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VOLUME 1

EXECUTIVE SUMMARY

THE EMPIRE DISTRICT ELECTRIC COMPANY D/B/A LIBERTY ("LIBERTY-EMPIRE")

20 CSR 4240-22.080

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20 CSR 4240-22.080 EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Commission Rule 20 CSR 4240-22.080 provides in part as follows:

(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

1.1 Purpose of the 2022 IRP

The Empire District Electric Company d/b/a Liberty ("Liberty-Empire" or the "Company") has conducted its analysis of future loads and resources for this triennial Integrated Resource Plan ("IRP") to comply with the requirements of 20 CSR 4240-22 ("Rule" or "IRP Rule"). This triennial IRP analysis is conducted at least once every three (3) years, in conjunction with Liberty-Empire's normal planning process, and assists Liberty-Empire in making decisions concerning the timing and type of system expansion that should ultimately occur.

Liberty-Empire's Preferred Resource Plan

Near-term retirement of the aging Riverton 10 and 11 natural gas-fired peaking units, which will be directly replaced by 30 MW of reliable, dual-fuel RICE

Extended life of the existing dual-fuel-capable Energy Center units 1 and 2 until 2035 to further bolster portfolio reliability

Additions of solar and storage resources in the medium and long term to take advantage of federal tax incentives and interconnection rights at existing sites

Pursuit of distributed energy resources where significant T&D avoided costs are identified

Flexibility and optionality around long-term resource decisions to achieve significant carbon emissions reductions as policy and technology evolve

Examine demand-side resource options during the next MEEIA cycle

Consistent with the fundamental objective as stated in the IRP Rule, Liberty-Empire's 2022 IRP and the selection of its recommended Preferred Plan have been guided by a commitment to providing customers with energy services that are safe, reliable, and efficient, at just and reasonable rates, and in a manner that serves the public interest and is consistent with state energy and environmental policies. Based on a technically rigorous, balanced, and innovative analysis of potential future costs and market outcomes, Liberty-Empire believes that its recommended Preferred Plan not only carries out these objectives, but further prioritizes safety and reliability and maintains a pathway to meaningfully reduce carbon emissions over the long-term.

To develop this IRP, and the Preferred Plan and contingency plans that represent its core conclusions, Liberty-Empire engaged in an extensive eleven-month process to assess how it can

best meet its customers' needs for affordable energy that is highly reliable, safe, resilient, and environmentally sustainable. Liberty-Empire deployed state-of-the-art tools and techniques to help delineate and clarify choices and tradeoffs between technologies, parameterize the potential evolution of new sources of risk and opportunity, address some of the most relevant issues regarding the future of the market, and forecast and evaluate the interaction of important variables including customer load requirements, market and technology trends, and existing and potential environmental policy.

With the 2022 IRP, Liberty-Empire 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 with key improvements based on recent portfolio and market developments. Like in the prior triennial IRP filing, the 2022 IRP incorporates the advancement of utility-scale and distributed solar and storage resources and the adoption of a low-cost energy efficiency plan as key parts of a reconfigured generation portfolio. To further bolster reliability, the 2022 IRP Preferred Plan also proposes to extend the operating life of Energy Center 1 and 2 units to 2035 with the option to co-locate renewable resources at the site, taking advantage of surplus existing interconnection capabilities, and to retire the Riverton 10 and 11 units in 2025 to be replaced by new, highly reliable, dual-fuel ** [redacted] ** reciprocating internal combustion engine ("RICE") resources.[1]

Finally, to facilitate a clear and transparent decision-making process around Preferred Plan selection, Liberty-Empire deployed a new scorecard approach in the 2022 IRP. The scorecard identifies and documents key tradeoffs that drive Preferred Plan selection. This helps stakeholders clearly understand how Liberty-Empire has evaluated the attributes of various plan alternatives in arriving at its ultimate Preferred Plan. The scorecard is described in more detail in Section 9 of this executive summary.

[1] ** [redacted] **

1.2 Highlights of Liberty-Empire's Preferred Resource Plan

Thermal Peaking Resources

A key component of Liberty-Empire's Preferred Plan is the near-term retirement of the existing natural gas peaking units at the Riverton site. The existing Riverton units 10 and 11 provide value to Liberty-Empire's portfolio due to their ability to ** [redacted] ** operate on both natural gas and fuel oil. Although the units were installed by Liberty-Empire in 1988, the primary equipment used at Riverton 10 and 11 is of 1960s vintage. Based on the units' age, Liberty-Empire has determined that it is no longer appropriate to rely on these units for reliable dispatch, although the performance and operating characteristics of thermal generation ** [redacted] ** should be retained. Therefore, the Preferred Plan calls for the Riverton 10 and 11 units to be replaced directly at the site with 30 MW of more reliable, new dual-fuel ** [redacted] ** RICE, taking advantage of existing interconnection rights.

Liberty-Empire's Preferred Plan also includes the life extension of two of its dual-fuel-capable natural gas peaking resources, Energy Center units 1 and 2, until 2035 to maintain and improve the capability of its generation portfolio to provide reliable services during a wide range of market conditions. These resources provided significant value to customers and helped stabilize the system during the events of Storm Uri in early 2021 due to their ability to operate on fuel oil in addition to natural gas. Liberty-Empire believes maintaining Energy Center 1 and 2 through 2035 will significantly help to hedge market risks at a relatively low cost of investment. As further described in Volume 6, the IRP modeling demonstrates that a potential earlier retirement of Energy Center 1 and 2 could result in only a very modest savings under the base planning assumptions (approximately 0.1% of total portfolio costs over a 30-year period), while retaining the units preserves key reliability services currently under study by several SPP Working Groups.

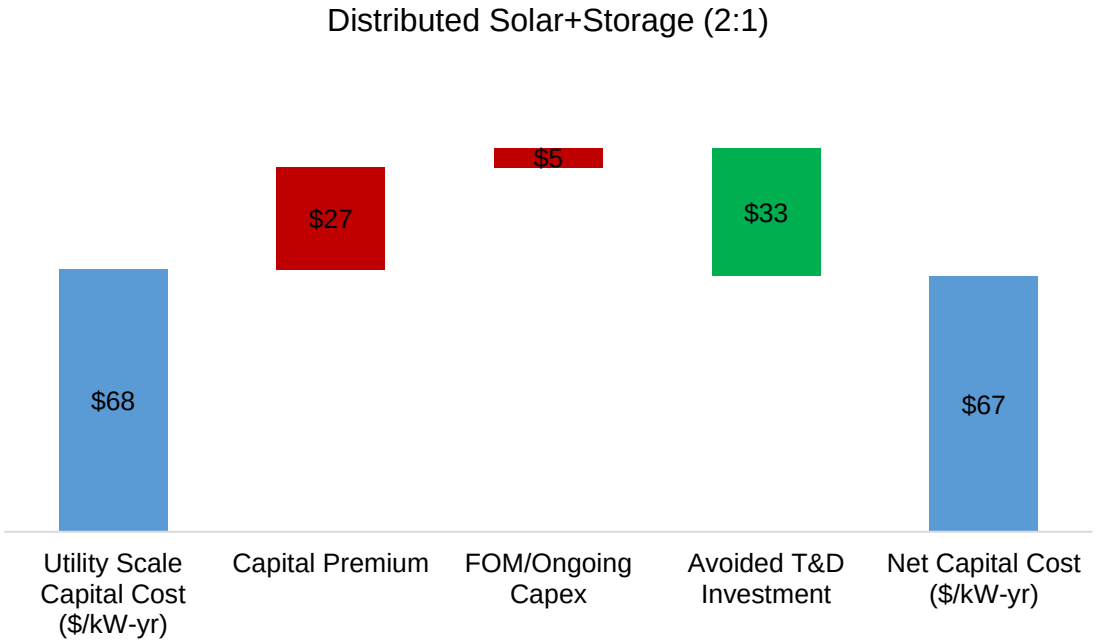
Investment in Solar and Storage

The Preferred Plan calls for investment in solar and storage as the primary medium- and long-term capacity and energy options. In the nearer term, Liberty-Empire expects to take advantage of federal investment tax credits and interconnection rights at existing facilities to significantly lower the overall cost of solar and storage for customers. Over the longer term, Liberty-Empire expects the cost of solar development to decline, improving the relative economics of the technology even if tax credits are no longer available.

Investment in Distributed Energy Resources

As a complement to utility-scale resources, and in addition to Liberty-Empire's current community solar pilot project, Liberty-Empire's Preferred Plan also includes investment in distribution-level resources to meet future resource requirements. Distributed solar and storage can avoid otherwise needed transmission and distribution system upgrades. Liberty-Empire estimates that distributed solar + storage is 30 to 40% more expensive than comparable utility-scale configurations but offers the benefit of potentially significant deferred substation upgrades, generator interconnection costs, and avoided transmission line losses. Figure 1-1 illustrates the potential incremental costs and benefits of distributed resources as evaluated in the 2022 IRP.

Figure 1-1 – Potential DER Benefits



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.

SECTION 2 IRP REPORT ORGANIZATION

This IRP filing contains eight (8) volumes in total, including an executive summary, a volume dedicated to the Missouri IRP filing requirements and an index of Rule compliance, and six (6) technical volumes. Their ordering and subject matter correspond to the IRP Rule sections as laid out in 20 CSR 4240-22.030 through 20 CSR 4240-22.070. The technical volumes contain the Rule reference and the Company's response as appropriate. The responses to Special Contemporary Issues can be found in the final section of Volume 6.

The eight volumes that comprise the IRP filing are summarized as follows:

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

SECTION 3 COMPANY DESCRIPTION

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;

3.1 Liberty-Empire Utility Overview

Liberty-Empire is a regulated utility based in Joplin, Missouri that provides electric service to approximately 180,000 customers as of December 31, 2021. In 2017, The Empire District Electric Company was acquired by Liberty Utilities (Central) Corp., a subsidiary of Liberty Utilities Co. ("Liberty"), itself a U.S. subsidiary of Algonquin Power & Utilities Corp. Liberty-Empire is part of Liberty's Central Region. The Liberty-Empire relationship provides many benefits to the Company, including opportunities to share corporate resources and engage in multi-company research efforts.

This IRP applies to the Liberty-Empire electric business. The electric operation generates, purchases, and distributes electricity to its customers in parts of Missouri (89.0%), Kansas (5.4%), Oklahoma (2.6%), and Arkansas (2.9%). 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 portions of sixteen counties in Missouri, portions of three counties in Oklahoma, one county in Kansas, and a portion of 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. 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 one municipally owned distribution system.

3.1.1 Existing Generation Facilities and Purchase Power Agreements

Liberty-Empire meets its load requirements through a diverse combination of existing owned and contracted supply-side resources. Liberty-Empire's fleet of existing and committed supply-side resources includes both fully or jointly owned resources and resources for which Liberty-Empire has power purchase agreements ("PPA"). The existing owned resource fleet consists of a variety of fuel and ownership types, including partial ownership shares in two coal-fired plants, several wholly owned natural gas-fired combustion turbines ("CT"), a wholly owned natural gas-fired combined cycle ("CC") unit, a partial ownership share in a natural gas-fired combined cycle unit, a hydroelectric facility, and three wind facilities. Additionally, Liberty-Empire meets its customer needs with long-term PPAs for coal or wind units. Table 1-1 provides a summary of the existing generating facilities owned or contracted by Liberty-Empire. The unit ratings represent summer operating capacity ratings at the time of the 2022 IRP analysis and reflect Liberty-Empire's ownership share of jointly owned units. Units are rerated from time to time as routine capability tests are performed.

Table 1-1 – Liberty-Empire Existing Supply-Side Resources – Owned and Contracted

Owned Resources	Fuel Type	State	% Owned	Summer Operating Capacity (MW)	Winter Operating Capacity (MW)
Iatan 1	Coal	MO	12%	84	84
Iatan 2	Coal	MO	12%	108	108
Plum Point (Owned)	Coal	AR	7.52%	50	50
Riverton 10 CT	Natural Gas/Oil	KS	100%	13	15
Riverton 11 CT	Natural Gas/Oil	KS	100%	15	15
Riverton 12 CC	Natural Gas	KS	100%	254	283
Empire Energy Center 1 CT	Natural Gas/ Oil	MO	100%	81	95
Empire Energy Center 2 CT	Natural Gas/ Oil	MO	100%	80	80
Empire Energy Center 3 CT	Natural Gas/ Oil	MO	100%	40	55
Empire Energy Center 4 CT	Natural Gas/ Oil	MO	100%	43	58
State Line CT	Natural Gas/ Oil	MO	100%	93	113
State Line CC	Natural Gas	MO	60%	300	329
Ozark Beach	Hydro	MO	100%	16	16
North Fork Ridge	Wind	MO	100%	149	149
Kings Point	Wind	MO	100%	149	149

Neosho Ridge	Wind	KS	100%	301	301
Total Owned Capacity:				1,776	1,900
Long Term PPAs	Fuel Type	State		Summer Operating Capacity (MW)	Winter Operating Capacity (MW)
Plum Point	Coal	AR		50	50
Elk River Wind Farm	Wind	KS		150	150
Meridian Way Wind Farm	Wind	KS		105	105
Total Contracted Capacity:				305	305
Capacity Sales	Fuel Type	State		Summer Operating Capacity (MW)	Winter Operating Capacity (MW)
MJMEUC Capacity Sale	Capacity	n/a		-78	-78
Total Capacity Sales:				78	78

Table 1-2 summarizes the "baseline" (i.e., age-based) retirement and expected PPA expiration dates for the existing supply-side resources in Liberty-Empire's portfolio for IRP purposes. For resources that are wholly or majority-owned and operated by Liberty-Empire, the retirement date represents the resource's age-based end of life. For resources for which Liberty-Empire is a minority owner, the retirement date represents the planned retirement date indicated by the joint and majority owners. PPA expiration dates represent the expected date of contract expiration with no assumed extensions.

Table 1-2 – Base Retirement and PPA Expiration Dates

Owned Unit Name	Commercial Online Year	Age of Facility As of 2022 (Years)	Baseline IRP Retirement Year
Iatan 1	1980	42	2039
Iatan 2	2010	12	n/a
Plum Point (Owned)	2010	12	n/a
Riverton 10 CT	1988[1]	54[1]	2025
Riverton 11 CT	1988[1]	54[1]	2025
Riverton 12 CC	2007 & 2016[2]	15 & 6	n/a
Empire Energy Center 1 CT	1978	44	2026 or 2035[4]
Empire Energy Center 2 CT	1981	41	2026 or 2035[4]
Empire Energy Center 3 CT	2003	19	n/a
Empire Energy Center 4 CT	2003	19	n/a
State Line CT	1995	27	n/a
State Line CC	1997 & 2001[3]	25 & 21	n/a
Ozark Beach	1931	91	n/a
North Fork Ridge	2020	2	n/a
Kings Point	2021	1	n/a
Neosho Ridge	2021	1	n/a

Long Term Power Purchases and Sales	PPA Start Year	PPA Term (Years)	Expected PPA Expiration Year
Plum Point	2010	30	2040
Elk River Wind Farm	2005	20	2025
Meridian Way Wind Farm	2008	20	2028
MJMEUC Capacity Sale	2020	5	2025

Notes:
1. Riverton 10 and 11 were installed at Liberty-Empire in 1988, but the equipment was manufactured in 1967.
2. Combustion turbine Riverton 12 was installed in 2007. The steam cycle addition (combined cycle conversion) was completed in 2016.
3. One of the gas turbines at State Line CC was installed in 1997. The other gas turbine and the steam turbine were installed in 2001.
4. Based on the age of the units, Liberty-Empire plans to retire Energy Center Units 1 and 2 by 2035. The ultimate decision for the planned year of retirement was supported through economic analysis in the 2022 IRP (see Volume 6 for details).

3.1.1.1 Long-Term Net Zero Target Considerations

In 2021, Algonquin Power & Utilities Corp established a goal of net-zero by 2050 for scope 1 and scope 2 emissions across its business operations.[2] Today, a significant portion of Liberty-Empire's generation comes from its two existing natural gas-fired CC units, Riverton 12 and State Line CC. In addition to "baseline" retirement assumptions which assume that both CCs operate beyond 2050, Liberty-Empire evaluated earlier retirement years for these units to assess the economic feasibility and cost impact of achieving long-term net zero carbon emissions by 2035 or by 2050.[3] While Liberty-Empire's selected Preferred Plan assumes baseline retirement dates for the existing CCs, the Preferred Plan preserves the optionality to pivot toward a net zero strategy in the long term. Environmental sustainability (carbon reduction) was a key factor considered in the decision scorecard approach, and although 2050 is beyond the planning horizon of this twenty-year IRP, the Preferred Plan is considered a pathway to the corporate net-zero target.

[2] Scope 1 emissions refer to direct greenhouse gas emissions from sources that are controlled or owned by Liberty-Empire. Scope 2 emissions refer to indirect greenhouse gas emissions associated with the purchase of electricity. Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization. For Liberty-Empire, all emissions except those associated with the owned portion of Plum Point and Iatan 1 and 2 are scope 1 and 2 emissions and are counted against Liberty-Empire's net zero goals. Scope 3 emissions are subject to environmental costs but do not count against Liberty-Empire's emissions accounting.

[3] "Net Zero" refers to the reduction of carbon emissions from Liberty-Empire's generating portfolio towards levels that are close to zero. Given the potential for "offsets" from outside the electric sector to cover small amounts of emissions from the portfolio, such as those from natural gas peaking units, the term *Net* Zero is used.

3.1.2 Existing Demand-Side Resources

As of 2022, Liberty-Empire offers demand-side programs in two of its four state jurisdictions, Missouri and Arkansas. Customer programs began in Missouri in mid-2007 and in Arkansas in October 2007. The current Missouri and Arkansas programs are shown in Table 1-3.

Table 1-3 – Demand-Side Programs by State

Missouri	Arkansas
● Efficient Products	● Residential Products
● Low-Income Weatherization	● Residential Weatherization
● Low-Income Multi-Family	● School-Based Energy Education
● HVAC Rebate	● High-efficiency Residential Lighting (LED)
● Pay As You Save ("PAYS")	● Online Audit and Energy Calculator
● Small Business Direct Install ("SBDI")	● Commercial and Industrial Rebate Program
● Commercial and Industrial Rebate Program	

3.1.3 Transmission and Distribution Facilities

In addition to its existing supply-side resources, Liberty-Empire serves its customers through an interconnected grid of transmission and distribution ("T&D") circuits and substations, which 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 4 LOAD ANALYSIS AND LOAD FORECASTING

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 and its load forecasting consultant, Itron, performed highly rigorous load analysis and forecasting as part of its triennial IRP analysis, consistent with the requirements set forth in the IRP Rule. Itron's load forecasts were developed using cost-of-service class energy models, cost-of-service class load profiles, and a system peak model. The forecast method employs at least ten years of historic load data and thirty years of historical weather data. Load profiles were calibrated to both class energy and system peak forecasts resulting in both energy and coincident peak forecasts for all classes and for the system.

In forecasting load for the residential and commercial classes, Liberty-Empire used Itron's Statistically Adjusted End-Use ("SAE") modeling framework. The SAE models rely on end-use technology saturation and energy efficiency trend data for each census region based on data from the Energy Information Administration's ("EIA") 2021 Annual Energy Outlook ("AEO"), calibrated to Liberty-Empire's specific saturation and efficiency survey results. Calibrating to Liberty-Empire's historical saturation data included smoothing the transitions between known Liberty-Empire saturation levels and long-term trends. Both residential and commercial end-use data were adjusted to include the effects of historical demand-side management ("DSM") savings on loads, electric vehicles ("EV"), and customer-owned solar distributed generation ("DG"). The SAE models also included adjustments for economic and weather drivers and the price of electricity. Ultimately, these data were used to produce load forecasts by major class and for the system from 2022 through 2051.

Based on the load analysis, Liberty-Empire forecasts its net system input ("NSI" or "net energy for load") and retail energy sales to remain relatively flat through the planning period. Retail energy sales, which exclude losses and the impact of customer-owned solar DG and EV load, are

forecast to rise from **[redacted],** with an overall growth rate over the 20-year period of **[redacted]** NSI, which includes losses which are not billed, is forecast to rise from **[redacted].**

Figure 1-2 shows the Base Case NSI forecast for the planning horizon by each major class.

Figure **1-3** shows the Base Case retail sales forecast for the planning horizon by each major class. These forecasts include the impacts of Liberty-Empire's existing DSM but exclude the impacts of future DSM.

Figure 1-2 – NSI Forecast 2022-2041 (GWh)

****Confidential in its Entirety****

Figure 1-3 – Retail Sales Forecast 2022-2041 (GWh)

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Figure 1-4 shows the total annual NSI requirements over the IRP study period for the Base Case with and without the impact of the future DSM selected in the Preferred Plan (i.e., the low-cost bundle of RAP DSM).

Figure 1-4 - RAP DSM Impact on Annual Energy Requirements (Low-Cost RAP DSM Bundle)

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As required by the IRP Rule, Liberty-Empire also produced two additional weather-normal load forecasts in addition to the Base Case load forecast: a "High Load" growth case and a "Low Load" growth case. Figure 1-5 shows the 2022 IRP NSI forecasts for the Base, High, and Low Load cases.

Figure 1-5 – Net Energy for Load Forecast – Base, High, and Low Scenarios (GWh)

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On a peak demand basis, Liberty-Empire's IRP load forecast shows that Liberty-Empire is primarily a winter peaking system. However, Liberty-Empire is a member of SPP, which is overall a summer-planning system. Thus, Liberty-Empire must also be able to adequately serve load in the summer months when natural gas units have a lower capacity rating due to warmer ambient temperatures. To ensure that Liberty-Empire has adequate resources to meet both summer and winter planning needs, the 2022 IRP alternative resource plans all meet a 12 percent minimum planning reserve margin in both seasons. As a result, both the summer and winter peaks are important and are presented below.

Figure 1-6 shows the seasonal Base Case peak load requirements over the IRP study period by season with and without the impact of demand-side resources selected in the Preferred Plan. Figure 1-7 and Figure 1-8 show the summer and winter peak demand forecasts, respectively, for the Base, High, and Low Load cases. Under the Base Case, annual (winter) peak load is forecast to rise from **[redacted].** Summer peak load is forecast to rise from **[redacted].**

Figure 1-6 – RAP DSM Impact on Load (Low Cost Bundle)

****Confidential in its Entirety****

Figure 1-7 – Summer Peak MW

****Confidential in its Entirety****

Figure 1-8 – Winter Peak MW

****Confidential in its Entirety****

4.1 Load Forecast Variance Request

On April 1, 2021, one year in advance of the 2022 IRP filing, Liberty-Empire filed an application for variance of portions of 20 CSR 4240-22.030 and 20 CSR 4240-20.094. Although Liberty-Empire's application related to 20 CSR 4240-22.030 committed to adopting a load forecasting approach based on cost-of-service class, as required by the Rule, and did not seek approval of variance in this area, the new load forecasting approach represented a change from the approach used in previous IRPs, which was based on revenue classes. Due to the changing methodology and in an abundance of caution, Liberty-Empire sought clarification of class definitions for stakeholders. On May 12, 2021, the MPSC issued an Order effective June 11, 2021 in Case No. EO-2021-0331 approving the agreement and Liberty-Empire's application for variance of portions of 20 CSR 4240-22.030 and 20 CSR 4240-22.094.

SECTION 5 SUPPLY-SIDE RESOURCE ANALYSIS

5.1 Existing Supply-Side Resources

Consistent with the IRP Rule, Liberty-Empire performed an economic analysis of its existing portfolio of supply-side generation resources and of the candidate supply-side resources that it could reasonably expect to use, develop, or acquire during the planning horizon to serve future customer needs. Liberty-Empire's existing resources and assumed age-based retirement or PPA expiration dates were described in Section 3.1.1, and a detailed description of each of these resource facilities and contracts can be found in Volume 4.

During the 20-year study horizon covered by the 2022 IRP (2022-2041), the age-based resource retirements and expected PPA expirations of the existing resources were as follows:[4]

- Retirement of Riverton 10 and 11 in 2025;
- Expiration of the Elk River Wind PPA in 2025;
- Expiration of the MJMEUC Capacity Sale PPA in 2025;
- Expiration of the Meridian Way Wind PPA in 2028;
- Retirement of Energy Center 1 and 2 in 2026 or 2035;
- Retirement of Iatan 1 in 2039;
- Expiration of the Plum Point PPA in 2040.

All other existing Liberty-Empire generating units were assumed to continue operations throughout the planning horizon, and Liberty-Empire did not assume any extensions of PPA contracts for IRP purposes.

As indicated in the list above, Liberty-Empire included two key decisions in all alternative resource plans that differed from the existing resource assumptions modeled in the previous IRP.

[4] As described in Section 3.1.1.1, the 2022 IRP also contemplated a set of "net zero" plans which assumed earlier retirement dates for Liberty-Empire's existing gas CCs, Riverton 12 and State Line CC, by 2050 or by 2035 in order to achieve net zero carbon emissions targets.

First, given the age of the original equipment at the Riverton 10 and Riverton 11 facilities, Liberty-Empire assumed the retirement of both units in 2025.[5] To preserve the units' dual-fuel capability **[redacted]**, Riverton 10 and 11 were assumed to be replaced directly at the site by a dual-fuel RICE unit, taking advantage of Riverton 10 and 11's existing interconnection rights at the site.

Second, in the 2022 IRP, Liberty-Empire evaluated the cost of maintaining two of its older natural gas-fired peaking units, Energy Center 1 and 2, until 2035 relative to the cost of retiring them in 2026 (based on the 2019 IRP). Although these units were assumed to retire by 2026 in the previous IRP analysis based on their age, their low average historical capacity factors and high potential reliability benefits, the 2022 IRP found that maintaining them until 2035 with some capital investment would help provide reliable energy services to customers at minimal additional cost. In addition, Liberty-Empire intends to explore co-locating renewable resources (i.e., solar and storage) directly at the site prior to unit retirement to complement Energy Center 1 and 2's low expected capacity factors and take advantage of surplus interconnection rights. To help determine the preferred retirement date for Energy Center 1 and 2, Liberty-Empire performed an initial economic analysis comparing the costs of earlier and later retirement. The results of the analysis showed that while an earlier retirement of the Energy Center units could potentially provide savings for customers, the savings were minimal (approximately 0.1% of total portfolio costs over a 30-year period) and the retirement would remove significant reliability benefits from the portfolio. Thus, Liberty-Empire maintained a 2035 retirement date for the Energy Center 1 and 2 units across all plans evaluated in the IRP.

[5] In the 2019 IRP, Liberty-Empire assumed an age-based retirement date of 2033 for both Riverton 10 and 11. However, the 2033 retirement date assumption from the 2019 IRP was based on the date that Riverton 10 and 11 were installed at the Liberty-Empire system (1988). The primary equipment used at Riverton 10 and 11 is of 1960s vintage.

5.2 Candidate Supply-Side Resources

5.2.1 Overview of Supply-Side Resource Option Analysis

Consistent with the IRP Rule, Liberty-Empire considered a wide range of potential supply-side resource options for inclusion in its future portfolio resource mix, then narrowed the range down to a subset of feasible and commercially viable options to be evaluated in the fuller integrated portfolio analysis in conjunction with demand-side resources. Liberty-Empire began with a broad list of all potential resource types that it could reasonably expect to use, develop, implement, or acquire, including plants utilizing existing generation technologies, new generation technologies, emerging technology types expected to become commercially viable within the 20-year IRP horizon, distributed resources, any available existing resource upgrades or life extensions, and purchased power from SPP. Liberty-Empire then used a screening process to narrow down the broader list of resource options to only those that were likely feasible to develop and operate in the Company's service territory. The potential supply-side resource options selected for further investigation were as follows:

1. Carbon Capture and Storage ("CCS") – supercritical coal CCS, natural gas-fired combined cycle with CCS, retrofit CCS on existing plants;
2. Natural gas-fired simple cycle – Aeroderivative CT and F-class frame CT;
3. Natural gas-fired combined cycle – 1 x 1 H Class;
4. Natural gas-fired RICE;*
5. Traditional nuclear and small modular nuclear reactor;
6. Wind – on-shore and off-shore, including re-powering of existing assets;
7. Biomass – wood waste and poultry waste;
8. Landfill gas;
9. Solar photovoltaic ("PV")* – fixed tilt and single axis tracking, with and without paired storage;
10. Energy storage – lithium-ion battery*, vanadium redox flow battery, molten salt, Energy Vault concrete block gravity storage, compressed air;
11. Combined heat and power ("CHP");* and

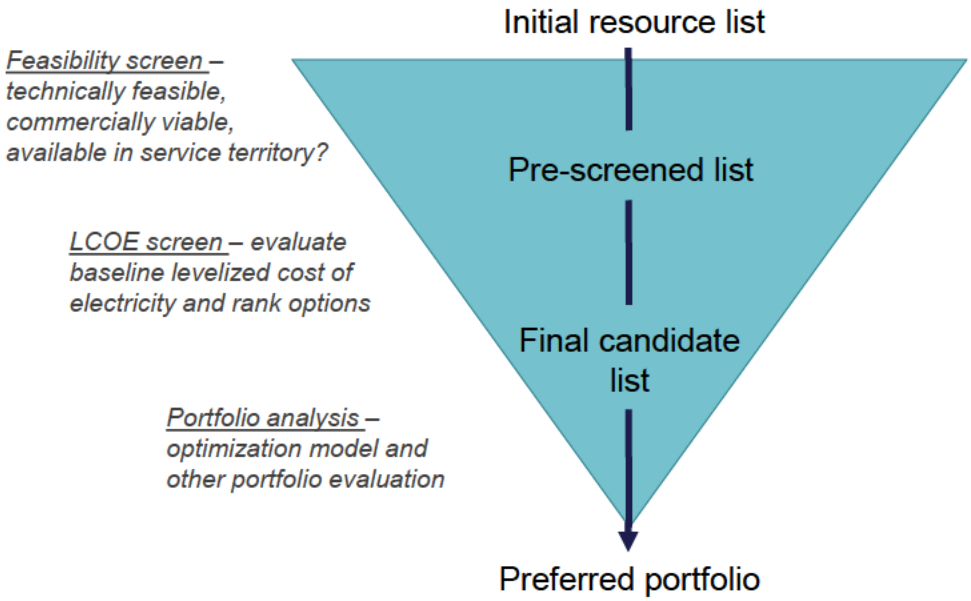
12. Hydrogen – retrofit on existing gas-fired combined cycle units and new combined cycle combustion turbine.

*Denotes a resource option evaluated as both a distributed and utility scale energy resource.

After the identification of the feasible supply-side resource options, planning-level cost and operating assumptions for each of the feasibility-screened resource options were collected and developed by Liberty-Empire's IRP consultant, Charles River Associates ("CRA"), with review and input by experts from a third-party engineering firm, Black and Veatch. Cost and operating estimates for the resource options were developed using a market scan approach for cost and operational parameters. The market scan approach involved in-depth research into recent cost data points from a variety of sources, including public reports, other utility IRP filings and Requests for Proposals, proprietary subscription-based data sources, and Liberty-Empire's and Black and Veatch's internal view based on actual and recent project estimates. The results of the market research were used to develop current cost estimates for the technologies as well as projections for cost changes over time. Using the cost and operating parameters from this market scan analysis, Liberty-Empire evaluated the levelized cost of electricity ("LCOE") and levelized cost of capacity of the feasible resource options to determine whether any options were commercially unviable relative to other resources under consideration.

Based on the results of the two rounds of preliminary screening analyses, as well as considerations for probable environmental costs of each potential supply-side resource option, Liberty-Empire ultimately identified a "shortlist" of potential supply-side resource options, representing the preliminary supply-side candidate resource options to be included in the integrated resource planning analysis. The screening process is illustrated in Figure 1-9.

Figure 1-9 – Supply-Side Resource Screening Approach



5.2.2 Feasibility Screening

Based on Liberty-Empire's feasibility screen, the following supply-side resource options were eliminated from consideration:

- Off-shore wind, given the lack of the resource type in Liberty-Empire's region;
- Re-powering of existing wind assets, given feedback from owners of the projects currently under contract with Liberty-Empire that they are not exploring re-powering opportunities at this time;
- CHP options, given uncertainty regarding feasible sites within Liberty-Empire's service territory and the lack of potential partners that have shown interest in pursuing CHP relationships with Liberty-Empire;
- Carbon capture, given the engineering complexity of capture and transportation, lack of natural geology for storage, and scarcity of operating examples to draw upon;
- Traditional nuclear, given the large size of the option (~1,000 MW) and the inability to assume with confidence that Liberty-Empire would have access to a partial ownership

interest in a new development in any proximity to its service territory;

- Biomass and landfill gas, given limited access to a reliable source of fuel near the Liberty-Empire service territory; and
- Molten salt energy storage and compressed air energy storage, given the engineering complexity of development and operation, lack of natural geology for compressed air storage, and scarcity of operating examples of molten salt energy storage to draw upon.

5.2.3 Cost Screening

Using the cost and operating parameters from the market scan analysis, Liberty-Empire evaluated the levelized cost of electricity and levelized cost of capacity of the feasible resource options to determine whether any options were commercially unviable relative to other resources under consideration. Figure 1-10 and Figure 1-11 summarize the results of the levelized cost analysis for select years, 2023 and 2035, in nominal dollars per MWh for LCOE (on the y-axis) and in nominal dollars per UCAP kW-year for the levelized cost of capacity (on the x-axis). Each graphic represents the projected cost for a resource that would enter into service in the indicated year. A resource in the lower left quadrant of the graphic has both a low levelized cost of electricity and low levelized cost of capacity relative to other resources; meanwhile, a resource in the upper right quadrant has both a high levelized cost of electricity and a high levelized cost of capacity relative to other resources. Further detail on this analysis can be found in Volume 4.

Figure 1-10 – LCOE and Levelized Cost of Capacity Projections (2023)

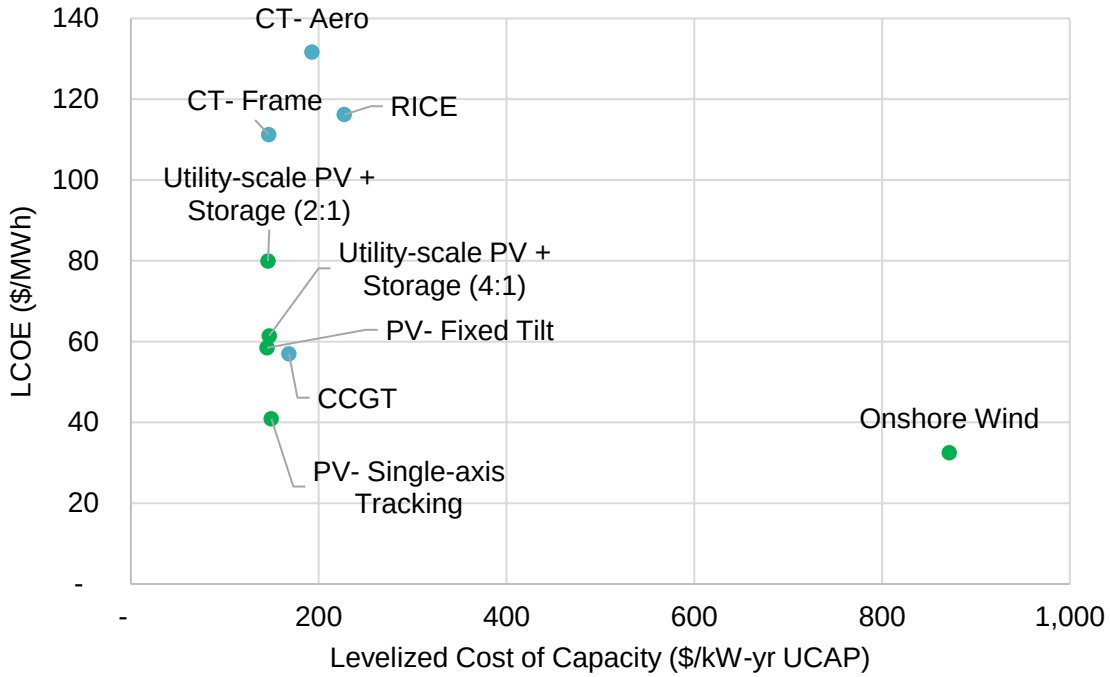
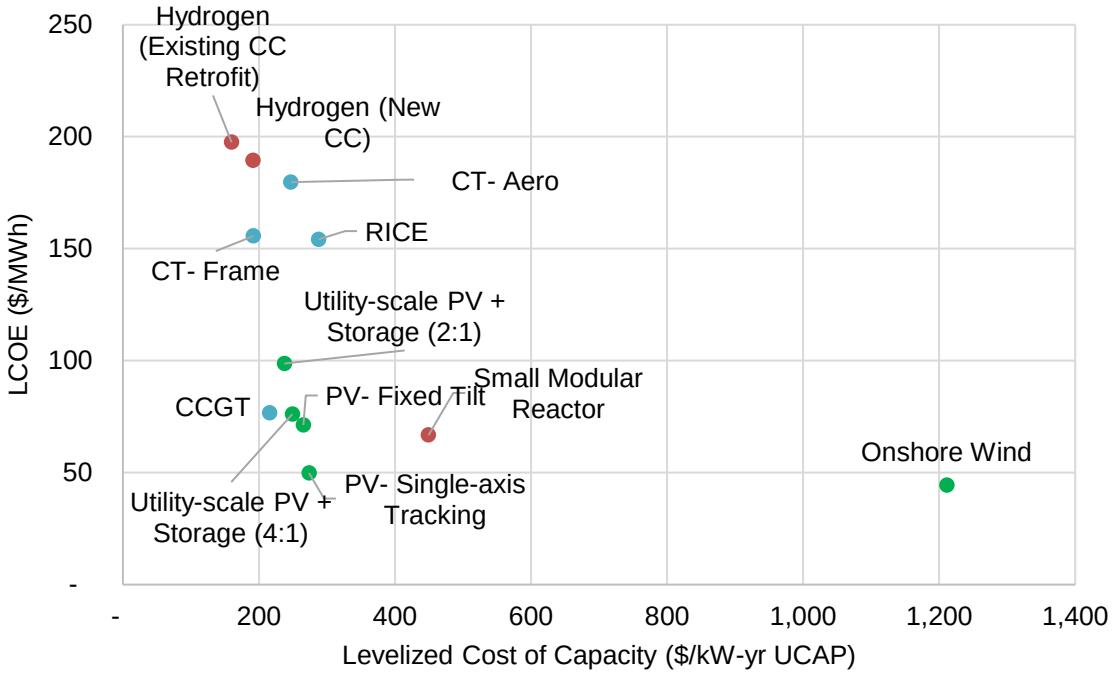


Figure 1-11 - LCOE and Levelized Cost of Capacity Projections (2035)



In addition to generation resources, Liberty-Empire also evaluated three energy storage technologies in the 2022 IRP: 4-hour lithium-ion battery storage, 8-hour vanadium flow battery storage, and Energy Vault concrete block gravity storage. Unlike typical generating resources, storage resources do not provide net energy to the grid, but instead shift energy during the day or even across a week to peak or high-priced hours. Because storage resources do not produce net generation, they cannot be appropriately evaluated in the traditional LCOE framework. Instead, Liberty-Empire assessed and screened storage options based on total cost of capacity, including capital, FOM, and ongoing capex, levelized over the lifetime of the resource. Liberty-Empire found that lithium-ion batteries were cost-competitive with standard generation resources on a capacity basis, although the value of the capacity is likely to erode over time as more storage is added to the system. The screening analysis also demonstrated that flow batteries and gravity storage were expected to be competitive with lithium-ion in the longer term, due in large part to the longer duration configuration of these technologies, which allowed them to provide more capacity value for deployment during times of peak demand. All three storage technologies were kept in the resource screening and evaluated further in the integrated planning analysis.

Overall, the supply-side candidate resource options were found to represent a wide range of costs. Due to a wide range of economic and performance benefits for the Liberty-Empire system, Liberty-Empire determined that nearly all generation technology types should advance to the next phase of analysis.[6] These benefits are summarized as follows:

- Energy – Wind, solar, paired solar + storage, and CCGT offer low cost of levelized energy;
- Capacity – Natural gas options including CCGT, simple cycle CT, and RICE have the lowest levelized cost of capacity;
- Clean baseload – For net-zero evaluation, hydrogen and nuclear SMR offer various levels of energy and capacity value;

[6] Fixed tilt solar PV was excluded from the candidate list because the small capital cost premium associated with single-axis tracking PV relative to fixed tilt PV is more than offset by a significantly improved expected capacity factor.

- Locational – Distributed options including solar, RICE, and storage are at a cost premium to their utility scale counterparts; however, they may provide benefits associated with avoided distribution system-level expenditures.

5.2.4 Final Candidate Supply-Side Resources

Based on the feasibility and cost ranking screening analyses, Liberty-Empire identified a final list of technologies representing the preliminary supply-side future candidate resource options to be included in the 2022 IRP. The final list of candidate supply-side resource options is as follows:

- Natural gas-fired simple cycle Aeroderivative CT and frame CT;
- Natural gas-fired CC – 1 x 1 H Class;
- Natural gas-fired RICE*;
- Onshore wind;
- Solar photovoltaic (PV)* – single axis tracking, with and without paired storage;
- Energy storage – lithium ion battery*, vanadium redox flow battery, concrete block gravity storage;
- Nuclear small modular reactor; and
- Hydrogen – retrofit on exiting CC plants, new 1 x 1 CC.

*Denotes a resource option evaluated as both a distributed and utility scale energy resource.

5.3 Commodity Market Price Forecasts

Fuel, power, 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 fuel, power, and emission price forecasts were developed primarily by third-party consultants in partnership with Liberty-Empire.

5.3.1 Fuel Price Forecasts

Coal price forecasts for Liberty-Empire's jointly-owned units were based on the operator's most recent 5-year fuel projection in the near term, which incorporates the most recent coal contracts at each of the plants for those years. In the medium to longer term, the coal price forecasts were escalated based on forecasted growth rates for Powder River Basin ("PRB") coal costs as developed by Horizons Energy, combined with transportation adders for Liberty-Empire's coal units. Liberty-Empire did not develop high or low scenario coal price forecasts for two primary reasons. First, Liberty-Empire's coal-fired resources consist only of Iatan and Plum Point, both of which are minority-owned and are not operated by the Company. Second, Liberty-Empire did not consider adding any new coal resources to the portfolio in the future.

To forecast natural gas fuel prices, Liberty-Empire relied on CRA to develop a set of market fundamentals-based natural gas price scenario forecasts (Base, High, and Low) for use in the portfolio analysis for both existing and new natural gas-fired resources. CRA developed natural gas prices using a set of fundamental market models, including the Natural Gas Fundamentals ("NGF") model, which produces bottom-up natural gas price and production projections in North America. Inputs to NGF include the latest views from public sources (e.g., EIA and PGC) on natural gas demand by sector, production forecasts, drilling costs, and oil prices under various fundamental potential market conditions. CRA also forecasted seasonal and regional basis over the long-term using the Gas Pipeline Competition Model ("GPCM") model, blended with market forwards over the near term to maintain consistency with observed market prices. More information on the development of the natural gas price forecasts can be found in Volume 4.

Figure 1-12 shows the forecasted Henry Hub natural gas prices for the Base, High, and Low Case price scenarios on a monthly basis. Figure 1-13 shows the forecasted Southern Star Delivered natural gas prices for the Base, High, and Low Case price scenarios on a monthly basis.

Figure 1-12 - Forecasted Base, High, and Low Natural Gas Prices (Henry Hub)

****Confidential in its Entirety****

Figure 1-13 - Forecasted Base, High, and Low Natural Gas Prices (Southern Star Delivered)

****Confidential in its Entirety****

5.3.2 Carbon Price Forecast

Three levels of possible future carbon costs were assumed in the 2022 IRP modeling, as shown in

Figure 1-14 in both nominal and real 2020 dollars. Liberty-Empire's Base Case incorporated a modest price on carbon emissions of $9-10/short ton starting in 2026. This level of carbon pricing was intended to represent carbon regulation that would achieve 70-80% carbon-free generation from the U.S. power sector over the long term relative to a historical year baseline, depending on other market factors and dynamics. Liberty-Empire also evaluated a High Case carbon scenario, representing a much more stringent federal carbon policy designed to push the power market toward a net-zero-type target in the long term, and a Low Case carbon scenario, which assumes no carbon price through the study period.

Figure 1-14 – CO_2 Price Forecast

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5.3.3 Power Price Forecast

Based on the three fuel price scenarios and three carbon price scenarios, Liberty-Empire developed nine permutations of power market outcomes and resulting market power price trajectories to be used as inputs in the IRP analysis. Power prices were developed through CRA's fundamental modeling of the power market, which incorporates key assumptions regarding fuel

forecasts, hourly load forecasts, resource additions and retirements, and power plant operations. The nine power price scenarios, summarized for SPP South Hub, are shown in Figure 1-15 on an annual average basis.

Figure 1-15 – SPP South Hub All Hours Power Prices

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SECTION 6 TRANSMISSION AND DISTRIBUTION SYSTEM ANALYSIS

The Transmission and Distribution ("T&D") Analysis section of the IRP Rule requires the utility to:

- Assess the adequacy of the existing T&D system;
- Consider opportunities to reduce T&D losses;
- Consider interconnection of new generation facilities;
- Consider the potential incorporation of advanced T&D network technologies;
- Develop avoided T&D capacity costs for demand-side analysis; and
- Describe participation with the utility's regional transmission organization ("RTO").

Liberty-Empire is a member of SPP and, as such, is reliant on SPP's determination of which transmission lines will be built and on what schedule. As a member of SPP, Liberty-Empire is assigned a cost sharing allocation of all lines that are built in the SPP. Volume 4.5 describes the provides copies of the RTO transmission expansion plan, describes utility-specific T&D projects, and identifies and describes any transmission projects under consideration by SPP for Liberty-Empire's service territory.

Liberty-Empire makes every effort to incorporate advanced technologies in presently budgeted projects. As demonstrated by its investments in Advanced Metering Infrastructure ("AMI"), Advanced Distribution Management Systems ("ADMS"), and distribution automation, Liberty-Empire is taking significant action to incorporate advanced technologies into its T&D network and is modernizing its grid to better set the stage for future advanced grid technologies. Organization-wide, Liberty is working to establish a platform of capabilities involving AMI, ADMS, and other capabilities that are important for the safe, compliant, and cost-effective operation of the distribution grid. Over time, Liberty-Empire will better understand the extent of implementation of these programs, determining Liberty-Empire's specific requirements in relation to load and customer needs, and when said advanced technologies may become cost-effective. Liberty-Empire will continue to evaluate the possible influence these technologies may have within future filings.

SECTION 7 DEMAND-SIDE RESOURCE ANALYSIS

7.1 DSM Program Analysis

Liberty-Empire analyzed demand-side resources and supply-side resources on an equivalent basis as options for meeting load requirements. For the 2022 IRP, Liberty-Empire engaged Applied Energy Group ("AEG") to conduct a DSM Potential Study in the Company's service territory and develop DSM program inputs for the IRP analysis. The integrated portfolio analysis evaluated two levels of achievable potential for energy savings associated with DSM programs: realistic achievable potential ("RAP") and maximum achievable potential ("MAP"). Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. MAP is defined as the maximum amount of savings that can be realized under ideal market, implementation, and customer preference conditions, and has higher incentives than RAP due to higher program participation. RAP reflects expected program participation given barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets.

Within the RAP and MAP scenarios, AEG bundled DSM programs together based on the $/kWh cost of the programs (low, mid, and high-cost energy efficiency bundles plus a demand side rates bundle) for use in the integrated portfolio analysis. These DSM bundles were incorporated into the IRP as eligible resources in the portfolio optimization analysis along with supply-side resources in the alternative plan development stage. A summary of the demand-side program bundles used in the integrated analysis is presented below.

Table 1-4 – Description of DSM IRP Bundles

DSM	Program Bundle	Description
RAP	Low Cost	Programs with a three-year average $/kWh saved below $0.18 per kWh. Includes: - Retail Lighting - Residential Behavioral - Commercial Custom - SEM - Retrocommissioning
	Mid Cost	Programs with a three-year average $/kWh saved between $0.18 to $0.25 per kWh. Includes: - Residential Prescriptive - Appliance Recycling - Commercial Prescriptive - Midstream Food Service
	High Cost	Programs with a three-year average $/kWh saved above $0.25 per kWh. Includes: - Whole Home Efficiency - SBDI
	Demand Side Rates ("DSR")	DR and DSR programs. Includes: - Time of Use Rate (Res & Non-Res) - Critical Peak Pricing (Res & Non-Res) - DLC Smart Thermostat - Real Time Pricing
MAP	Low Cost	Programs with a three-year average $/kWh saved below $0.18 per kWh. Includes: - Retail Lighting - Residential Behavioral - Commercial Custom - SEM - Retrocommissioning
	Mid Cost	Programs with a three-year average $/kWh saved between $0.18 to $0.25 per kWh. Includes: - Residential Prescriptive - Appliance Recycling - Commercial Prescriptive - Midstream Food Service
	High Cost	Programs with a three-year average $/kWh saved above $0.25 per kWh. Includes: - Whole Home Efficiency - SBDI
	Demand Side Rates ("DSR")	DR and DSR programs. Includes: - Time of Use Rate (Res & Non-Res) - Critical Peak Pricing (Res & Non-Res) - DLC Smart Thermostat - Real Time Pricing

7.2 2022 Market Potential Study and Variance Request

On April 1, 2021, one year in advance of the 2022 IRP filing, Liberty-Empire filed an application for variance of portions of 20 CSR 4240-20.030 and 20 CSR 4240-20.094. The application related to 20 CSR 4240-20.094 requested relief from the obligation to collect primary data in support of the 2022 market potential study for demand-side resources. On April 25, 2021, Liberty-Empire, MPSC Staff, and the Office of the Public Counsel ("OPC") filed a Notice of Agreement Regarding Application for Variances ("Agreement"). The parties agreed that although it would be beneficial to collect primary data for Liberty-Empire's future MEEIA filings, due to time constraints, collecting the data and incorporating it into the 2022 IRP analysis would likely not be feasible. Thus, the parties agreed to grant variances from the provisions of 20 CSR 4240-22.030 and 20 CSR 4240-20.094 for the 2022 IRP, but on the condition that Liberty-Empire must begin conducting residential and commercial surveys to collect the primary data needed for future market potential studies as soon as practical. On May 12, 2021, the MPSC issued an Order effective June 11, 2021 in Case No. EO-2021-0331 approving the agreement and Liberty-Empire's application for variance of portions of 20 CSR 4240-22.030 and 20 CSR 4240-22.094.

As agreed, the Company conducted the residential and commercial surveys in partnership with AEG. On March 23, 2022, Liberty-Empire filed its 2021 Market Study in Missouri's Electronic Filing Information System ("EFIS") in File No. EO-2021-0331. As anticipated, the data was not fully analyzed and available in time to be incorporated into the 2022 IRP analysis, but the market research will inform the development of the next MEEIA cycle and future IRP processes.

SECTION 8 INTEGRATED RESOURCE PLANNING AND RISK ANALYSIS

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;

The supply-side and demand-side candidate resource options described previously were used in the integrated resource planning analysis in conjunction with future load expectations to develop a set of optimized alternative resource plans. Each alternative resource plan was subject to resource acquisition strategy constraints that defined the type of resources that could be added to the portfolio over the IRP study period. Given these resource selection constraints, the additions in each portfolio were optimized in terms of their amount and timing using a long-term portfolio optimization model known as Aurora. Each alternative resource plan was then evaluated based on the performance measures required by the Rule.

8.1 Development of Alternative Resource Plans

As a part of the 2022 IRP analysis, Liberty-Empire designed and developed 15 alternative resource plans using various combinations of demand-side and supply-side resources (both renewable and non-renewable). Nine of the 15 alternative resource plans assumed "baseline" (i.e., age-based or planned) retirement dates and expected PPA expirations for the existing resources in Liberty-Empire's portfolio. The remaining six of the 15 alternative resource plans were intended to examine the feasibility and tradeoffs of achieving two different hypothetical long-term net zero carbon emissions goals: Net Zero by 2035 and Net Zero by 2050. Given that most of Liberty-Empire's long-term scope 1 and 2 emissions come from its two natural gas-fired CCs, in addition to the expected retirements and PPA expirations listed previously, the "net zero" portfolios assumed the retirement or conversion of Riverton 12 and State Line CC at various points in time.

In addition to the assumed retirements of the existing resources, each resource portfolio was subject to constraints on the type of resources that could be added to the portfolio over the IRP study period. Liberty-Empire developed a set of plans that allowed the addition of only thermal

resources versus only renewable and storage resources; plans that allowed the addition of distributed resources versus not allowing the addition of distributed resources; and plans that allowed the addition of RAP DSM versus MAP DSM programs. For the "net zero" portfolios, the existing natural gas-fired CCs were replaced by a combination of renewables and/or emerging technologies such as advanced storage, nuclear SMR, and hydrogen. A summary of the 15 alternative resource plans is shown in Table 1-5.

Table 1-5 - Summary of Alternative Resource Plans

Plan	Plan Description	Replacement Tech.	Scale	Key Retirements*	DSM Bundle
1	Gas Only – Utility-Scale	Natural Gas	Utility		RAP
2	Gas Only – Utility-Scale + Distributed	Natural Gas	Utility/Distributed		RAP
3	Gas Only – Utility-Scale + Distributed	Natural Gas	Utility		MAP
4	Gas/Renew Mix – Utility-Scale	Natural Gas + Renew.	Utility		RAP
5	Gas/Renew Mix – Utility-Scale + Distributed	Natural Gas + Renew.	Utility/Distributed		RAP
6	Gas/Renew Mix – Utility-Scale + Distributed	Natural Gas + Renew.	Utility/Distributed		MAP
7	Renewable – Utility-Scale	Renewable	Utility		RAP
8	Renewable – Utility-Scale + Distributed	Renewable	Utility/Distributed		RAP
9	Renewable – Utility-Scale + Distributed	Renewable	Utility/Distributed		MAP
10	Net Zero 2050 – Renewable + Storage	Renewable	Utility/Distributed	Riverton CC 2045 Stateline CC 2050	RAP
11	Net Zero 2050 – Nuclear SMR	Nuclear + Renew.	Utility/Distributed	Riverton CC 2045 Stateline CC 2050	RAP
12	Net Zero 2050 – Hydrogen	Hydrogen + Renew.	Utility/Distributed	Riverton CC 2045 Stateline CC 2050	RAP
13	Net Zero 2035 – Renewable / Storage	Renewable	Utility/Distributed	Riverton CC 2035 Stateline CC 2035	RAP
14	Net Zero 2035 – Nuclear SMR	Nuclear + Renew.	Utility/Distributed	Riverton CC 2035 Stateline CC 2035	RAP
15	Net Zero 2035 – Hydrogen	Hydrogen + Renew.	Utility/Distributed	Riverton CC 2035 Stateline CC 2035	RAP

DSM = "Demand-Side Management"
RAP = "Realistic Achievable Potential"
MAP= "Maximum Achievable Potential"

Renewable options include storage. Advanced storage options are allowed only in the net zero portfolios.

* Key Retirements are incremental to retirements and PPA expirations that are common across all plans:
- Retirement of Riverton 10 and 11 in 2025
- Expiration of the Elk River Wind PPA in 2025
- Expiration of the MJMEUC Capacity Sale PPA in 2025
- Expiration of the Meridian Way Wind PPA in 2028
- Retirement of Energy Center 1 and 2 by 2035
- Retirement of Iatan 1 in 2039
- Expiration of the Plum Point PPA in 2040

All alternative plans were required to meet both summer and winter resource adequacy needs. The results of the portfolio optimization analysis are described in detail in Volume 6.

8.2 Relative Performance of Alternative Resource Plans

Given the set of 15 alternative plans developed through the portfolio optimization analysis, Liberty-Empire evaluated all 15 plans with respect to the performance measures specified in the IRP Rule. Figure 1-16 displays the present value of revenue requirements ("PVRR") of all 15 plans under Base Case planning assumptions for the twenty-year planning period of the IRP. Table 1-6 shows the results of all alternative plans evaluated under Base Case market conditions for all key IRP performance metrics.

Of the alternative plans that assume age-based or baseline retirements (Plans 1 through 9), Plan 8 was the lowest-cost. While Plan 10 (Net Zero 2050 with renewable and advanced storage replacements) was marginally lower-cost than Plan 8 on a 20-year PVRR basis, it became slightly higher-cost on a 30-year PVRR basis, as further described in Volume 7. Due to the long-term nature of the net zero decision, Plan 10 did not differ significantly from Plan 8 in technology buildout during the 20-year IRP study period. Put another way, Plan 8 keeps the portfolio on a viable path toward Plan 10's long term net zero position assuming the necessary steps are taken in the 2041-2051 period.

Figure 1-16 – 20-Year PVRR for All Plans (2022-2041) ($ millions)

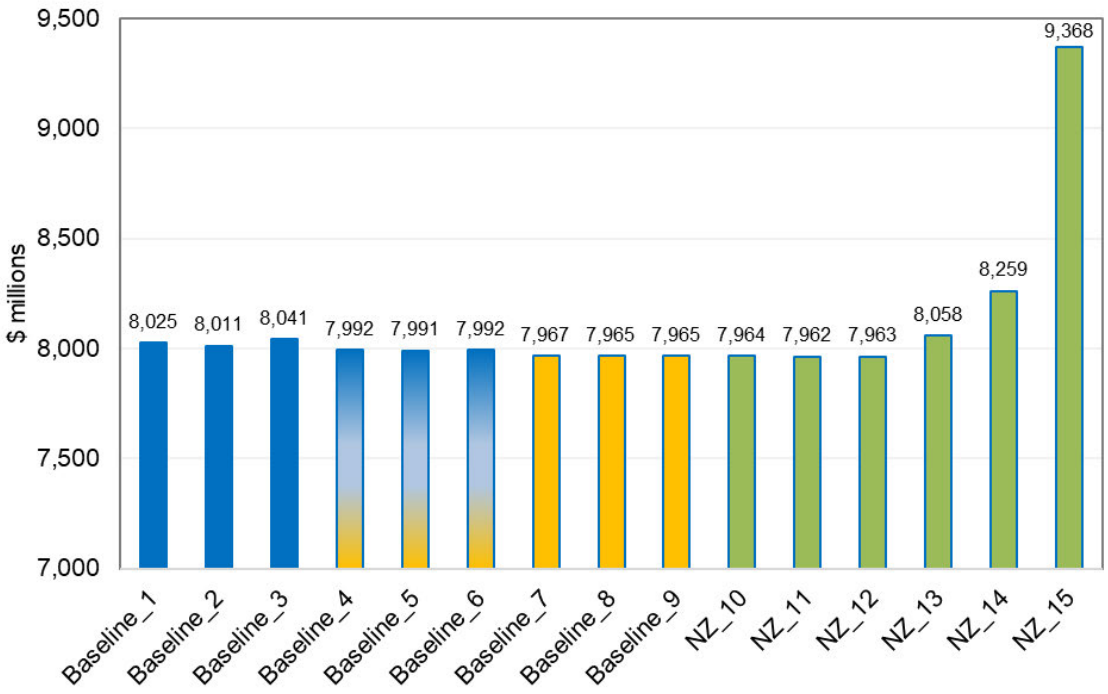

Table 1-6 - 20 Year Performance of Alternative Resource Plans

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[redacted]

8.3 Critical Uncertain Factors

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

To assess each alternative plan's resiliency to a wide range of market risks, for the 2022 IRP, Liberty-Empire developed a list of uncertain factors that could potentially impact the performance of the resource plans. This list included, but was not limited to, the uncertain factors listed in the Rule. Liberty-Empire compiled information concerning the uncertain factors from subject matter experts within the Company and from its consultants. The subject matter experts and consultants developed wide but reasonable scenario ranges for each of the identified factors. Some of the uncertain factor scenarios were grouped together into a single uncertain factor for purposes of simplifying the analysis. Figure 1-17 lists the uncertain factors and factor groupings developed by Liberty-Empire.

Figure 1-17 – List of Uncertain Factors[7]

Uncertain Factor	Scenarios	Group
Load	3	"Load"
Capital Cost Trajectories	3	"Cost of New Builds" (Capital Cost Interest Rate Interconnection Cost Tax Credits FOM CF)
Interest Rates	3	
Interconnection Costs	3	
Tax Credits	3	
FOM	3	
Renewable Capacity Factor	3	
Carbon Prices	3	"Carbon / Emission"
SO2, NOX Prices	3	
NG Prices	3	"NG Price"
Forced Outage Rates	3	"FOR"
Power / Capacity Prices	9 (based on market modeling)	"Power / A/S / ELCC" (Carbon / Emission & NG Price permutations)
Solar and Storage ELCC	9 (based on market modeling)	
A/S Value	9 (based on market modeling)	

[7] "FOM" = Fixed O&M; "NG" = natural gas; "ELCC" = effective load carrying capability; "A/S" = ancillary service / sub-hourly. Solar and storage ELCC and A/S value were developed based on the nine power market outcomes described in Section 5.3.3.

A critical uncertain factor ("CUF") is any uncertain factor that is likely to materially affect the outcome of the resource planning decision. To determine whether an uncertain factor was critical, Liberty-Empire tested the impact of changing one uncertain factor at a time on the PVRR rankings of a subset of thematically distinct replacement portfolios. If the PVRR rankings changed relative to the rankings under the Base Case (defined as the market scenario assuming the "base" scenario for all uncertain factors) because of the impact of a given uncertain factor, then that uncertain factor was deemed "critical." An illustration of the uncertain factor scenarios that were tested for critical impact on PVRR rankings is shown in **Figure 1-18**.[8]

Figure 1-18 – Uncertain Factor Testing Approach

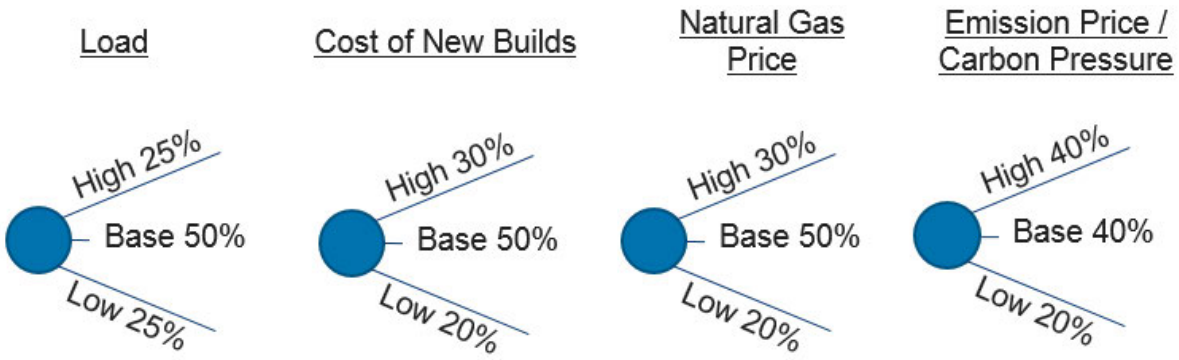
Case	CO2, NOX, SO2	NG	Load	FOR	Capital	Interest Rate	IC	Tax Policy	FOM	Renew CF
0 – Base	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**
1 – Low Emission Price	Low	Base	Base	Base	Base	Base	Base	Base	Base	Base
2 – High Emission Price	High	Base	Base	Base	Base	Base	Base	Base	Base	Base
3 – Low Gas Price	Base	Low	Base	Base	Base	Base	Base	Base	Base	Base
4 – High Gas Price	Base	High	Base	Base	Base	Base	Base	Base	Base	Base
5 – Low Load	Base	Base	Low	Base	Base	Base	Base	Base	Base	Base
6 – High Load	Base	Base	High	Base	Base	Base	Base	Base	Base	Base
7 – Low FOR	Base	Base	Base	Low	Base	Base	Base	Base	Base	Base
8 – High FOR	Base	Base	Base	High	Base	Base	Base	Base	Base	Base
9 – Low Cap Cost	Base	Base	Base	Base	Low	Base	Base	Base	Base	Base
10 – High Cap Cost	Base	Base	Base	Base	High	Base	Base	Base	Base	Base
11 – Low Interest Rate	Base	Base	Base	Base	Base	Low	Base	Base	Base	Base
12 – High Interest Rate	Base	Base	Base	Base	Base	High	Base	Base	Base	Base
13 – Low IC Cost	Base	Base	Base	Base	Base	Base	Low	Base	Base	Base
14 – High IC Cost	Base	Base	Base	Base	Base	Base	High	Base	Base	Base
15 – Low Tax Credit	Base	Base	Base	Base	Base	Base	Base	Low	Base	Base
16 – High Tax Credit	Base	Base	Base	Base	Base	Base	Base	High	Base	Base
17 – Low FOM	Base	Base	Base	Base	Base	Base	Base	Base	Low	Base
18 – High FOM	Base	Base	Base	Base	Base	Base	Base	Base	High	Base
19 – Low Renew CF	Base	Base	Base	Base	Base	Base	Base	Base	Base	Low
20 – High Renew CF	Base	Base	Base	Base	Base	Base	Base	Base	Base	High

Based on this analysis, Liberty-Empire identified the following critical uncertain factors: load growth, carbon prices, natural gas fuel prices, and a grouping of factors related to the cost of new

[8] Note that the variables related to the power market outcomes (i.e., power prices, ELCC, and ancillary service value) are dependent on the underlying market carbon price and natural gas fuel price scenario, and were tested within the scenarios for those factors.

builds.[9] These uncertain factors were found to have the greatest potential influence on the selection of the Preferred Plan and were deemed to be the critical uncertain factors. These critical uncertain factors and their ranges form the nodes and the branches of the uncertainty tree in Figure 1-19.

Figure 1-19 - Critical Uncertain Factors Tree

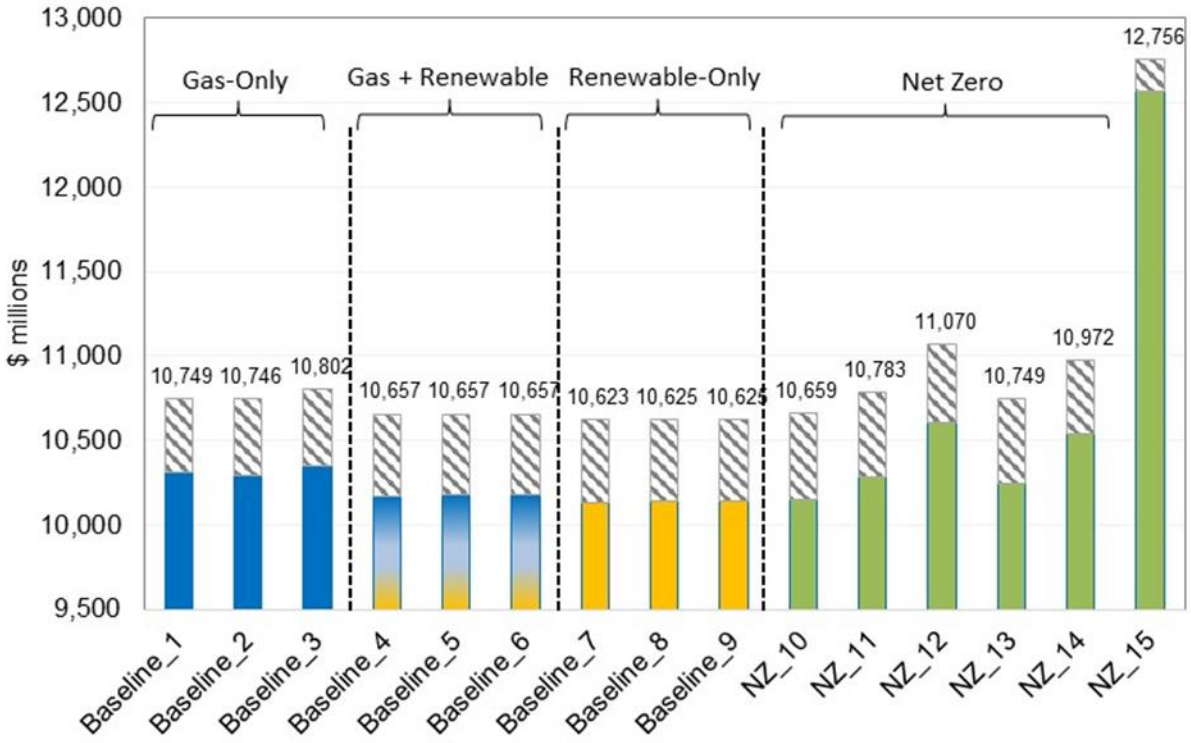


The subjective probabilities shown above were assigned by the utility decision-makers after review and discussion of the various critical uncertain factor scenario trajectories. The three potential endpoints for four critical uncertain factors resulted in 81 endpoints per plan, probability-weighted depending on the subjective probabilities of the scenario components. By calculating the PVRR of each plan on an expected value basis across all 81 subjective probability-weighted endpoints, Liberty-Empire determined the resilience of each plan to a wide range of risk for all critical uncertain factors.

Liberty-Empire found that Plans 7 through 9 performed best on an expected value basis for both 20-year and 30-year PVRRs, with Plan 8 remaining the lowest cost and preserving flexibility to pivot to a "Net Zero by 2050" resource acquisition strategy under Plan 10 in the longer term, as established by the corporate net zero target. The expected value 20-year PVRRs for all plans are shown in Figure 1-20, with the shaded component of the bar being incremental to the Base Case.

[9] As discussed in Volume 6, the cost of new builds CUF itself includes high, base, and low scenarios of component factors including capital costs, interconnection costs, interest rates, tax credit provisions (if relevant), and renewable capacity factors (if relevant).

Figure 1-20 - PVRR with Risk Value for All Plans (2022-2041) – ($ millions)



SECTION 9 RESOURCE ACQUISITION STRATEGY SELECTION

9.1 Preferred Plan Selection Criteria

As described previously, Liberty-Empire's 2022 IRP analysis was intended to select a resource strategy that provides energy services that are safe, reliable, and efficient, at just and reasonable rates, consistent with state energy and environmental policies, in compliance with all legal mandates, and in a manner that serves the public interest. Consistent with 20 CSR 4240-22.010(2)(C), the selection of the resource strategy was based on the minimization of the present value of long-run utility costs and the mitigation of risks associated with critical uncertain factors, legal compliance, and rate increases. Finally, Liberty-Empire also considered the capability of the Preferred Plan to allow for the significant reduction of carbon emissions over the long term.

To document the process and rationale used by Liberty-Empire's decision-makers to assess the tradeoffs and determine the appropriate balance between minimization of expected utility costs and other resource planning considerations and metrics, Liberty-Empire's 2022 IRP deployed an IRP scorecard. The scorecard is a means of reporting key metrics for different alternative resource plans to facilitate the evaluation of relative portfolio performance and key tradeoffs. Liberty-Empire's scorecard did not produce a single ranking of portfolios but served as a tool to help facilitate structured tradeoff discussions and support the internal decision-making and approval process. As prescribed by the IRP Rule, minimization of the present worth of long-run utility costs was the primary selection criterion for the Preferred Plan, with all remaining planning objectives given equal consideration. In the judgment of utility decision-makers, the Preferred Plan represented an appropriate balance between the various planning objectives specified in 20 CSR 4240-22.010(2).

Liberty-Empire's 2022 IRP Scorecard is shown in Figure 1-21. While the scorecard does not include all performance metrics evaluated in Volume 6, it represents the criteria that utility decision-makers weighed most heavily in determining Liberty-Empire's Preferred Plan. For each metric in the populated scorecard, values in darker shades of green illustrate a "stronger"

performance of the plan (i.e., more favorable), and values in darker shades of red illustrate a "weaker" performance (i.e., more unfavorable).

Figure 1-21 – Populated 2022 IRP Scorecard

Objective	Metric	Metric Description	Portfolio														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Customer Affordability	NPV Revenue Requirement	Total long-term (20-year) annual costs paid by customers on a net present value basis under Base Case scenario	8,025	8,011	8,041	7,992	7,991	7,992	7,967	7,965	7,965	7,964	7,962	7,963	8,058	8,259	9,368
Risk Mi igation	Resilience to Critical Uncertain Factors	Expected value of 20-year PVRRs when evaluated against all critical uncertain factor probabilities	8,286	8,280	8,312	8,286	8,284	8,284	8,266	8,262	8,262	8,263	8,264	8,265	8,385	8,556	9,530
		Range (delta) between higher-cost (P95) and median (P50) PVRR outcomes when calculated against the CUF probabilities	641	615	637	885	880	880	901	871	870	879	785	853	1,292	1,321	821
Reliability	Operational Flexibility	Dispatchable capacity (Summer UCAP MW) included in portfolio by 2041	1,266	1,237	1,264	1,037	1,037	1,037	1,027	1,030	1,030	1,053	1,101	1,087	1,076	1,003	1,052
Environmental Sustainability	Carbon Reduction	Million short tons CO2 emissions in 2041 (scope 1/2 only)	1.97	1.90	1.95	1.53	1.53	1.53	1.45	1.45	1.45	1.45	1.45	1.45	0.10	0.10	0.10
Compliance and Safety	Environmental and Legal Compliance	Adherence to legal mandates and energy policies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
	Safety	Adherence to safety standards	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Based on this decision-making approach, Liberty-Empire selected Plan 8 as the Preferred Plan. The Preferred Plan for the 20-year IRP study period is shown in Table 1-7 .

Table 1-7 - Preferred Plan Supply Side Resource Retirements and Additions

Year	Supply-Side Retirements and PPA Expirations	Supply-Side Additions
2022		RAP DSM (Low-Cost Bundle)
2023		
2024		
2025	Elk River Contract Expires (150 MW) Riverton 10-11 Retires (27 MW)	RICE utilizing existing IC (30 MW)
2026		
2027		Utility-Scale 2:1 S+S utilizing existing IC (105 MW) Dist. Solar (5 MW)
2028	Meridian Way Contract Expires (105 MW)	
2029		
2030		Utility-Scale Solar utilizing existing IC (70 MW)
2031		Dist. Solar (10 MW) Dist. 2:1 S+S (3 MW)
2032		Dist. Solar (10 MW) Dist. 2:1 S+S (6 MW)
2033		Utility-Scale Solar (100 MW) Dist. Solar (10 MW)
2034		Dist. Solar (10 MW)
2035	Energy Center 1 and 2 Expires (160 MW)	Dist. Solar (10 MW)
2036		Dist. Solar (10 MW)
2037		Dist. Solar (10 MW)
2038		Utility-Scale Solar (50 MW) Dist. Solar (10 MW)
2039	Iatan 1 Retires (84 MW)	Utility-Scale 2:1 S+S (480 MW) Dist. Solar (10 MW)
2040	Plum Point PPA Expires (50 MW)	Dist. Storage (4 MW) Dist. Solar (10 MW)
2041		Utility-Scale Solar (50 MW) Utility-Scale 2:1 S+S (120 MW) Dist. Storage (1 MW) Dist. 2:1 S+S (3 MW) Dist. Solar (10 MW) Flow Battery (50 MW)

IC = Interconnection
S+S = Solar + Storage
RAP DSM = Realistic Achievable Potential Demand Side Management

The Preferred Plan will satisfy future capacity and energy needs with a broad mix of solar, paired solar + storage, standalone storage, and natural gas resources at both the utility and distributed scale. The plan includes dual-fuel RICE units to replace the retirements at Riverton 10 and 11 in

2025. The plan also adds 175 MW of solar and storage at existing interconnection sites in a 4:1 solar to storage ratio by 2030. By 2041, the plan adds 200 MW of utility-scale solar, 600 MW of utility-scale 2:1 solar + storage, 50 MW of flow battery, and 132 MW of distributed solar and/or storage. The plan also adds the "low-cost" bundle of RAP DSM. In addition, Plan 8 preserves flexibility to pivot to a "Net Zero by 2050" resource acquisition strategy under Plan 10 in the longer term, as established by the corporate net zero target.

9.2 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;

6. If the estimated company financial ratios in subparagraph (2)(E)5.C. of this rule are below investment grade in any year of the planning horizon, a description of any changes in legal mandates and cost recovery mechanisms necessary for the utility to maintain an investment grade credit rating in each year of the planning horizon and the resulting performance measures of the preferred resource plan;

The performance measures of the Preferred Plan are shown in Table 1-8. Liberty-Empire does not anticipate below investment grade financial ratios based on the Preferred Plan presented.

Table 1-8 – Performance Measures of the Preferred Plan

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9.3 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 Plan over the implementation period, i.e., the time between the triennial compliance filings. The next triennial IRP filing is scheduled for 2025. Therefore, the implementation period is the period 2022-2025.

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

- Make use of the recently completed Residential and Non-Residential Market Study to help develop primary data driven demand-side programs for the next MEEIA Cycle ("MEEIA Cycle 2");
- Perform feasibility and environmental studies, begin permitting as required, and issue a request for proposal ("RFP") in preparation of acquiring 30 MW of RICE to directly replace the retirements of Riverton 10 and 11 in 2025;
- Prioritize the implementation of low-cost energy efficiency programs from MEEIA Cycle 2 as appropriate;
- **[redacted]** and
- Monitor federal tax credit policy, cost trends for solar and storage resources, and co-location opportunities at Liberty-Empire's existing generation resource sites to plan for anticipated solar and storage additions, as well as prepare to adapt the timing of medium-term co-located solar additions to 2026 or 2027 depending on the length of ITC extension that materializes (1-year or 2-year).

SECTION 10 CONCLUSIONS

Liberty-Empire's 2022 IRP, its evaluation of alternative plans, and its recommendation for its Preferred Plan are offered to the MPSC and the wider community of Company stakeholders in full compliance with its legal requirements under 20 CSR 4240-22.

Based on the assumptions of this IRP study, Liberty-Empire believes that its Preferred Plan is in the best interest of its customers. It represents a low cost and low risk resource acquisition strategy that also prioritizes 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. The results of the IRP analysis documented in this report reflect only current and projected conditions as they were known at the time the results were developed. However, IRP is a fluid process and involves numerous assumptions about the future. Liberty-Empire will continually monitor critical uncertain factors and re-examine its decisions as the need for additional resources become more evident. The IRP will be subjected to ongoing evaluation as modeling assumptions change based on evolving business conditions.