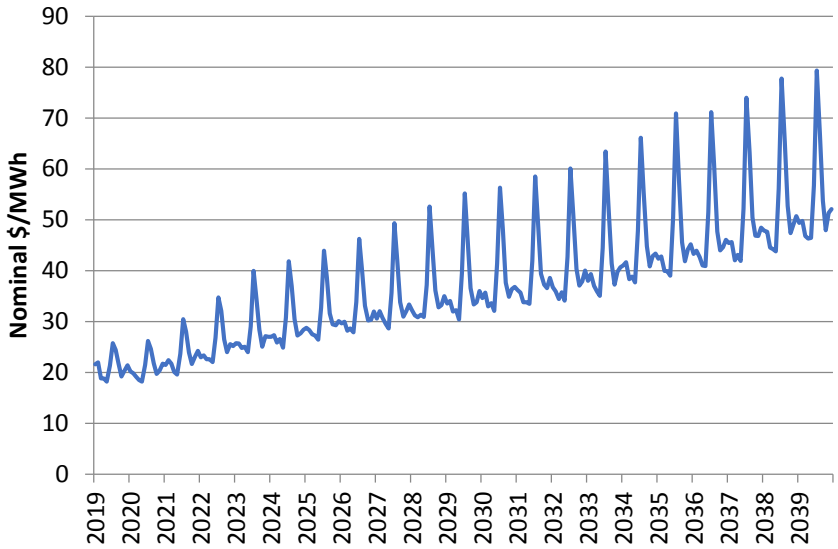
**Figure 1-11 – Base Case Coal Price Forecast – Southern PRB**




## 5.3 Market Price Forecast

Liberty-Empire relied on ABB to produce market price forecasts for the Southwest Power Pool Kansas-Missouri ("SPP KSMO") region, as it has done in past Triennial IRPs. ABB's models perform detailed, fundamental simulations of the energy markets, using assumptions about fuel forecasts, load forecasts, resource additions and retirements, and power plant operations. Liberty-Empire's base case market price forecast is characterized by flat to declining prices in the short term, consistent with the natural gas price forecast trajectory, followed by a gradual increase in prices over time.

**Figure 1-12 – Base Case Market Price Forecast**




## 5.4 Carbon Price Forecast

Liberty-Empire assumes no carbon price in the base case.

## SECTION 6 PORTFOLIO ALTERNATIVES

Liberty-Empire developed 16 alternative resource plans that attempted to address how it could optimize its portfolio consistent with stated objectives. This was a two-step process. First, Liberty-Empire considered the timing of plant retirements and contract expirations. While Liberty-Empire makes a default assumption in resource planning that plants retire at the end of their book or depreciable life, in the 2019 IRP Liberty-Empire considered the potential for the retirement of the Asbury coal-fired plant, Energy Center 1 and 2, and Riverton 10 and 11 before the plants are fully depreciated. These plants are generally older and, in some cases, facing challenging economic conditions. Liberty-Empire also considered that the Elk River and Meridian Way wind contracts would be expiring in 2025 and 2028, respectively.

Second, Liberty-Empire considered the replacement options that could be married with alternative retirement outcomes. Replacement options were thematically developed to consider the tradeoffs between utility-scale and distributed-level technologies as well as the tradeoffs between renewable-generated energy and thermally-generated energy (see Figure 1-13). While each of the plans considers a unique combination of retirements and replacements, the majority of the plans include common elements: the low-cost and mid-cost bundle for Realistic Achievable Potential ("RAP") DSM, a capacity upgrade to the Stateline combined cycle, and the addition of 600 MW of Liberty-Empire-owned wind (in conjunction with a tax equity partner) in 2021. All plans complied with Missouri Renewable Energy Standard ("RES") requirements. A plan utilizing Maximum Achievable Potential ("MAP") DSM was also evaluated.

**Figure 1-13 – Themes for Development of Alternative Resource Plans**

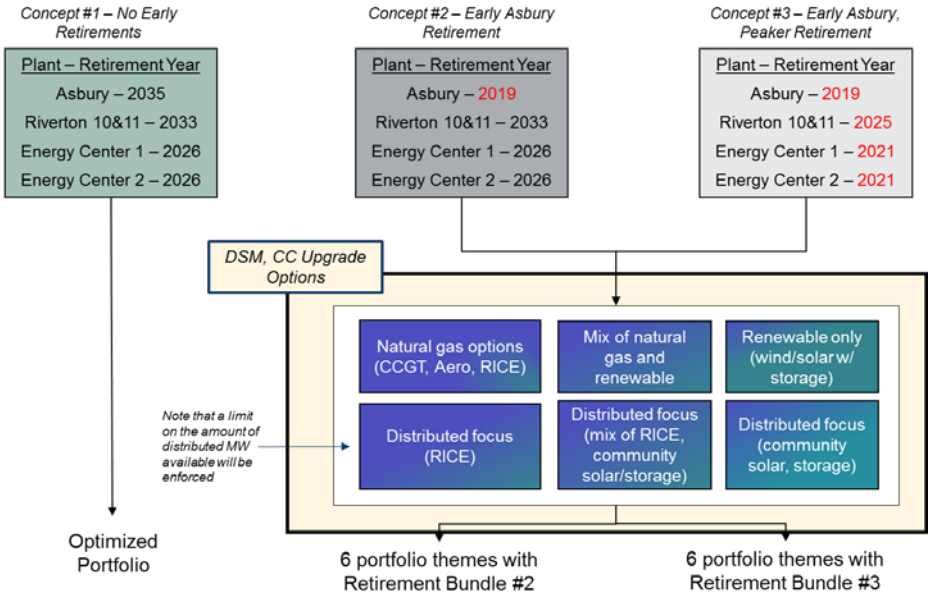



Table 1-2 provides a summary of Liberty-Empire's alternative resource plans. Each plan is described in greater detail in Volume 6.

**Table 1-2 – Summary of Alternative Resource Plans**

| Plan | Plan Description | Renewable vs. Gas | Utility Scale vs. Distributed | Retirements | DSM Portfolio |
|---|---|---|---|---|---|
| 0 | Customer Savings Plan | Gas | Utility Scale | No Early Retirements | RAP |
| 1 | Asbury End of Life - Least Cost | Renewable | Utility Scale | No Early Retirements | RAP |
| 2 | Early Asbury Retire - Utility Scale Renewables | Renewable | Utility Scale | Asbury 2019 | RAP |
| 2B | Early Asbury Retire - Utility Scale Renewables - All 2023 Solar | Renewable | Utility Scale | Asbury 2019 | RAP |
| 2 - MAP | Early Asbury Retire - Utility Scale Renewables + MAP DSM | Renewable | Utility Scale | Asbury 2019 | MAP |
| 3 | Early Asbury Retire - Utility Scale Thermal | Gas | Utility Scale | Asbury 2019 | RAP |
| 4 | Early Asbury Retire - Distributed Renewable | Renewable | Distributed | Asbury 2019 | RAP |
| 5 | Early Asbury Retire - Distributed Thermal | Gas | Distributed | Asbury 2019 | RAP |

| Plan | Plan Description | Renewable vs. Gas | Utility Scale vs. Distributed | Retirements | DSM Portfolio |
|---|---|---|---|---|---|
| 6 | Early Asbury Retire - Utility Scale Mix | Mix | Utility Scale | Asbury 2019 | RAP |
| 7 | Early Asbury Retire - Distributed Mix | Mix | Distributed | Asbury 2019 | RAP |
| 8 | Early Asbury, Peaker Retire - Utility Scale Renewables | Renewable | Utility Scale | Asbury 2019; Energy Center Units 1&2 2021; Riv[7] Units 10&11 2025 | RAP |
| 9 | Early Asbury, Peaker Retire – Utility Scale Thermal | Gas | Utility Scale | Asbury 2019; Energy Center Units 1&2 2021; Riv Units 10&11 2025 | RAP |
| 10 | Early Asbury, Peaker Retire - Distributed Renewable | Renewable | Distributed | Asbury 2019; Energy Center Units 1&2 2021; Riv Units 10&11 2025 | RAP |
| 11 | Early Asbury, Peaker Retire - Distributed Thermal | Gas | Distributed | Asbury 2019; Energy Center Units 1&2 2021; Riv Units 10&11 2025 | RAP |
| 12 | Early Asbury, Peaker Retire - Utility Scale Mix | Mix | Utility Scale | Asbury 2019; Energy Center Units 1&2 2021; Riv Units 10&11 2025 | RAP |
| 13 | Early Asbury, Peaker Retire - Distributed Mix | Mix | Distributed | Asbury 2019; Energy Center Units 1&2 2021; Riv Units 10&11 2025 | RAP |

Notes:
DSM – Demand-side Management
RAP – Realistic Achievable Potential
MAP – Maximum Achievable Potential

## 6.1 Role of Demand-Side Resources

Numerous DSM options were considered in the screening process by Applied Energy Group ("AEG"), Liberty-Empire's DSM consultant. The DSM programs that passed AEG's screening tests and were analyzed by CRA are shown in Table 1-3.

[7] "Riv" denotes the Riverton power station.

**Table 1-3 – Candidate DSM Programs**

| DSM Programs | Description | Online Year |
|---|---|---|
| Residential Lighting | Upstream incentives for LEDs at qualifying retailers | 2020 |
| Whole House Efficiency | The program is comprised of two program offerings:<br>- Direct Install - free home energy audit and direct installation of energy conservation measures<br>- Rebates - incentives for insulation, water heater, infiltration measures, and wi-fi thermostats | 2020 |
| Residential Behavioral | Behavior program utilizing customized energy reports sent periodically to households | 2020 |
| Low Income Whole House Efficiency | The program is comprised of two program offerings:<br>- Direct Install - free home energy audit and direct installation of energy conservation measures<br>- Rebates - incentives for insulation, water heater, infiltration measures, and wi-fi thermostats | 2020 |
| Low Income Behavioral | Behavior program utilizing customized energy reports sent periodically to households. | 2020 |
| Low Income Weatherization | Improve home efficiency for low income customers, install energy conservation measures and repair/replace heating | 2020 |
| Residential Time of Use | This rate provides a higher price during the designated peak period and lower prices during off-peak periods | 2025 |
| Residential Critical Peak Pricing | This rate higher rate for a particular block of hours that occurs on a critical peak event day | 2025 |
| Residential Inclining Block | An inclining block rate applies a rate(s) to a customer's bill if they exceed certain thresholds | 2025 |
| C&I Prescriptive & Custom Rebate | C&I customers may receive incentives for prescriptive or custom measures | 2020 |
| C&I Time of Use Rate | This rate provides a higher price during the designated peak period and lower prices during off-peak periods | 2025 |
| C&I CPP Rate | This rate higher rate for a particular block of hours that occurs on a critical peak event day | 2025 |
| C&I Real Time Pricing | This rate is a varied rate that is linked to the hourly market price for electricity. Typically targeted a large C&I customers | 2025 |

## SECTION 7 CRITICAL UNCERTAIN FACTORS

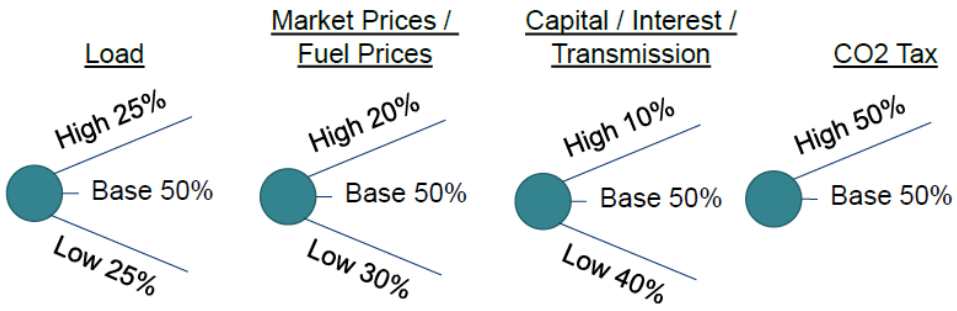
*4. Identification of critical uncertain factors affecting the preferred resource plan;*

Under the IRP Rule, Liberty-Empire must describe and document its assessment of the impacts and interrelationships of critical uncertain factors on the expected performance of each of the alternative resource plans and analyze the risks associated with alternative resource plans. The uncertain factors determined by the Company to impact the expected performance of the alternative resource plans were (1) load growth, (2) carbon prices, (3) gas and power prices, and (4) capital costs (combined with interest rates and transmission costs).

Liberty-Empire followed a multi-step process to arrive at the critical uncertain factors. First, it applied its expertise and judgment to determine what factors most likely play a significant role in alternative plan selection. This is essentially a screening step. It includes preliminary analysis to determine the likely effects of the variables on plan outcomes. Next, it intensively analyzes those factors deemed to be critical and uncertain to determine their influence on the alternative resource plans, including the Preferred Plan. This step includes evaluating the factors by attaching probabilities so as to enable a risk-oriented comparative analysis.

For each uncertain factor, Liberty-Empire developed alternative forecasts to be used in the portfolio modeling. These alternative forecasts are designed to reasonably bind the uncertainty. Consistent with the IRP Rule, Liberty-Empire assigned probabilities to the critical uncertain factors and these respective alternative forecasts. The alternative forecasts and their probabilities are shown in Figure 1-14.

**Figure 1-14 – Probabilities Assigned to Critical Uncertain Factors**




The tree of uncertain factors, which were all modeled as independent variables, results in a total of 54 unique uncertainty combinations. Each of the plans, described above, was exposed to each uncertainty combination, resulting in a total of 864 unique cost outcomes.

## 7.1 Liberty-Empire's Preferred Resource Plan

Liberty-Empire selected the Preferred Plan through an analysis of 16 discrete plans that included unique combinations of plant retirements and additions. Liberty-Empire selected Plan 4 as the Preferred Plan. Major elements of Plan 4 include the potential near-term retirement of Asbury, the addition of solar and storage at *both* the utility-scale and distributed levels, and RAP DSM. Energy Center 1&2 and Riverton 10&11 are retired at the end of their book lives in 2026 and 2033, respectively.

**Figure 1-15 – Preferred Plan (Plan 4) Supply-Side Retirements and Additions 2019-2038**

| Year | Supply-Side Retirements / PPA Expirations | Supply-Side Additions |
|---|---|---|
| 2019 | Asbury (200 MW) | |
| 2020 | | |
| 2021 | | Wind (600 MW)[8], Community Solar (10 MW) |
| 2022 | | Distributed Solar + Storage (19.5 MW) |
| 2023 | | Utility-Scale Solar (50 MW) |
| 2024 | | |
| 2025 | Elk River Contract Expiration (150 MW) | |
| 2026 | Energy Center 1 and 2 (162 MW) | |
| 2027 | | Utility-Scale Solar + Storage (50 MW) |
| 2028 | Meridian Way Contract Expiration (105 MW) | Distributed Solar + Storage (19.5 MW) |
| 2029 | | |
| 2030 | | |
| 2031 | | |
| 2032 | | Distributed Solar + Storage (13.5 MW) |
| 2033 | Riverton 10 and 11 (28 MW) | |
| 2034 | | Utility-Scale Solar (50 MW) |
| 2035 | | |
| 2036 | | Distributed Solar + Storage (13.5 MW) |
| 2037 | | |
| 2038 | | |

[8] Construction on the wind is expected to be completed by December 31, 2020. For capacity planning purposes, the units are assumed online starting in 2021.

## 7.2 Supply Side Resources in the Preferred Plan

The Preferred Plan will satisfy Liberty-Empire's future capacity needs with a mix of utility-scale[9] and distributed solar, utility-scale solar + storage, and distributed solar + storage. Plan 4 adds utility-scale solar in 2023 and 2034, distributed solar in 2021 (community solar), utility-scale solar + storage in 2027, and distributed solar + storage in 2022, 2028, 2032, and 2036.

For purposes of evaluating distributed resource options, Liberty-Empire developed estimates for potential distribution system infrastructure projects that could be avoided by the presence of a distributed energy resource. These avoided distribution costs informed the availability, size and timing of potential distributed resource additions. Potential distributed renewable resource options included distributed solar, distributed storage, and distributed solar + storage.

## 7.3 Demand-Side Programs in the Preferred Plan

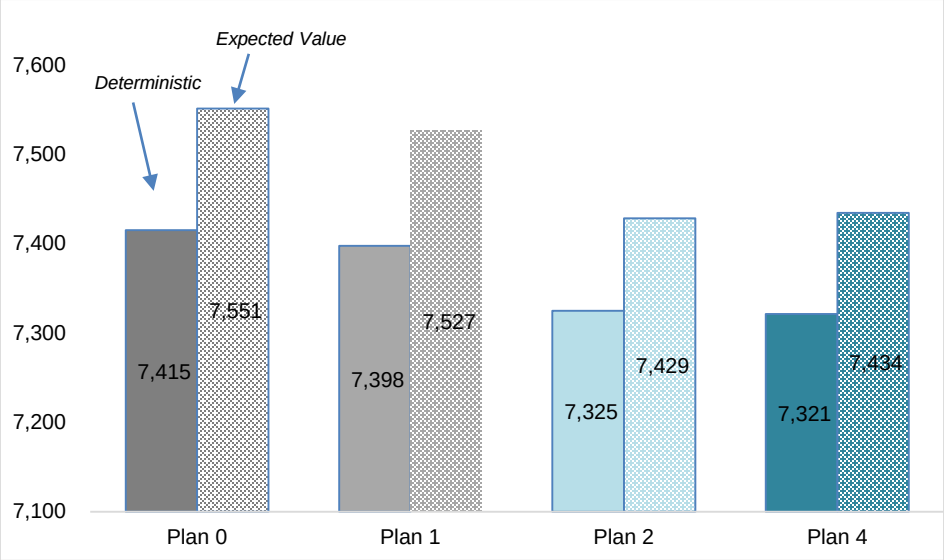
Liberty-Empire's 2019 Preferred Plan includes the low-cost and mid-cost bundles of RAP DSM.

## 7.4 Comparison to Plan 0 and Plan 1

Liberty-Empire analyzed the early retirement of Asbury by comparing Plan 0 and Plan 1, which both retain Asbury through end of life, to plans which retire Asbury in 2019. Figure XX below illustrates the deterministic and expected value of PVRR Retiring Asbury in 2019 saves Liberty-Empire customers $76 million on a 20-year deterministic basis and $93 million on a 20-year expected value basis (comparing Plan 1 to Plan 4). Relative to Liberty-Empire's prior Preferred Plan, retiring Asbury saves $94 million on a 20-year deterministic basis and $117 million on a 20-year expected value basis (comparing Plan 0 to Plan 4). This is illustrated in Figure 1-16.

[9] Utility-scale refers to larger systems typically connected to the transmission system.

**Figure 1-16 – 20 Year Deterministic and Expected Value PVRR Comparison for Plans that Keep and Retire Asbury ($ millions)**




## 7.5 Comparison to Plan 2

Both Plan 2 and Plan 4 retire Asbury in 2019 and replace the generation with a combination of solar and storage. The difference is that Plan 4 relies on a mix of utility-scale and distributed resources, while Plan 2 relies on utility-scale resources. The plans show similar 20-year and 30-year deterministic PVRRs, as seen in Figure 1-17 and Figure 1-18. On an expected value basis, Plan 2 is lower-cost than Plan 4 for both a 20-year and 30-year horizon.

**Figure 1-17 – 20 Year Deterministic and Expected Value PVRR Comparison ($ millions)**

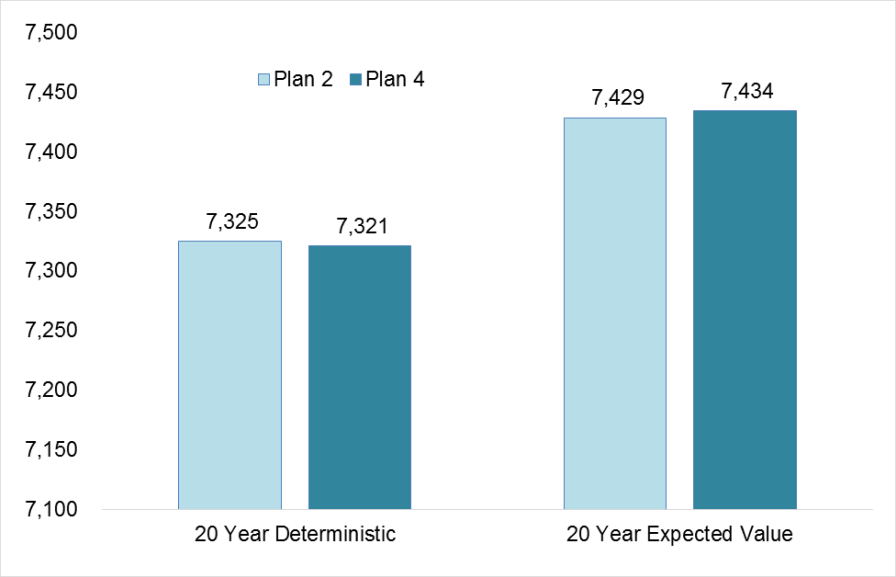
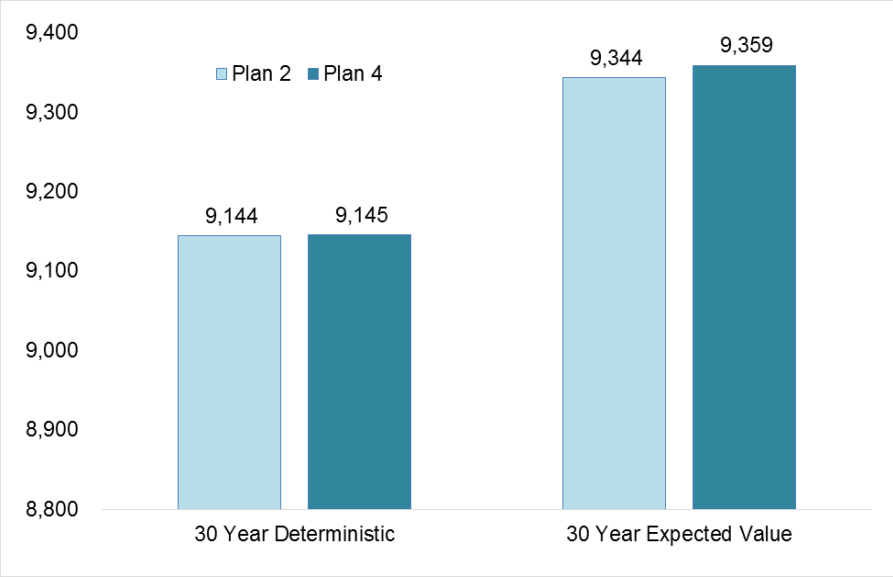


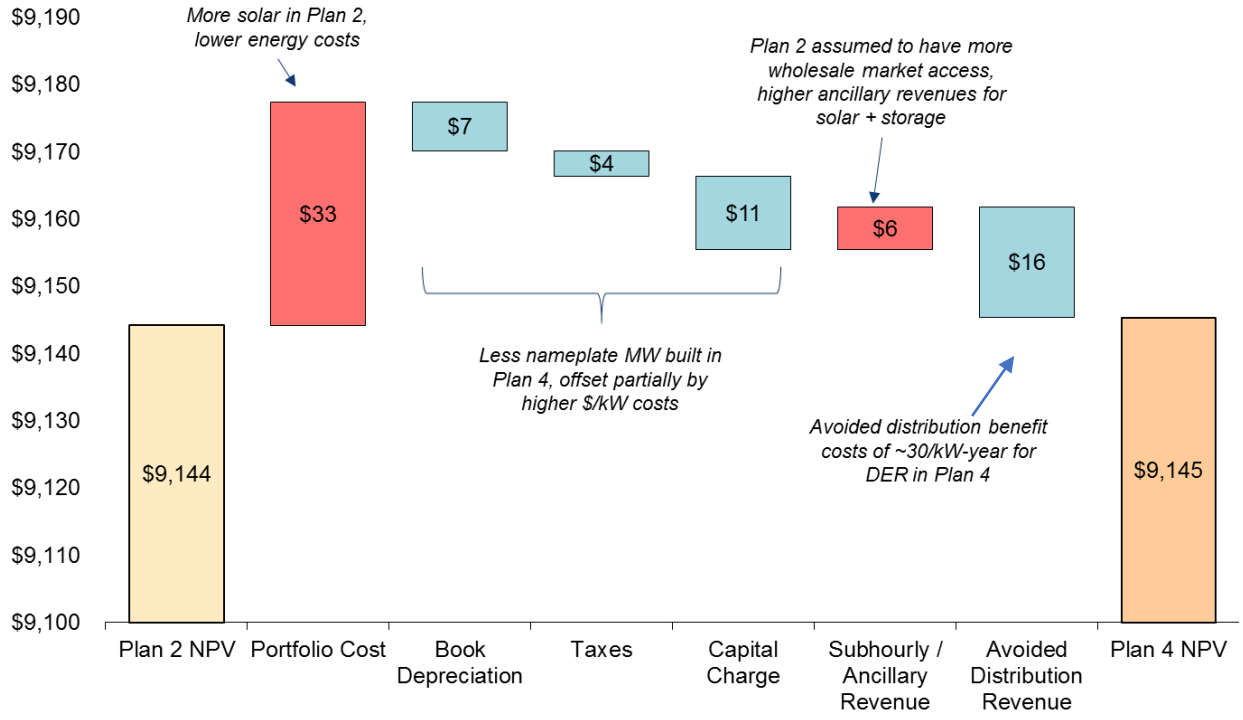

**Figure 1-18 – 30 Year Deterministic and Expected Value PVRR Comparison ($ millions)**




Differences in PVRRs between Plan 2 and Plan 4 reflect the amount and timing of build outs of utility-scale solar + storage generation. Plan 2 adds all utility-scale solar and utility-scale solar + storage, while Plan 4 adds a mix of utility-scale and distributed solar + storage. From a planning reserve margin perspective, utility-scale solar + storage can be built around the SPP summer peak, while distributed resources must consider that Liberty-Empire is primarily a dual peaking

system. Utility-scale solar + storage has a 4:1 solar-to-storage ratio, while distributed solar + storage has a 2:1 ratio. Plan 2 adds more nameplate solar capacity and benefits more from wholesale power market revenues and ancillary services revenues. Plan 4 benefits more from avoided distribution investment costs, as shown in Figure 1-19.

**Figure 1-19 – Drivers of Cost Difference between Plan 2 and 4 (30 Year PVRR) ($ millions)**




Liberty-Empire believes that there is value in investing in some level of distributed resources from an energy security and reliability perspective. Distributed resources can help improve local reliability, prevent blackouts/outages, avoid distribution system investment, and improve energy security in the event of large-scale disruptions at the transmission level. Distributed energy resources are also becoming increasingly more important for customers and regulators as customers continue to demand more flexibility and choice with regard to their energy needs. Plan 4 aligns with Liberty-Empire's planning objectives: providing safe, reliable electric service at just and reasonable rates; investing in advanced T&D technologies; minimizing present worth of utility costs; and balancing objectives around energy security, reliability, and anticipating future customer energy needs.

## SECTION 8 PERFORMANCE MEASURES OF THE PREFERRED RESOURCE PLAN

*5. For existing legal mandates and approved cost recovery mechanisms, the following performance measures of the preferred resource plan for each year of the planning horizon:*

*A. Estimated annual revenue requirement;*

*B. Estimated level of average retail rates and percentage of change from the prior year; and*

*C. Estimated company financial ratios;*

The performance measures of the Preferred Plan are shown in Table 1-4.

**Table 1-4 – Performance Measures of the Preferred Plan**

****Confidential in its Entirety**[10]**

[redacted]

[10]4 CSR 240-2.135(2)(A)5 allows information to be marked confidential when using reports, work papers, or other documentation related to work produced by internal or external auditors or consultants.

## SECTION 9 IMPLEMENTATION PLAN

*7. Actions and initiatives to implement the resource acquisition strategy prior to the next triennial compliance filing; and*

*8. A description of the major research projects and programs the utility will continue or commence during the implementation period; and*

The implementation plan contains the descriptions and schedules for the major tasks necessary to implement the preferred resource plan over the implementation period, which is the time interval between the triennial compliance filings. The next triennial IRP filing is scheduled for 2022. Therefore, the implementation period is the period 2019-2022.

Major areas of focus in the Implementation Plan, which are described in Volume 7, are as follows:

- Conduct an appliance saturation study for the service area prior to its next triennial filing.
- Make a MEEIA filing prior to the next annual update.
- Acquire 600 MW of wind in January 2021.
- File a community solar tariff by the end of 2019, and install 10 MW of community solar by 2021.
- Install 19.5 MW of distributed solar + storage by 2022.
- Install AMI as part of a broader grid modernization effort.
- Retire Asbury once a determination has been made by the Company.

## SECTION 10 CONCLUSIONS

Liberty-Empire's 2019 IRP, its evaluation of alternative plans, and its recommendation for its Preferred Plan are offered to the Missouri PSC and the wider community of Company stakeholders in full compliance with its legal requirements under 4 CSR 240-22, sections 020 – 080.

Liberty-Empire strongly believes that its Preferred Plan is in the best interest of its customers. It continues to build on the findings and conclusions of its prior Preferred Plan, but also introduces new proposed actions such as the potential closure of the Asbury plant as soon as the end of 2019. It also represents a low cost and low risk pathway for the securing of the necessary energy supplies that customers require, and in a manner that protects system safety, reliability and security. The Preferred Plan also meets customers' growing demand and interest in renewable energy, improved environmental performance, and distributed energy resources.

## SECTION 11 IRP REPORT ORGANIZATION

This IRP filing contains eight (8) volumes. Their ordering and subject matter correspond to the IRP Rule sections as laid out in 4 CSR 240-22, sections 020 – 080. The volumes are:

| | |
|---|---|
| Volume 1: | Executive Summary |
| Volume 2: | Missouri Filing Requirements and an Index of Rule Compliance |
| Volume 3: | Load Analysis and Load Forecasting |
| Volume 4: | Supply-Side Resource Analysis |
| Volume 4.5: | Transmission and Distribution Analysis |
| Volume 5: | Demand-Side Resource Analysis |
| Volume 6: | Integrated Resource Plan and Risk Analysis |
| Volume 7: | Resource Acquisition Strategy Selection |

Liberty-Empire's Special Contemporary Issues responses are included in Volume 6.