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VOLUME 6

INTEGRATED RESOURCE PLAN AND RISK ANALYSIS

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

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INTEGRATED RESOURCE PLAN AND RISK ANALYSIS

Commission Rule 20 CSR 4240-22.060, Integrated Resource Plan and Risk Analysis, provides in part as follows:

PURPOSE: This rule requires the utility to design alternative resource plans to meet the planning objectives identified in 4 CSR 240-22.010(2) and sets minimum standards for the scope and level of detail required in resource plan analysis and for the logically consistent and economically equivalent analysis of alternative resource plans. This rule also requires the utility to identify the critical uncertain factors that affect the performance of alternative resource plans and establishes minimum standards for the methods used to assess the risks associated with these uncertainties.

SECTION 1 RESOURCE PLANNING OBJECTIVES

(1) Resource Planning Objectives. The utility shall design alternative resource plans to satisfy at least the objectives and priorities identified in 4 CSR 240-22.010(2). The utility may identify additional planning objectives that alternative resource plans will be designed to meet. The utility shall describe and document its additional planning objectives and its guiding principles to design alternative resource plans that satisfy all of the planning objectives and priorities.

1.1 Resource Planning Objective

The fundamental objective of the electric utility resource planning process, as stated in 20 CSR 4240-22.010, is to provide the public with 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. In support of the fundamental objective, Liberty-Empire's 2025 Integrated Resource Plan ("IRP") considered and analyzed demand-side resources and supply-side renewable and non-renewable resources on an equivalent basis, subject to compliance with legal mandates that may affect the selection of electric energy resources in the resource planning process.

Minimizing the present worth of long-run utility costs was the primary criterion for evaluating the comparative performance of the alternative resource plans, subject to certain constraints as defined in 20 CSR 4240-22.010(2)(C). In addition, Liberty-Empire identified and, where possible, quantitatively analyzed other considerations critical to meeting the fundamental resource planning objective, evaluating them in conjunction with minimizing the present worth of long-run expected utility costs. According to 20 CSR 4240-22.010(2)(C), these considerations included, but were not limited to, mitigation of:

1. Risks associated with critical uncertain factors that would affect the actual costs associated with alternative resource plans;

2. Risks associated with new or more stringent legal mandates that might be imposed at some point within the planning period; and

3. Rate increases associated with alternative resource plans.

Liberty-Empire's decision-makers further identified long-term objectives associated with reliability and environmental stewardship, which were also evaluated as part of the IRP process. More specifically, they were defined as the ability to provide reliable energy services to Liberty-Empire's customers and the commitment to significantly reduce carbon emissions over the long term.

Together, these priorities drove the development of the 2025 IRP alternative resource plans and the metrics against which Liberty-Empire evaluated the alternative plans and selected the preferred plan.

1.1.1 2025 IRP Planning Objectives and Scorecard Approach

To better 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, Liberty-Empire's 2025 IRP utilized an IRP scorecard approach to transparently illustrate the comparative performance of the alternative resource plans across several key metrics. 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 was not intended to produce a single ranking of portfolios but served as a tool to help validate and rationalize decisions, facilitate structured tradeoff discussions, and support the internal decision-making and approval process.

Consistent with 20 CSR 4240-22.010(2), Liberty-Empire's 2025 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. Further, consistent with 20 CSR 4240-22.010(2)(C), the selected resource strategy was intended to minimize the present value of long-run utility costs and mitigate risks associated with critical uncertain factors, legal compliance, and rate increases. Liberty-Empire also evaluated the performance measures specified at 20 CSR 4240-22.060(2)(A). Finally, Liberty-Empire also considered the preferred plan's capability to significantly reduce carbon emissions over the long term. While Liberty-Empire used the minimization of the present worth of long-run utility costs as the primary selection criterion for the preferred plan, it also considered these objectives as priorities and used them as guidelines for developing and evaluating alternative resource plans.

Liberty-Empire identified five major planning objectives and nine performance metrics as summarized in Figure 6-1. The objectives included Customer Affordability, Risk Mitigation, Reliability, Environmental Sustainability, and Compliance and Safety. By populating the 2025 IRP Scorecard metrics for all alternative resource plans, Liberty-Empire could evaluate the plans holistically and recommend a preferred resource plan based on transparent selection criteria, as discussed in Volume 7.

Figure 6-1 – 2025 IRP Scorecard Metrics

Objective	Metric	Metric Description
Customer Affordability	Short-Term NPV Revenue Requirement	NPV of short-term (5-year) total annual costs paid by ratepayers under the Base Case scenario
	Long-Term NPV Revenue Requirement	NPV of long-term (20-year) total annual costs paid by ratepayers under the Base Case scenario
Risk Mitigation	Scenario Range	Expected value of 20-year PVRRs when evaluated against all CUF probabilities
	Cost Risk	Range (delta) between higher-cost (P95) and median (P50) PVRR outcomes when calculated against CUFs
Reliability	Planning Reserves	Summer and Winter % Reserve Margin, CUFs Average
	Operational Flexibility	Dispatchable Capacity (Summer/Winter UCAP MW) included in portfolio by 2045
Environmental Sustainability	Carbon Emissions	Million short tons CO2 emissions in 2045 (scope 1/2 only)
Compliance and Safety	Environmental and Legal Compliance	Adherence to legal mandates and energy policies
	Safety	Adherence to safety standards

The scorecard was presented to stakeholders and the Missouri Public Service Commission at Liberty-Empire's 2025 IRP Stakeholder Meeting #2 on October 30, 2024.

1.2 Planning and Analysis

As specified in 20 CSR 4240-22.010(2)(A), Liberty-Empire considered and analyzed demand-side resources, renewable energy, and supply-side resources on an equivalent basis. As discussed further in this volume, Liberty-Empire and its IRP modeling consultant, Charles River Associates ("CRA"), developed and analyzed a set of twelve alternative resource plans based on substantively different mixes of supply-side resources and demand-side resources and variations in the timing of resource acquisition to assess their relative performance under expected future conditions as well as their robustness under a broad range of future conditions. The twelve alternative resource plans differed based on the timing of potential resource retirements, the inclusion of various types of demand-side management ("DSM") programs, and the timing and inclusion of different levels of supply-side generation technology types. Once the alternative resource plans were developed, Liberty-Empire calculated the present worth of long-run utility costs for each plan by calculating the present value of revenue requirements ("PVRR") over the IRP analysis period and used the minimization of PVRR as the primary criterion for determining the economic rank of each plan. Liberty-Empire also documented a set of quantitative measures for assessing the performance of the alternative plans, including all metrics defined in the IRP Scorecard and all metrics defined at 20 CSR 4240-22.060(2)(A).

The remainder of this volume describes and documents the details of Liberty-Empire's alternative resource plan development, evaluation, and risk analysis.

SECTION 2 PERFORMANCE MEASURES

(2) Specification of Performance Measures. The utility shall specify, describe, and document a set of quantitative measures for assessing the performance of alternative resource plans with respect to resource planning objectives.

(A) These performance measures shall include at least the following:

2.1 Present Worth of Utility Revenue Requirements

1. Present worth of utility revenue requirements, with and without any rate of return or financial performance incentives for demand-side resources the utility is planning to request;

The annual revenue requirement includes the total cost of Liberty-Empire's electric operations and any costs for probable environmental compliance. The annual revenue requirement is the total of Liberty-Empire's annual expenses, including operating costs[1] as well as its authorized return on rate base. Capital expenditures for plant investments increase the rate base, while depreciation and amortization of assets reduce the rate base. The PVRR is calculated by applying Liberty-Empire's utility discount rate, equal to Liberty-Empire's after-tax weighted average cost of capital ("WACC"), to the future long-term annual revenue requirements to arrive at the net present value ("NPV") of future utility costs. This value was calculated for each alternative resource plan and was used as the primary measure for preferred plan selection.

2.2 Present Worth of Probable Environmental Costs

2. Present worth of probable environmental costs;

The present worth of probable environmental costs was calculated based on the cost to implement potential future CO_2 regulations under the 2025 IRP Base Case assumptions. Although no federal policies directly regulating carbon emissions are in effect as of March

[1] Note that DSM program costs are expensed in annual revenue requirements in the year they are incurred and do not increase the rate base or rate of return. The impact of financial performance incentives for DSM programs has been shown in the performance measures.

2025, given previous federal efforts to regulate carbon emissions, the Base Case federal CO_2 regulation scenario includes a modest price on carbon emissions of $13/short ton beginning in 2031, rising slightly over the planning period to achieve approximately 60-70% carbon-free generation from the U.S. power sector over the long-term. This price represents a proxy for several different potential pathways for legislative action or executive regulation (not explicitly a carbon tax).

2.3 Present Worth of DSM Participant's Costs

3. Present worth of out-of-pocket costs to participants in demand-side programs and demand-side rates;

Demand-side management ("DSM") program costs were inputs to the integrated resource plan and risk analysis. As described in Volume 5, Liberty-Empire considered multiple levels of incentives in its DSM program analysis: Realistic Achievable Potential ("RAP") and Maximum Achievable Potential ("MAP"). MAP is defined as the maximum amount of savings that can be realized under ideal market, implementation, and customer preference conditions. It also has higher incentives than RAP due to higher program participation. Within the RAP and MAP scenarios, Liberty-Empire's DSM analysis consultant, Applied Energy Group ("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. The DSM bundles were incorporated into the IRP as eligible resources in the portfolio optimization analysis and supply-side resources in the alternative plan development stage.

The present value of DSM program costs over a 30-year period (2025-2054), calculated using the estimated future cost of the programs with the discount factor per 20 CSR 4240-22.060(2)(B), is shown by the bundle in Table 6-1. Additional information regarding these program bundle definitions can be found in Volume 5 and Section 3.2.18.

Table 6-1 – DSM Out of Pocket Costs

DSM	Program Bundle	30-Year NPV of Program Costs
RAP	Low Cost	$8,499,820
	Mid Cost	$3,537,350
	High Cost	$2,076,581
	Demand Side Rates ("DSR")	$17,189,129
MAP	Low Cost	$10,897,095
	Mid Cost	$4,863,599
	High Cost	$2,262,225
	Demand Side Rates ("DSR")	$32,841,520

2.4 Levelized Rates

4. Levelized rates;

The levelized rate represents the levelized present value of the annual rates over a given period. Annual rates are calculated by dividing the annual revenue requirements by the forecasted annual retail energy sales, resulting in annual $/MWh values. The levelized rate is then determined by calculating the net present value of the stream of annual rates over time and amortizing the net present value into a levelized rate applicable to the full study period. Liberty-Empire's utility discount rate, equal to Liberty-Empire's after-tax weighted average cost of capital ("WACC"), is used in this calculation.

2.5 Maximum Single-Year Increase in Annual Average Rates

5. Maximum single-year increase in annual average rates;

For each alternative resource plan, the year-over-year percent change in annual average rates was calculated to determine the maximum single-year increase. The maximum value represents the maximum single-year increase in annual average rates. This value was calculated for each alternative plan under the 2025 IRP Base Case.

2.6 Financial Ratios

6. Financial ratios (e.g., pretax interest coverage, ratio of total debt to total capital, ratio of net cash flow to capital expenditures) or other credit metrics indicative of the utility's ability to finance alternative resource plans; and

For each alternative resource plan, Liberty-Empire calculated the pre-tax interest coverage, ratio of total debt to total capital, and ratio of net cash flow to capital expenditures to indicate Liberty-Empire's ability to finance alternative resource plans.

2.7 Other Measures for Assessing Relative Performance Plans

7. Other measures that utility decision-makers believe are appropriate for assessing the performance of alternative resource plans relative to the planning objectives identified in 4 CSR 240-22.010(2).

As discussed in Section 1.1.1, Liberty-Empire used an IRP Scorecard approach in the 2025 IRP 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. As a part of its scorecard development, Liberty-Empire developed five major planning objectives and nine performance metrics, summarized in Figure 6-1. The objectives include Customer Affordability, Risk Mitigation, Reliability, Environmental Sustainability, and Compliance and Safety. While Liberty-Empire used the minimization of the present worth of long-run utility costs as the primary selection criterion for the preferred plan, it also considered these objectives priorities and used them as guidelines for developing and evaluating alternative resource plans.

2.8 Utility Discount Rate

(B) All present worth and levelization calculations shall use the utility discount rate and all costs and benefits shall be expressed in nominal dollars.

Liberty-Empire utilized a discount rate of 6.82 percent for all analyses of alternative resource plans. This discount rate is equal to Liberty-Empire's after-tax WACC. All PVRR dollar amounts were discounted back to 2025 dollars.

SECTION 3 ALTERNATIVE RESOURCE PLANS

(3) Development of Alternative Resource Plans. The utility shall use appropriate combinations of demand-side resources and supply-side resources to develop a set of alternative resource plans, each of which is designed to achieve one (1) or more of the planning objectives identified in 4 CSR 240-22.010(2). Demand-side resources are the demand-side candidate resource options and portfolios developed in 4 CSR 240-22.050(6). Supply-side resources are the supply-side candidate resource options developed in 4 CSR 240-22.040(4). The goal is to develop a set of alternative plans based on substantively different mixes of supply-side resources and demand-side resources and variations in the timing of resource acquisition to assess their relative performance under expected future conditions as well as their robustness under a broad range of future conditions.

3.1 Overview of Alternative Resource Plan Development

(A) The utility shall develop, and describe and document, at least one (1) alternative resource plan, and as many as may be needed to assess the range of options for the choices and timing of resources, for each of the following cases. Each of the alternative resource plans for cases pursuant to paragraphs (3)(A)1.-(3)(A)5. shall provide resources to meet at least the projected load growth and resource retirements over the planning period in a manner specified by the case. The utility shall examine cases that—

For 2025 IRP analysis purposes, Liberty-Empire developed a set of alternative plans based on substantively different mixes of supply-side and demand-side resources and variations in the timing of resource acquisition. The 2025 IRP analysis also applies an accredited capacity ("ACAP") resource adequacy construct being implemented by SPP. The construct represents a major shift in resource adequacy with reserve margin requirements for both summer and winter seasons along with resource accreditation revisions. Moreover, installed reserve margin requirements are increasing for summer and being initiated for winter. All alternative resource plans were developed under the following key reserve margin planning constraints:

- Summer SPP installed reserve margin requirement, increasing from 15% in 2024 to 17% by 2029[2]
- Winter SPP installed reserve margin requirement, increasing from 36% in 2026 to 44% by 2029[3]
- Maximum annual net energy market sales position (50 percent of annual load volume)

In addition to the key planning constraints, each resource portfolio 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. A description of the Aurora model can be found in Section 4.2.15. Section 3.1.1 describes the definitions of alternative resource plans in more detail.

3.1.1 Summary of 2025 IRP Alternative Resource Plans

Liberty-Empire developed 12 alternative resource plans for purposes of the 2025 IRP analysis.[4] Eight of the 12 alternative resource plans assumed "baseline" (i.e., age-based) retirement dates and expected PPA expirations for the existing resources in Liberty-Empire's portfolio. During the 20-year study horizon explicitly covered by this 2025 triennial IRP (2025-2044), the assumed resource retirements and PPA expirations of the existing resources are as follows:

[2] Summer accredited capacity requirement increasing from 5% in 2026 to 8% in 2029, and 10% by the end of the 20-year outlook period. Installed capacity refers to the maximum output a generator can produce based on its design specifications, while accredited capacity represents the amount of power a generator is realistically expected to deliver during peak demand periods, taking into account factors like reliability and availability, as described in SPP's RR554 filing.

[3] Winter accredited capacity requirement increasing from 10% in 2026 to 19% in 2029, and 24% by the end of the 20-year outlook period. Installed capacity refers to the maximum output a generator can produce based on its design specifications, while accredited capacity represents the amount of power a generator is realistically expected to deliver during peak demand periods, taking into account factors like reliability and availability, as described in SPP's RR554 filing.

[4] In addition to plans under standard load forecasts, Liberty-Empire assessed resource plans with new large loads (such as data center loads). This was requested as a part of a Commission Ordered special contemporary issue, for which the analysis is presented in Section 8 of this volume which is dedicated to the SCIs.

- Expiration of the Elk River Wind PPA in 2025;
- Expiration of the 78 MW MJMEUC Capacity Sale PPA in 2025;
- Retirement of Riverton 10 and 11 in 2026;
- Expiration of the 25 MW MJMEUC Capacity Sale PPA in 2027;[5]
- Expiration of the Meridian Way Wind PPA in 2028;
- Retirement of Energy Center 1 and 2 in 2035;
- Retirement of Iatan 1 in 2039;
- Expiration of the Plum Point PPA in 2040.

The remaining four of the 12 alternative resource plans were intended to examine the feasibility and tradeoffs of achieving the hypothetical long-term net zero carbon emissions by 2050 and to examine compliance with the EPA Greenhouse Gas ("GHG") Rule.[6] Given that most of Liberty-Empire's long-term scope 1 and 2 emissions come from its two natural gas-fired CCs,[7] 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 in 2045 and 2050, respectively.

To address the adequacy gap resulting from the assumed retirements of existing resources and load growth, each resource portfolio was subject to constraints on resource acquisition strategy. These constraints defined the type of resources that could be added to the portfolio over the IRP study period. The "baseline" portfolios included a subset of plans that allowed the addition of only thermal resources versus only renewable and storage resources and a subset of plans that allowed the addition of RAP DSM versus

[5] 25 MW MJMEUC Capacity Sale PPA that begins in 2025 is an amended and restated contract to the original MJMEUC capacity sale that began in 2020.
[6] 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.
[7] 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, emissions associated with the owned portion of Plum Point and Iatan 1 and 2 are scope 3, while those from other portfolio resources are scope 1 and 2.

MAP DSM programs. For the "net zero" portfolios, the existing natural gas-fired CCs were assumed to be replaced by a combination of renewables and emerging technologies such as advanced storage, nuclear small modular reactors ("SMR"), and/or hydrogen.

Finally, Liberty-Empire included two key decisions in all alternative plans that maintain "baseline" retirements and assumptions modeled in the 2022 IRP. First, given the advanced age of the original equipment at the Riverton 10 and Riverton 11 facilities, Liberty-Empire assumed the retirement of both units in 2026.[8] To preserve the units' dual-fuel **[redacted]** capability,[9] Riverton 10 and 11 were assumed to be replaced directly at the site by dual-fuel **[redacted]**capable industrial gas combustion turbines, taking advantage of Riverton 10 and 11's existing interconnection rights at the site.

Second, Liberty-Empire assumed a retirement date of 2035 for two of its older natural gas peaking units, Energy Center 1 and 2, as in the 2022 IRP. Their potential reliability benefits, as demonstrated during Storm Uri, suggest that maintaining them until 2035 with some capital investment could help provide reliable energy services to customers. After retirement of Energy Center units 1 and 2, Liberty-Empire intends to maintain interconnection at the site by installing new resources in their place.

A summary of the 12 alternative resource plans is illustrated in Figure 6-2. The definitions of the alternative plans were presented to stakeholders and Missouri Public Service Commission staff at Stakeholder Meeting #2 on October 30, 2024.[10]

[8] 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 actually of 1960s vintage.

[9] **[redacted].**

[10] Definitions of overall concepts along with plans 1-3 and 6-12 were presented to stakeholders in October 2024. Plans 4 and 5 were subsequently added to test additional gas resource configurations.

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Figure 6-2 – Themes for the Development of Alternative Resource Plans

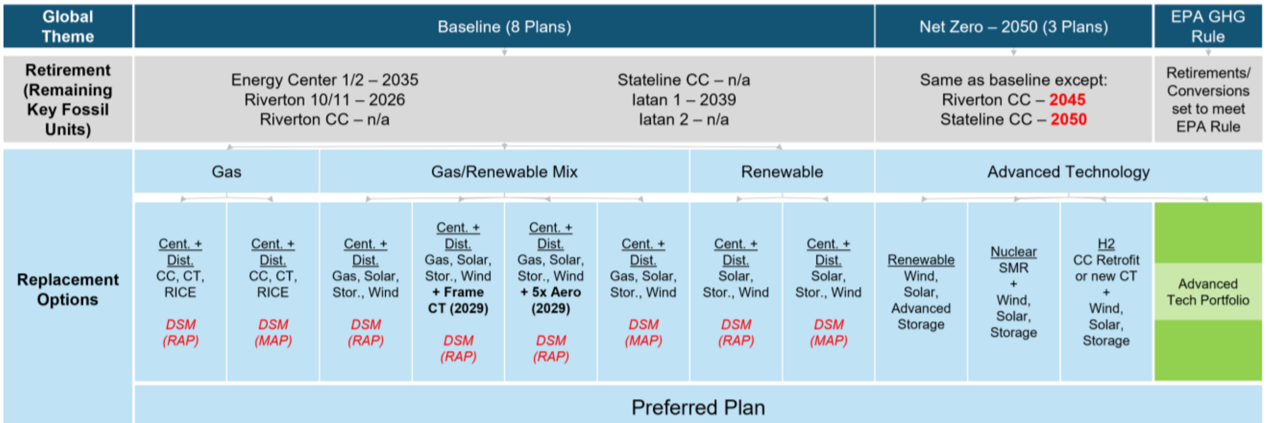


Table 6-2 provides a high-level summary of Liberty-Empire's alternative resource plans.

Table 6-2 – Summary of Alternative Resource Plans

Plan	Plan Description	Replacement Tech.	Key Retirements*	DSM Bundle
1	Gas Only – Utility-Scale + Distributed	Natural Gas		RAP
2	Gas Only – Utility-Scale + Distributed	Natural Gas		MAP
3	Gas/Renew Mix – Utility-Scale + Distributed	Natural Gas + Renew.		RAP
4	Gas/Renew Mix – Utility-Scale + Distributed + Frame CT (2029)	Natural Gas + Renew.		RAP
5	Gas/Renew Mix – Utility-Scale + Distributed + 5x Aero (2029)	Natural Gas + Renew.		RAP
6	Gas/Renew Mix – Utility-Scale + Distributed	Natural Gas + Renew.		MAP
7	Renewable – Utility-Scale + Distributed	Renewable		RAP
8	Renewable – Utility-Scale + Distributed	Renewable		MAP
9	Net Zero 2050 – Renewable + Storage	Renewable	Riverton CC 2045 Stateline CC 2050	RAP
10	Net Zero 2050 – Nuclear SMR	Nuclear + Re-newable	Riverton CC 2045 Stateline CC 2050	RAP
11	Net Zero 2050 – Hydrogen	Hydrogen + Re-newable	Riverton CC 2045 Stateline CC 2050	RAP
12	EPA GHG Rule – Advanced Tech	Advanced Tech. + Renew.	Iatan 1 2031 Iatan 2 2031 Plum Point 2031	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.

*Incremental to retirements and PPA expirations that are common across all plans:
Expiration of the Elk River Wind PPA in 2025
Expiration of the 78 MW MJMEUC Capacity Sale PPA in 2025
Retirement of Riverton 10 and 11 in 2026
Expiration of the 25 MW MJMEUC Capacity Sale PPA in 2027
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

3.2 Development of Alternative Resource Plans

3.2.1 Rule Compliant Alternative Resource Plans

1. Minimally comply with legal mandates for demand-side resources, renewable energy resources, and other mandated energy resources. This constitutes the compliance benchmark resource plan for planning purposes;

All alternative resource plans developed for the 2025 IRP consider the impact of future renewable generation requirements for Liberty-Empire. Liberty-Empire is required under 393.1030 RSMo and 20 CSR 4240-20.100 to comply with the state Renewable Energy Standard ("RES"), which is based on the total retail electric sales or the total retail electric usage that Liberty-Empire delivers each year to its Missouri retail customers. The Missouri RES requirements are summarized in Table 6-3. These values are based on a percentage of an electric utility's Missouri annual retail sales. Two percent of the RES requirement must be met with solar resources. Each eligible kilowatt-hour of energy generated within the state of Missouri counts as 1.25 kWh. Additionally, some or all of the requirements may be satisfied by purchasing Renewable Energy Credits ("RECs").

Table 6-3 – Missouri RES Requirements

Current Dates	Current RES Percentage (no less than)
2011-2013	2%
2014-2017	5%
2018-2020	10%
Beginning in 2021	15%

As of March 2025, Liberty-Empire complies with the RES by utilizing the Neosho Ridge Wind, North Fork Ridge Wind, Kings Point Wind, and Ozark Beach hydroelectric facilities alongside the Elk River Windfarm PPA, Meridian Way Windfarm PPA, and a solar component supplied by the Customer Solar Rebate program. If new renewable energy requirements are implemented in the future, the Company is in a favorable position to meet additional requirements.

Since Liberty-Empire meets the RES requirements throughout the IRP horizon with its existing resources, the company considers any alternative plan that does not incorporate additional renewable capacity during this period to be the baseline for minimal compliance with legal renewable mandates. Within the 2025 IRP, this approach is reflected in Plans 1 and 2.

To further develop an alternative plan that is also minimally compliant with legal mandates for demand-side resources, Liberty-Empire developed a “Plan 1A,” which does not allow any new DSM resources. Given that at least some level of new DSM resources was found to be cost-effective in all plans, Plan 1A was analyzed primarily for compliance purposes and only under base planning assumptions.

3.2.2 All-Renewable Resource Plan

> *2. Utilize only renewable energy resources, up to the maximum potential capability of renewable resources in each year of the planning horizon, if that results in more renewable energy resources than the minimally-compliant plan. This constitutes the aggressive renewable energy resource plan for planning purposes;*

Liberty-Empire met this planning requirement through the development of several of the alternative resource plans. Specifically, alternative resource plans 7, 8, and 9 utilize only renewable energy resources to meet capacity needs.

3.2.3 All-Demand-Side Resource Plan

> *3. Utilize only demand-side resources, up to the maximum achievable potential of demand-side resources in each year of the planning horizon, if that results in more demand-side resources than the minimally-compliant plan. This constitutes the aggressive demand-side resource plan for planning purposes;*

Alternative Resource Plans 2, 6, and 8 are designed to utilize MAP DSM programs.

3.2.4 All Other Mandated Resources Plan

> *4. In the event that legal mandates identify energy resources other than renewable energy or demand-side resources, utilize only the other energy resources, up to the maximum capability of the other energy resources in each year of the planning horizon, if that results in more of the other energy resources than the compliance benchmark*

resource plan. For planning purposes, this constitutes the aggressive legally-mandated other energy resource plan;

No other legal mandates were identified. Liberty-Empire are mandated to address special contemporary issues which are found in Section 8 of Volume 6.

3.2.5 Optimally Compliant DSM, Renewable, and Other Targeted Resource Plans

5. Optimally comply with legal mandates for demand-side resources, renewable energy resources, and other targeted energy resources. This constitutes the optimal compliance resource plan, where every legal mandate is at least minimally met, but some resources may be optimally utilized at levels greater than the mandated minimums;

As discussed in Section 3.2.1, all alternative plans developed by Liberty-Empire comply with minimum legal mandates for demand-side resources, renewable energy resources, and other targeted energy resources.

3.2.6 Special Contemporary Issue Plan

6. Any other plan specified by the commission as a special contemporary issue pursuant to 4 CSR 240-22.080(4);

In Docket No. EO-2025-0079, the Commission issued an order on October 23, 2024, effective November 2, 2024, establishing nine (9) special contemporary planning issues for Liberty-Empire to analyze and document in its 2025 triennial Integrated Resource Plan. These issues are addressed in Section 8 of this volume. The commission specified no other plans incremental to those defined in Section 3.1 in the special contemporary issues.

3.2.7 Other Commission-Specified Plans

7. Any other plan specified by commission order; and

The Commission order specified no other plans, other than those addressing the special contemporary issues (SCI C in Section 8 of Volume 6).

3.2.8 Other Utility-Suggested Plans

8. Any additional alternative resource plans that the utility deems should be analyzed.

Including the alternative plans specified in 20 CSR 4240-22.060(3)(A) discussed in Sections 3.2.1 through 3.2.7, Liberty-Empire developed and analyzed a total of 12 alternative plans that tested for contributions from a variety of future resources. The rationale and definition of these alternative plans are described in Section 3.1. These 12 alternative resource plans collectively provide a reasonable basis of information for Commission and stakeholder review. In addition to the 12 alternative resource plans, Liberty-Empire is considering a contingency without the assumed 175 MW firm solar addition in 2028 which would add a modest amount of incremental gas in the 2030's to offset lower solar capacity.

3.2.9 Load-Building Programs in Plans

(B) The alternative resource plans developed at this stage of the analysis shall not include load-building programs, which shall be analyzed as required by 4 CSR 240-22.070(5).

No load-building plans were included in any of Liberty-Empire's alternative resource plans.

3.2.10 Potential Retirement or Life Extension of Existing Generating Plants

(C) The utility shall include in its development of alternative resource plans the impact of—

1. The potential retirement or life extension of existing generation plants;

Riverton 10 and 11 were assumed to retire in 2026 and Energy Center 1 and 2 were assumed to retire in 2035 in all alternative plans. Iatan unit 1 was assumed to retire in 2039 in plans 1 through 11, whereas both Iatan units 1 and 2 along with Plum Point were assumed to retire in 2032 in plan 12. Table 6-2 summarizes the retirement assumptions for all other existing generation plants across all alternative plans.

3.2.11 Additions of Environmental Equipment at Generating Plants

2. The addition of equipment and other retrofits on generation plants to meet environmental requirements; and

During the planning period for this IRP, Liberty-Empire's existing supply-side resources are expected to undergo no other major upgrades or require additional environmental equipment.

3.2.12 Conclusion of Any Currently-Implemented DSM Resources

3. The conclusion of any currently-implemented demand-side resources.

Previously, Liberty-Empire offered a demand-side portfolio in each state it served (Missouri, Arkansas, Kansas, and Oklahoma). Currently, Liberty-Empire offers demand-side programs in Missouri and Arkansas only. DSM customer programs began in Missouri in mid-2007 and Arkansas in October 2007. Customer programs that began in Oklahoma in 2010 were discontinued on May 1, 2014 (Order No. 624718 in Oklahoma PUC Cause No. PUD 201300203), and the three-year Kansas pilot program that began in June 2010 concluded in June 2013. In its previous general rate case before the Oklahoma Corporation Commission, filed in PUD Case No. 202100163, Liberty-Empire expressed a desire and willingness to begin offering DSM programs in Oklahoma again. As of March 2025, Liberty-Empire does not offer demand-side programs in Kansas or Oklahoma.

In January 2022, Liberty-Empire began offering its first portfolio of programs under the regulatory framework prescribed by the Missouri Energy Efficiency Investment Act (“MEEIA”). At the time of inception, Liberty-Empire’s portfolio represented a three-fold increase in its investment in energy efficiency in its Missouri service territory. The first cycle of the MEEIA (“MEEIA Cycle 1”) was intended to run for one year through December 31, 2022, but the State of Missouri Public Commission approved an extension of Liberty-Empire’s MEEIA Cycle 1 through December 31, 2024. On December 13, 2024, Liberty-Empire reached an agreement with multiple parties to extend their MEEIA Cycle 1 for a third time, through March 31, 2025, while Liberty-Empire works on a MEEIA Cycle 2 application or settlement (Missouri PSC Docket EO-2022-0078). This agreement extends the terms of Liberty-Empires' current MEEIA tariffs without change to the tariff language and without additional budget. The agreement also contemplates Liberty-Empire submitting their MEEIA Cycle 2 filing with a proposal for a two-year cycle for energy efficiency programs and a three-year cycle for demand response programs. According to the agreement, Liberty-Empire's MEEIA Cycle 2 would commence on April 1, 2025.

The current Missouri and Arkansas DSM programs are shown in Table 6-4 below. Currently, Liberty-Empire has an Energy Efficiency Cost Recovery rider in Arkansas that was designed to recover the full cost of implementing energy efficiency programs with an annual rate reconfiguration. Liberty-Empire also has a cost-recovery mechanism in Missouri, as the MEEIA rule prescribes. This Demand-Side Investment Mechanism ("DSIM") allows Liberty-Empire to comprehensively recover the costs of delivering energy efficiency programs.

Table 6-4 – Demand-Side Programs by State

Missouri	Arkansas
Residential Efficient Products	Residential Products
Low-Income Weatherization	School Based Energy Education
Low-Income Multi-Family	Residential Weatherization
HVAC Rebate	C&I Prescriptive
Pay As You Save ("PAYS")	C&I Custom
Small Business Direct Install ("SBDI")	Online Energy Calculator
Commercial and Industrial Rebate Program	Marketplace – Limited Time Offers

3.2.13 Description of Alternative Resource Plans

(D) The utility shall provide a description of each alternative resource plan including the type and size of each demand-side resource and supply-side resource addition and a listing of the sequence and schedule for the end of life of existing resources and for the acquisition of each new resource.

Liberty-Empire developed 12 alternative resource plans for purposes of the 2025 IRP analysis. Eight of the 12 alternative resource plans assumed "baseline" (i.e., age-based) retirement dates and expected PPA expirations for the existing resources in Liberty-Empire's portfolio. Three of the remaining four plans were designed to achieve net zero scope 1 and 2 carbon emissions by 2050 and include the retirement or retrofit of Liberty-Empire's two existing gas CCs, Riverton 12 and State Line CC, in 2045 and 2050, respectively. The final plan was designed to meet the EPA's GHG rule, issued under section 111 of the Clean Air Act. This alternative resource plan involves retiring all coal units by 2032 while capping any new combined cycle gas turbine and single cycle gas turbine units at 40% and 20% capacity factor, respectively.

In all plans, Riverton 10 and 11 were assumed to retire in 2026 and to be replaced directly at the site by 27 MW of dual-fuel capable industrial gas combustion turbines. Energy Center 1 and 2 will be retired in 2035. Iatan unit 1 was assumed to retire in 2039 in plans 1 through 11, whereas both Iatan units 1 and 2 along with Plum Point were assumed to retire in 2032 in plan 12. However, new resources added after 2035 can be located at the Energy Center site to avoid incremental interconnection costs up to the 175 MW left vacant by the retiring units.

On top of the assumed retirements of the existing resources, each resource portfolio was subject to constraints on resource acquisition strategy, which defined the type of resources that could be added to the portfolio over the IRP study period. The "baseline" portfolios included plans that allowed the addition of only thermal resources versus only renewable and storage 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 assumed to be replaced by a combination of renewables and emerging technologies such as advanced storage, nuclear SMR, and/or hydrogen.

The following is a summary of the 12 alternative resource plans modeled by Liberty-Empire[11]:

- Plan 1 (Utility- and Distributed-Scale Natural Gas + RAP DSM): Plan 1 was developed to analyze the value of a portfolio that utilizes only natural gas-fueled options for resource replacement. Specifically, this plan assesses the value of building some level of natural gas located on the lower-voltage distribution

[11] In addition to the resources described below, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028).

system in addition to new capacity additions being located on the transmission system (referred to as "utility scale" throughout). Liberty-Empire identified four main thermal units available as potential resource options: natural gas combined cycle, natural gas frame combustion turbine, natural gas reciprocating internal combustion engine ("RICE"), and aeroderivative natural gas combustion turbine. Plan 1 adds 200 MW of utility-scale aeroderivative natural gas by 2032, 240 MW of utility-scale natural gas frame combustion turbines by 2036, and 40 MW of distributed-scale natural gas RICE by 2044. Plan 1 also adds the low-, mid-, and high-cost bundles of RAP DSM.

- Plan 2 (Utility-Scale and Distributed-Scale Natural Gas Mix + MAP DSM): Plan 2 was developed to analyze the same combination of available utility and distributed-scale natural gas-fueled options for resource replacement as in Plan 1, although with MAP DSM instead of RAP. Plan 2 adds 200 MW of utility-scale aeroderivative natural gas by 2041, 240 MW of utility-scale natural gas frame combustion turbines by 2036, and 86 MW of distributed-scale natural gas RICE by 2044. Plan 2 also adds the low-, mid-, and high-cost bundles of MAP DSM.

- Plan 3 (Utility- and Distributed-Scale Natural Gas and Renewable Mix + RAP DSM): Plan 3 was developed to assess the value of a portfolio which utilizes a combination of natural gas-fueled and renewable options at the utility and distributed scale for resource replacement. Liberty-Empire identified several types of utility-scale renewable technologies that were available as potential resource options: wind, solar, 4-hour lithium-ion battery storage, and 8-hour lithium-ion battery storage. Plan 3 adds 250 MW of utility-scale aeroderivative natural gas by 2041, 240 MW of utility-scale natural gas frame combustion turbines by 2036, and 16 MW of distributed-scale natural gas RICE by 2034. Plan 3 also adds 300 MW of utility-scale solar by 2044 and 6 MW of distributed-scale 4-hour lithium-ion battery storage by 2034. Plan 3 adds the low-, mid-, and high-cost bundles of RAP DSM.

- Plan 4 (Utility- and Distributed-Scale Natural Gas and Renewable Mix + RAP

DSM + Frame CT 2029): Plan 4 was developed to analyze the availability of the same diverse combinations of gas and renewable resources as in Plan 3 while taking advantage of SPP's Expedited Resource Adequacy Study ("ERAS").[12] This process would allow for utilities to select any generation resource for a special one-time study conducted outside the regular generator interconnection ("GI") study queue, and requests accepted into the study will have priority over all GI requests without signed agreements. Plan 4 is designed to optimize resource replacement around 240 MW of utility-scale natural gas frame combustion turbines added in 2029 under ERAS. By 2044, Plan 4 adds a total of 480 MW of utility-scale natural gas frame combustion turbines (including the ERAS addition), 300 MW of utility-scale solar, 28 MW of distributed-scale natural gas RICE, and 1 MW of distributed-scale 4-hour lithium-ion battery storage. Plan 4 also adds the low-, mid-, and high-cost bundles of RAP DSM.

- Plan 5 (Utility- and Distributed-Scale Natural Gas and Renewable Mix + RAP DSM + 5x Aero 2029): Plan 5 was developed to analyze the availability of the same diverse combinations of gas and renewable resources and SPP's ERAS as in Plan 4, although with 250 MW of utility-scale aeroderivative natural gas instead of 240 MW of natural gas frame combustion turbines. In addition to the ERAS-driven additions, Plan 5 adds 240 MW of utility-scale natural gas frame combustion turbines in 2036. By 2044, Plan 5 also adds 250 MW of utility-scale solar and 22 MW of distributed-scale natural gas RICE. Plan 5 also adds the low-, mid-, and high-cost bundles of RAP DSM.

- Plan 6 (Utility- and Distributed-Scale Natural Gas and Renewable Mix + MAP DSM): Plan 6 was developed to analyze the availability of the same diverse combinations of gas and renewable resources located at both the utility and distributed scale as in Plan 3, although with MAP DSM instead of RAP. Plan 6 adds 200 MW of utility-scale aeroderivative natural gas by 2041, 240 MW of

[12] May be commissioned by 2029 with provision of the Expedited Resource Addition Study (ERAS) recently endorsed by SPP, which creates a one-time study process to expedite the interconnection of new generation projects to meet resource adequacy needs

utility-scale natural gas frame combustion turbines by 2036, and 52 MW of distributed-scale natural gas RICE by 2043. Plan 6 also adds 300 MW of utility-scale solar and 4 MW of distributed-scale 4-hour lithium-ion battery storage by 2044. Plan 6 adds the low-, mid-, and high-cost bundles of MAP DSM.

- Plan 7 (Utility- and Distributed-Scale Renewable Mix + RAP DSM): Plan 7 was developed to assess the value of a portfolio which includes only utility and distributed scale renewable options for resource replacement. Plan 7 adds 500 MW of utility-scale solar, 30 MW of distributed-scale solar, 550 MW of utility-scale 4-hour lithium-ion battery storage, 16 MW of distributed-scale 4-hour lithium-ion battery storage, and 100 MW of utility-scale 8-hour lithium-ion battery storage by 2035. By 2044, Plan 7 includes 850 MW of utility-scale 4-hour lithium-ion battery storage and 300 MW of utility-scale 8-hour lithium-ion battery storage. Plan 7 also adds the mid-cost and DSR bundles of RAP DSM.

- Plan 8 (Utility- and Distributed-Scale Renewable Mix + MAP DSM): Plan 8 was developed to analyze the same combination of available utility and distributed scale renewable options for resource replacement as for Plan 7, although with MAP DSM instead of RAP. Plan 8 adds 500 MW of utility-scale solar, 20 MW of distributed-scale solar, 550 MW of utility-scale 4-hour lithium-ion battery storage, 16 MW of distributed-scale 4-hour lithium-ion battery storage, and 100 MW of utility-scale 8-hour lithium-ion battery storage by 2035. By 2044, Plan 8 includes 800 MW of utility-scale 4-hour lithium-ion battery storage and 300 MW of utility-scale 8-hour lithium-ion battery storage. Plan 8 also adds the mid-cost and DSR bundles of MAP DSM.

- Plan 9 (Net Zero 2050, Renewable): Plan 9 was developed to analyze a portfolio that achieves net zero carbon emissions by 2050 using utility scale and distributed renewables and advanced storage options (i.e., lithium-ion battery, flow, or gravity storage) as replacements. Net zero by 2050 requires the retirement of combined cycle gas units at Riverton in 2045 and State Line in 2050, in addition to the other baseline resource retirements. While these retirements are outside of the core IRP study period of 2025-2044, they were still evaluated with renewables and advanced storage replacements. During the study period, Plan 9 adds 500 MW of utility-scale solar, 30 MW of distributed-scale solar, 50 MW of utility-scale 4-hour lithium-ion battery storage, and 6 MW of distributed-scale 4-hour lithium-ion battery storage by 2030. By 2044, Plan 9 also includes 300 MW utility-scale flow battery storage and 200 MW of distributed-scale gravity battery storage. Plan 9 also adds the mid-cost and DSR bundles of RAP DSM.

- Plan 10 (Net Zero 2050, Nuclear SMR and Renewables): Plan 10 was developed to analyze a portfolio that achieves net zero carbon emissions by 2050 using nuclear SMR supplemented by renewables and advanced storage. Net zero by 2050 requires the retirement of combined cycle gas units at Riverton in 2045 and State Line in 2050, in addition to the other baseline resource retirements. While these retirements are outside of the core IRP study period of 2025-2044, they were still evaluated with nuclear SMR, renewables, and advanced storage replacements. During the study period, Plan 10 adds 500 MW of utility-scale solar, 60 MW of distributed-scale solar, 50 MW of utility-scale 4-hour lithium-ion battery storage, 8 MW of distributed-scale 4-hour lithium-ion battery storage, and 100 MW of utility-scale wind by 2031. Plan 10 also adds 100 MW of distributed-scale 8-hour lithium-ion battery storage by 2035 and 300 MW of nuclear SMR in 2036. By 2044, Plan 10 includes 450 MW of utility-scale 4-hour lithium-ion battery storage and 300 MW of utility-scale 8-hour lithium-ion battery storage. Plan 10 also adds the low-cost, mid-cost, high-cost and DSR bundles of RAP DSM.

- Plan 11 (Net Zero 2050, Hydrogen and Renewables): Plan 11 was developed to analyze a portfolio that achieves net zero carbon emissions by 2050 using 100% hydrogen fuel in a new combined cycle or a new combustion turbine supplemented by utility scale renewables and advanced storage. Net zero by 2050 requires the retirement of combined cycle gas units at Riverton in 2045 and State Line in 2050, in addition to the other baseline resource retirements. While these retirements are outside of the core IRP study period of 2025-2044, they were still evaluated with replacement by a new 100% hydrogen-fired CC. The hydrogen-fired CC is assumed to operate at the same 50-60% annual average capacity factor as the natural gas-fired CCs. During the study period, Plan 11 adds 500 MW of utility-scale solar, 30 MW of distributed-scale solar, 550 MW of utility-scale 4-hour lithium-ion battery storage, 16 MW of distributed-scale 4-hour lithium-ion battery storage, and 100 MW of utility-scale wind by 2035. By 2044, Plan 11 includes 850 MW of utility-scale 4-hour lithium-ion battery storage and 300 MW of utility-scale wind. Plan 11 also adds the mid-cost and DSR bundles of RAP DSM.

- Plan 12 (EPA GHG Rule, Advanced Technology): Plan 12 was developed to analyze a portfolio that meets the EPA's final version of its Greenhouse Gas (GHG) rule, issued under section 111 of the Clean Air Act. The plan involves retiring all coal by 2032. Additionally, new combined cycle gas turbine and single cycle gas turbine units are capped at 40% and 20% capacity factors, respectively, while existing gas units remain unchanged. To meet these requirements, Plan 12 considers utility scale and distribution-scale thermal units (i.e., natural gas combined cycle, natural gas frame combustion turbine, natural gas RICE, or aeroderivative natural gas combustion turbine), renewables, and advanced storage options (i.e., lithium-ion battery, flow, or gravity storage). Plan 12 retires all existing coal units by 2032, including Iatan 1 and 2, Liberty-Empire's owned portion of Plum Point, and the Plum Point PPA. Plan 10 adds 150 MW of utility-scale aeroderivative natural gas, 240 MW of utility-scale natural gas frame combustion turbine, 200 MW of utility-scale solar by 2032. By 2044, Plan 12 includes 480 MW of utility-scale natural gas frame combustion turbine, 2 MW of distributed-scale natural gas RICE, and 3 MW of distributed-scale 4-hour lithium-ion battery storage. Plan 12 also adds the low-, mid-, and high-cost bundles of RAP DSM.

As mentioned previously, in addition to the 12 alternative plans, Liberty-Empire developed one compliance benchmark plan based on Plan 1, which assumes no new renewables and no new DSM resources are added. The compliance benchmark plan is called “Plan 1A”. Furthermore, the IRP analyzed potential large load growth scenarios (e.g., data center load) as part of the special contemporary issues and considered a special contingency plan if the 2028 solar project does not materialize. However, those are not considered part of the basic IRP set of plans presented in the following sections.

3.2.14 Schedule of Alternative Resource Plan Supply-Side Additions

The following tables summarize the demand-side and supply-side resource additions in each of Liberty-Empire’s alternative resource plans.

Table 6-5 – ICAP Capacity Additions for Plans 1 through 2

	Plan 1	Plan 1A	Plan 2
2025			
2026			
2027	RAP DSM (Low-, Mid-, and High-Cost Bundles)		MAP DSM (Low-, Mid-, and High-Cost Bundles)
2028			
2029	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)
2030			
2031		Dist. RICE (10 MW)	Dist. RICE (10 MW)
2032	Gas Aero (50 MW)	Dist. RICE (10 MW)	Dist. RICE (10 MW)
2033		Dist. RICE (10 MW)	Dist. RICE (10 MW)
2034		Dist. RICE (2 MW)	Dist. RICE (2 MW)
2035		Dist. RICE (6 MW)	Dist. RICE (6 MW)
2036	Gas Frame CT (240 MW)	Gas Frame CT (240 MW)	Gas Frame CT (240 MW)
2037			
2038			
2039		Dist. RICE (2 MW)	Dist. RICE (2 MW)
2040	Dist. RICE (6 MW)	Dist. RICE (10 MW)	Dist. RICE (10 MW)
2041	Gas Aero (50 MW); Dist. RICE (10 MW)	Gas Aero (50 MW); Dist. RICE (10 MW)	Gas Aero (50 MW); Dist. RICE (10 MW)
2042	Dist. RICE (4 MW)	Dist. RICE (6 MW)	Dist. RICE (6 MW)
2043	Dist. RICE (10 MW)	Dist. RICE (10 MW)	Dist. RICE (10 MW)
2044	Dist. RICE (10 MW)	Dist. RICE (10 MW)	Dist. RICE (10 MW)

Note – In addition to the resources above, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028)

Table 6-6 – ICAP Capacity Additions for Plans 3 through 5

	Plan 3	Plan 4	Plan 5
2025			
2026			
2027	RAP DSM (Low-, Mid-, and High-Cost Bundles)	RAP DSM (Low-, Mid-, and High-Cost Bundles)	RAP DSM (Low-, Mid-, and High-Cost Bundles)
2028			
2029	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)	Gas Frame CT (240 MW)	Gas Aero (250 MW)
2030			
2031			
2032	Dist. RICE (10 MW); Dist. Storage (2 MW)		
2033	Utility-Scale Solar (150 MW); Dist. RICE (4 MW); Dist. Storage (2 MW)		
2034	Dist. RICE (2 MW); Dist. Storage (2 MW)		
2035	Utility-Scale Solar (50 MW)	Utility-Scale Solar (150 MW)	Utility-Scale Solar (150 MW)
2036	Gas Frame CT (240 MW)	Gas Frame CT (240 MW)	Gas Frame CT (240 MW)
2037			
2038			
2039			
2040	Gas Aero (50 MW)		
2041	Gas Aero (50 MW)	Utility-Scale Solar (150 MW); Dist. RICE (2 MW)	Utility-Scale Solar (50 MW)
2042		Dist. RICE (8 MW)	Dist. RICE (6 MW)
2043		Dist. RICE (8 MW); Dist. Storage (1 MW)	Utility-Scale Solar (50 MW); Dist. RICE (6 MW)
2044	Utility-Scale Solar (100 MW)	Dist. RICE (10 MW)	Dist. RICE (10 MW)

Note – In addition to the resources above, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028)

Table 6-7 – ICAP Capacity Additions for Plans 6 through 8

	Plan 6	Plan 7	Plan 8
2025			
2026			
2027	MAP DSM (Low-, Mid-, and High-Cost Bundles)	RAP DSM (Mid-Cost and DSR Bundles); Utility-Scale Solar (300 MW); Dist. Solar (10 MW)	MAP DSM (Mid-Cost and DSR Bundles); Utility-Scale Solar (300 MW); Dist. Solar (10 MW)
2028		Utility-Scale Solar (200 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Utility-Scale Solar (200 MW); Dist. Storage (2 MW)
2029	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)	Dist. Solar (10 MW); Dist. Storage (2 MW)	Dist. Solar (10 MW); Dist. Storage (2 MW)
2030		Li-Ion 4hr (50 MW); Dist. Storage (2 MW)	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)
2031		Li-Ion 4hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2032	Dist. RICE (6 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2033	Utility-Scale Solar (100 MW); Dist. RICE (10 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2034	Dist. RICE (2 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW);	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2035	Utility-Scale Solar (50 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)
2036	Gas Frame CT (240 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)
2037		Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW);
2038		Dist. Storage (2 MW)	Dist. Storage (2 MW)
2039		Li-Ion 4hr (50 MW); Dist. Storage (2 MW)	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)
2040	Utility-Scale Solar (100 MW); Dist. RICE (8 MW)	Li-Ion 4hr (50 MW)	
2041	Gas Aero (50 MW); Utility-Scale Solar (50 MW); Dist. RICE (8 MW)	Li-Ion 4hr (50 MW)	
2042	Dist. RICE (8 MW)		
2043	Dist. RICE (10 MW)		
2044	Dist. RICE (10 MW)		

Note – In addition to the resources above, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028)

Table 6-8 – ICAP Capacity Additions for Plans 9 through 11

	Plan 9	Plan 10	Plan 11
2025			
2026			
2027	RAP DSM (Mid-Cost and DSR Bundles); Utility-Scale Solar (300 MW); Dist. Solar (10 MW)	RAP DSM (All Bundles); Utility-Scale Solar (50 MW); Dist. Solar (20 MW)	RAP DSM (Mid-Cost and DSR Bundles); Utility-Scale Solar (300 MW); Dist. Solar (10 MW)
2028	Utility-Scale Solar (200 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Dist. Solar (10 MW); Dist. Storage (2 MW)	Utility-Scale Solar (200 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)
2029	Dist. Solar (10 MW); Dist. Storage (2 MW)	Utility-Scale Solar (300 MW); Utility-Scale Wind (100 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Dist. Solar (10 MW); Dist. Storage (2 MW)
2030	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)	Utility-Scale Solar (150 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)
2031	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (50 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2032	Li-Ion 4hr (100 MW)	Li-Ion 4hr (50 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2033	Li-Ion 4hr (100 MW)	Dist. Solar (10 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2034	Li-Ion 4hr (100 MW)	Dist. Solar (10 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Dist. Storage (2 MW)
2035	Flow Battery (100 MW); Gravity Storage (100 MW); Li-Ion 4hr (100 MW)	Li-Ion 8hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)
2036	Flow Battery (100 MW); Gravity Storage (100 MW)	Nuclear SMR (300 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)
2037		Li-Ion 4hr (50 MW); Dist. Storage (2 MW)	Li-Ion 4hr (100 MW); Li-Ion 8hr (100 MW); Dist. Storage (2 MW)
2038	Li-Ion 4hr (50 MW)	Dist. Storage (2 MW)	Dist. Storage (2 MW)
2039	Li-Ion 4hr (50 MW)	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)	Dist. Storage (2 MW); Li-Ion 4hr (50 MW)
2040		Li-Ion 4hr (100 MW); Li-Ion 8hr (50 MW)	Li-Ion 4hr (50 MW); Dist. Storage (2 MW)
2041		Li-Ion 4hr (100 MW); Li-Ion 8hr (50 MW)	Li-Ion 4hr (50 MW)
2042		Dist. Storage (1 MW)	
2043		Li-Ion 4hr (50 MW); Dist. Storage (1 MW)	
2044	Flow Battery (100 MW)		

Note – In addition to the resources above, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028)

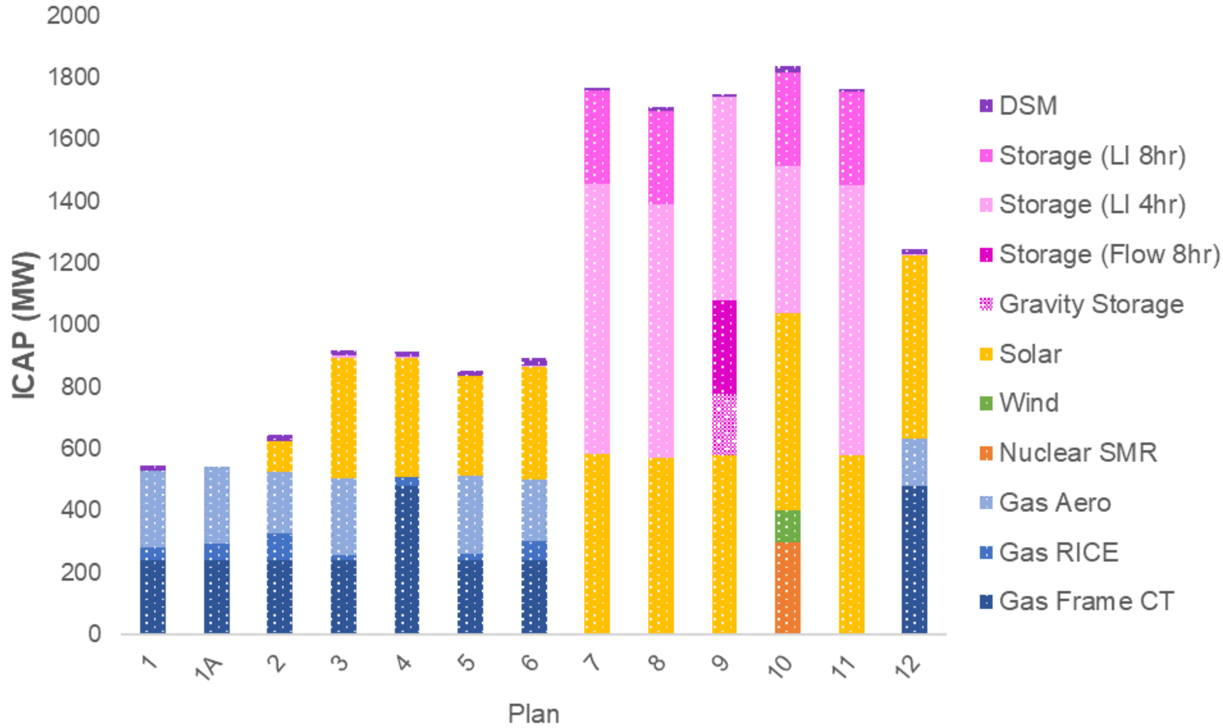
Table 6-9 – ICAP Capacity Additions for Plan 12

	Plan 12
2025	
2026	
2027	RAP DSM (Low-, Mid-, and High-Cost Bundles)
2028	
2029	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site)
2030	
2031	Dist. Storage (1 MW)
2032	Gas Frame CT (240 MW); Utility-Scale Solar (200 MW); Dist. Storage (2 MW)
2033	Utility-Scale Solar (200 MW); Dist. RICE (2 MW)
2034	Utility-Scale Solar (50 MW)
2035	Utility-Scale Solar (100 MW)
2036	Gas Frame CT (240 MW)
2037	
2038	
2039	
2040	
2041	
2042	
2043	
2044	

Note – In addition to the resources above, all plans include near-term firm additions established as a part of previous planning (27 MW gas CT at Riverton site in 2026, 175 MW solar in 2028)

The capacity additions shown in the above tables are presented in Figure 6-3, compared on a cumulative installed capacity basis by 2044.

Figure 6-3 – Cumulative ICAP Capacity Additions for all Plans by 2044



3.2.15 Schedule of Alternative Resource Plan Retirements

Table 6-10 presents the existing plant retirement assumptions for Liberty-Empire's alternative resource plans. The listed retirement year reflects a retirement effective as of December 31 of that year, unless otherwise noted.

Table 6-10 – Alternative Resource Plan Retirement Assumptions

<table>
<tr><th>Plan</th><th>Empire Energy Center 1 and 2</th><th>Riverton 10 and 11</th><th>Iatan 1</th><th>Iatan 2</th><th>Riverton CC</th><th>Stateline CC</th><th>Empire Plum Point</th><th>Plum Point PPA</th></tr>
<tr><td>Plan 1</td><td rowspan="12">2035</td><td rowspan="12">2026[13]</td><td rowspan="11">2039</td><td rowspan="11">n/a</td><td rowspan="8">n/a</td><td rowspan="8">n/a</td><td rowspan="11">n/a</td><td rowspan="11">2040</td></tr>
<tr><td>Plan 2</td></tr>
<tr><td>Plan 3</td></tr>
<tr><td>Plan 4</td></tr>
<tr><td>Plan 5</td></tr>
<tr><td>Plan 6</td></tr>
<tr><td>Plan 7</td></tr>
<tr><td>Plan 8</td></tr>
<tr><td>Plan 9</td><td rowspan="3">2044</td><td rowspan="3">2049</td></tr>
<tr><td>Plan 10</td></tr>
<tr><td>Plan 11</td></tr>
<tr><td>Plan 12</td><td>2031</td><td>2031</td><td>n/a</td><td>n/a</td><td>2031</td><td>2031</td></tr>
</table>

Table 6-11 shows the summer and winter ACAP ratings of the existing units assumed to retire during the IRP horizon. The accredited capacity for thermal resources is determined based on Southwest Power Pool ("SPP") criteria and is subject to re-rating from time to time.

Table 6-11 – ACAP of Retiring Existing Units

Unit	Summer Accredited Capacity (ACAP MW)	Winter Accredited Capacity (ACAP MW)
Energy Center 1	80	90
Energy Center 2	82	92
Riverton 10	13	16
Riverton 11	0	0
Iatan 1	84	84
Iatan 2	105	105
Riverton 12	247	287
State Line CC	316	346
Empire Plum Point	50	50
Plum Point PPA	50	50

[13] Riverton 10 and 11 retirement modeled for late 2026.

3.2.16 Schedule of Expiration of Liberty-Empire PPAs

Table 6-12 provides the sequence and schedule for the summer capacity accreditation of Liberty-Empire's PPA resources. Table 6-13 provides the sequence and schedule for the winter capacity accreditation of Liberty-Empire's PPA resources.[14]

In August of 2022, FERC approved SPP's proposal to determine the accreditation for wind and solar resources using the Effective Load Carrying Capability ("ELCC") methodology. ELCC is defined as the amount of incremental load that a resource can reliably serve while accounting for the probabilistic nature of generation shortfalls and random forced outages. It is an industry-wide accepted methodology for determining the capacity value of resources. In February 2024, SPP proposed a set of accreditation reforms to address deficiencies identified by FERC and a coalition of clean energy advocates. The proposal seeks to adopt an ELCC methodology for wind, solar, and energy storage resources and a performance-based accreditation ("PBA") methodology for thermal and other conventional resources. In August 2024, SPP issued a report with guidance about the ELCC levels for wind and solar. The ELCC methodology was used to calculate the accredited capacity value for wind and solar resources throughout the IRP study period.

Liberty-Empire also included a 78 MW system sale representing the Company's five-year PPA with the Missouri Joint Municipal Utility Commission ("MJMEUC") for capacity and energy beginning June 1, 2020, and ending May 31, 2025. The capacity sale is based on a "slice of Liberty-Empire system" approach, with a total capacity sale of 78 MW during the agreement period. An extension for a capacity sale of 25 MW will begin May 31, 2025, and run through June 1, 2027.

[14] These tables reflect capacity accreditation for Liberty-Empire's PPA resources for Plans 1-11 only. To comply with the GHG rule modeled in Plan 12, Plum Point is assumed to retire by 2032, including Liberty-Empire's existing PPA.

Table 6-12 – Liberty-Empire Renewable PPAs (Summer ACAP)

	Elk River Wind PPA	Meridian Way Wind PPA	Plum Point PPA	MJMEUC PPA
2024	17	7	50	-78
2025	17	7	50	-25
2026	0	11.8	45	-25
2027	0	11.8	45	0
2028	0	11.8	45	0
2029	0	0	45	0
2030	0	0	45	0
2031	0	0	45	0
2032	0	0	45	0
2033	0	0	45	0
2034	0	0	45	0
2035	0	0	45	0
2036	0	0	45	0
2037	0	0	45	0
2038	0	0	45	0
2039	0	0	45	0
2040	0	0	45	0
2041	0	0	0	0
2042	0	0	0	0
2043	0	0	0	0

Table 6-13 – Liberty-Empire Renewable PPAs (Winter ACAP)

	Elk River Wind PPA	Meridian Way Wind PPA	Plum Point PPA	MJMEUC PPA
2024	18	10	50	-78
2025	18	10	50	-25
2026	0	22.4	41.3	-25
2027	0	22.4	41.3	-25
2028	0	22.4	41.3	0
2029	0	0	41.3	0
2030	0	0	41.3	0
2031	0	0	41.3	0
2032	0	0	41.3	0
2033	0	0	41.3	0
2034	0	0	41.3	0
2035	0	0	41.3	0
2036	0	0	41.3	0
2037	0	0	41.3	0
2038	0	0	41.3	0
2039	0	0	41.3	0
2040	0	0	41.3	0
2041	0	0	0	0
2042	0	0	0	0
2043	0	0	0	0

3.2.17 Schedule of Wind Additions

Table 6-14 and Table 6-15 illustrate the capacity accreditation values for Liberty-Empire's owned wind additions. As described in Volume 4, 600 MW of wind resources were added in 2020 and 2021.

Table 6-14 – Liberty-Empire Renewable Intermittent Resources (Summer ACAP)

	Neosho Wind	North Fork Ridge Wind	Kings Point Wind
2024	47.00	21.00	12.00
2025	47.00	21.00	12.00
2026	30.30	18.30	14.80
2027	33.41	19.01	16.39
2028	36.52	19.73	17.98
2029	39.63	20.44	19.57
2030	42.74	21.16	21.16
2031	42.44	21.01	21.01
2032	42.44	21.01	21.01
2033	42.14	20.86	20.86
2034	42.14	20.86	20.86
2035	41.84	20.71	20.71
2036	41.84	20.71	20.71
2037	41.54	20.56	20.56
2038	41.54	20.56	20.56
2039	41.54	20.56	20.56
2040	41.54	20.56	20.56
2041	41.54	20.56	20.56
2042	41.24	20.41	20.41
2043	41.24	20.41	20.41

Table 6-15 – Liberty-Empire Renewable Intermittent Resources (Winter ACAP)

	Neosho Wind	North Fork Ridge Wind	Kings Point Wind
2024	50.00	18.00	10.00
2025	50.00	18.00	10.00
2026	78.40	42.60	40.40
2027	76.26	40.59	38.94
2028	74.12	38.58	37.48
2029	71.97	36.58	36.03
2030	69.83	34.57	34.57
2031	69.53	34.42	34.42
2032	68.93	34.12	34.12
2033	68.63	33.97	33.97
2034	68.33	33.82	33.82
2035	68.03	33.67	33.67
2036	67.73	33.53	33.53
2037	67.42	33.38	33.38
2038	67.42	33.38	33.38
2039	67.42	33.38	33.38
2040	67.12	33.23	33.23
2041	67.12	33.23	33.23
2042	66.82	33.08	33.08
2043	66.82	33.08	33.08

3.2.18 DSM Utilized in Alternative Resource Plans

As part of developing the alternative resource plans, several demand-side programs were evaluated as equivalent to the supply-side resources. The analysis of the DSM programs is described in detail in Volume 5. DSM measures screened for inclusion in a DSM program were bundled and evaluated in the integrated portfolio modeling. A summary of the demand-side program bundles is below:

Table 6-16 – Description of DSM IRP Bundles

DSM	Program Bundle	Description
RAP	Low Cost	Programs with a five-year average $/kWh saved between $0.20 to $0.40 per kWh. Includes: • Commercial Custom • Commercial Prescriptive
	Mid Cost	Programs with a five-year average $/kWh saved between $0.40 to $0.55 per kWh. Includes: • Residential Prescriptive
	High Cost	Programs with a five-year average $/kWh saved above $0.55 per kWh. Includes: • SBDI • Income Eligible Lighting
	Demand Side Rates ("DSR")	DR and DSR programs. Includes: • Time of Use Rate (Res & Non-Res) • Critical Peak Pricing (Res & Non-Res) • DLC Battery Storage (Res & Non-Res) • DLC Smart Thermostat (Res & Non-Res) • DLC Smart Appliances • Grid-Interactive Water Heater (Res & Non-Res)
MAP	Low Cost	Programs with a five-year average $/kWh saved between $0.20 to $0.40 per kWh. Includes: • Commercial Custom • Commercial Prescriptive
	Mid Cost	Programs with a five-year average $/kWh saved between $0.40 to $0.55 per kWh. Includes: • Residential Prescriptive
	High Cost	Programs with a five-year average $/kWh saved above $0.55 per kWh. Includes: • SBDI • Income Eligible Lighting
	Demand Side Rates ("DSR")	DR and DSR programs. Includes: • Time of Use Rate (Res & Non-Res) • Critical Peak Pricing (Res & Non-Res) • DLC Battery Storage (Res & Non-Res) • DLC Smart Thermostat (Res & Non-Res) • DLC Smart Appliances • Grid-Interactive Water Heater (Res & Non-Res)

SECTION 4 ANALYSIS OF RESOURCE PLAN

(4) Analysis of Alternative Resource Plans. The utility shall describe and document its assessment of the relative performance of the alternative resource plans by calculating for each plan the value of each performance measure specified pursuant to section (2). This calculation shall assume values for uncertain factors that are judged by utility decision-makers to be most likely. The analysis shall cover a planning horizon of at least twenty (20) years and shall be carried out on a year-by-year basis in order to assess the annual and cumulative impacts of alternative resource plans. The analysis shall be based on the assumption that rates will be adjusted annually, in a manner that is consistent with Missouri law. The analysis shall treat supply-side and demand-side resources on a logically-consistent and economically-equivalent basis, such that the same types or categories of costs, benefits, and risks shall be considered and such that these factors shall be quantified at a similar level of detail and precision for all resource types. The utility shall provide the following information:

4.1 Performance Measures of Resource Plans

(A) A summary tabulation that shows the performance of each alternative resource plan as measured by each of the measures specified in section (2) of this rule;

The performance of each of the 12 alternative resource plans with respect to the performance measures specified at 20 CSR 4240-22.060(2)(A) is provided in Table 6-17. All results were evaluated under Base Case market conditions. Table 6-18 provides a legend to facilitate the referencing of each alternative resource plan.

Table 6-17 – 20 Year Performance of Alternative Resource Plans

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Table 6-18 – Plan Legend

Plan	Plan Description
1	Baseline – Utility-Scale + Distributed Gas Only + RAP DSM
2	Baseline – Utility-Scale + Distributed Gas Only + MAP DSM
3	Baseline – Utility-Scale + Distributed Gas/Renew Mix + RAP DSM
4	Baseline – Utility-Scale + Distributed Gas/Renew Mix + RAP DSM + Frame CT
5	Baseline – Utility-Scale + Distributed Gas/Renew Mix + RAP DSM + 5x Aero
6	Baseline – Utility-Scale + Distributed Gas/Renew Mix + MAP DSM
7	Baseline – Utility-Scale + Distributed Renewable + RAP DSM
8	Baseline – Utility-Scale + Distributed Renewable + MAP DSM
9	Net Zero 2050 – Renewable + Storage + RAP DSM
10	Net Zero 2050 – Nuclear SMR + RAP DSM
11	Net Zero 2050 – Hydrogen + RAP DSM
12	EPA GHG Rule – Advanced Tech + RAP DSM

In addition to PVRRs calculated for the 20-year study horizon (2025-2044) required for the IRP analysis, Liberty-Empire also calculated PVRRs for the 30-year study horizon to properly compare plans that add significant amounts of capital and fixed costs in the longer term. The difference between the 20-year and 30-Year PVRRs does not materially change the ordering of the plans. The PVRR for each of Liberty-Empire's 12 alternative resource plans under the 2025 IRP Base Case conditions over the 20-year planning period of 2025-2044 is shown in Figure 6-4. The deterministic PVRR for each plan over the thirty years of 2025-2054 is shown in Figure 6-5.

Figure 6-4 – Deterministic 20-Year PVRR of All Plans ($ millions)

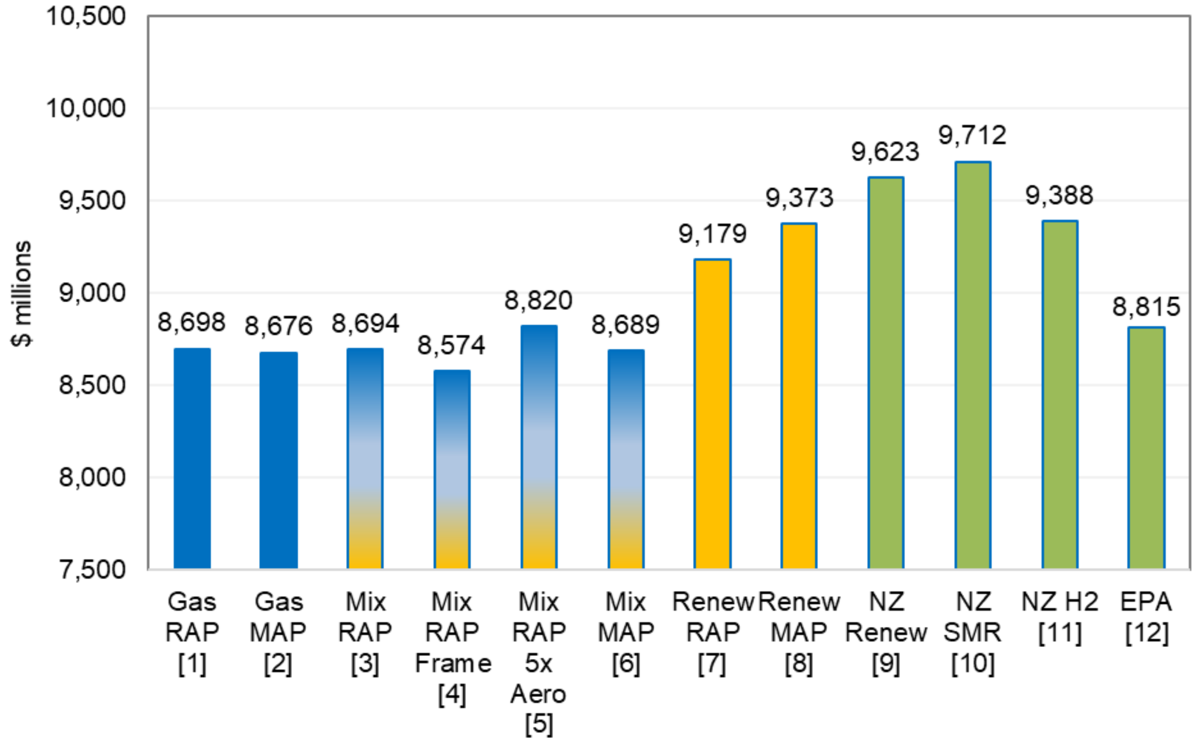
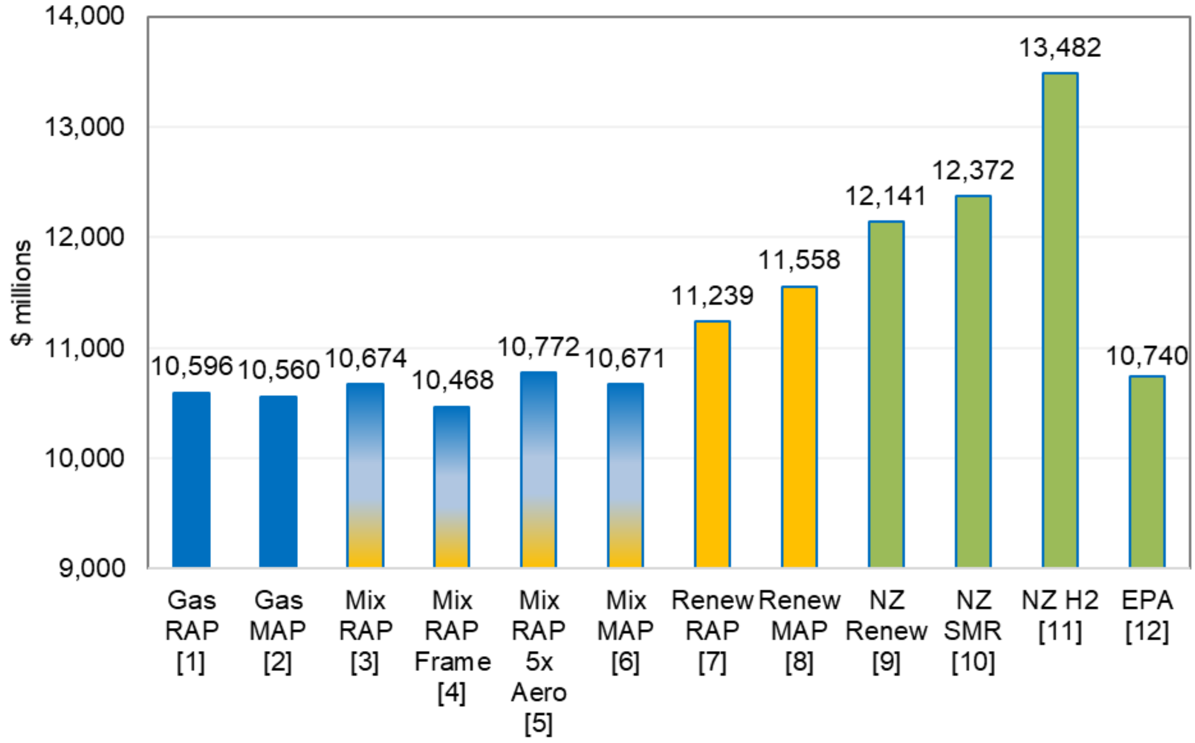


Figure 6-5 – Deterministic 30-Year PVRR of All Plans ($ millions)



As discussed in Section 3.2.1, Liberty-Empire also developed and analyzed an alternative plan that is minimally compliant with legal mandates for demand-side resources, renewable energy resources, and other mandated energy resources. This compliance benchmark plan is known as "Plan 1A," and is based on Plan 1 except that Plan 1A does not allow any new DSM resources. Given that at least some level of new DSM resources was found to be cost-effective in all other alternative plans, Plan 1A was analyzed under the Base Case primarily for compliance purposes and only under the Base Case. The results of this analysis are shown in Table 6-19. Liberty-Empire found that Plan 1A was approximately $3 million higher cost than Plan 1 on a 20-year PVRR basis.

Table 6-19 – 20 Year Performance of Alternative Resource Plan 1A

Plan	20 Year PVRR ($MM)	Probable Enviro Costs (NPV $MM)	DSM Costs (NPV $MM)	Levelized Annual Rates (cents/kWh)	Maximum Rate Increase (%)	Pre-Tax Interest Coverage	Total Debt to Capital	Net Cash Flow to CapEx
1A	8,702	253.0	-	15.51	8.5%	4.52	46.9%	1.89

4.2 Graphic Analysis of Plans

(B) For each alternative resource plan, a plot of each of the following over the planning horizon:

4.2.1 DSM Impact on Peak Demand

1. The combined impact of all demand-side resources on the base-case forecast of summer and winter peak demands;

The combined impact of all demand-side resources on the Base Case forecast of summer and winter peak demands for each of the 12 alternative resource plans is shown in the following figures.

Figure 6-6 – RAP DSM Impact on Load (Low-, Mid-, and High-Cost Bundle)

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[redacted]

Figure 6-7 – MAP DSM Impact on Load (Low-, Mid-, and High-Cost Bundle)

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[redacted]

Figure 6-8 – RAP DSM Impact on Load (Mid-Cost and DSR Bundle)

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[redacted]

Figure 6-9 – MAP DSM Impact on Load (Mid-Cost and DSR Bundle)

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[redacted]

Figure 6-10 – RAP DSM Impact on Load (Low-Cost, Mid-Cost, High-Cost, and DSR Bundle)

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[redacted]

4.2.2 DSM Program Composition of Plans

2. The composition, by program and demand-side rate, of the capacity provided by demand-side resources;

The composition by program and demand-side rate of the capacity provided by DSM resources for the RAP and MAP bundles selected in the alternative plans is shown in Figure 6-11 and Figure 6-12. The corresponding tables of values for all these figures are provided in Appendix 6B.

Figure 6-11 – DSM Composition of Selected RAP DSM

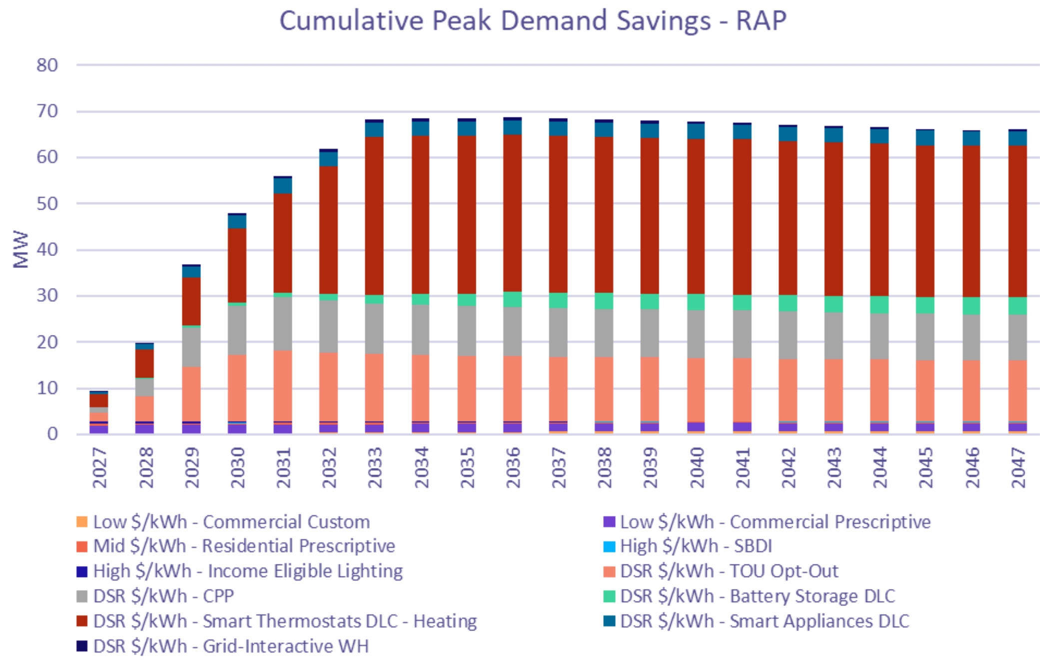
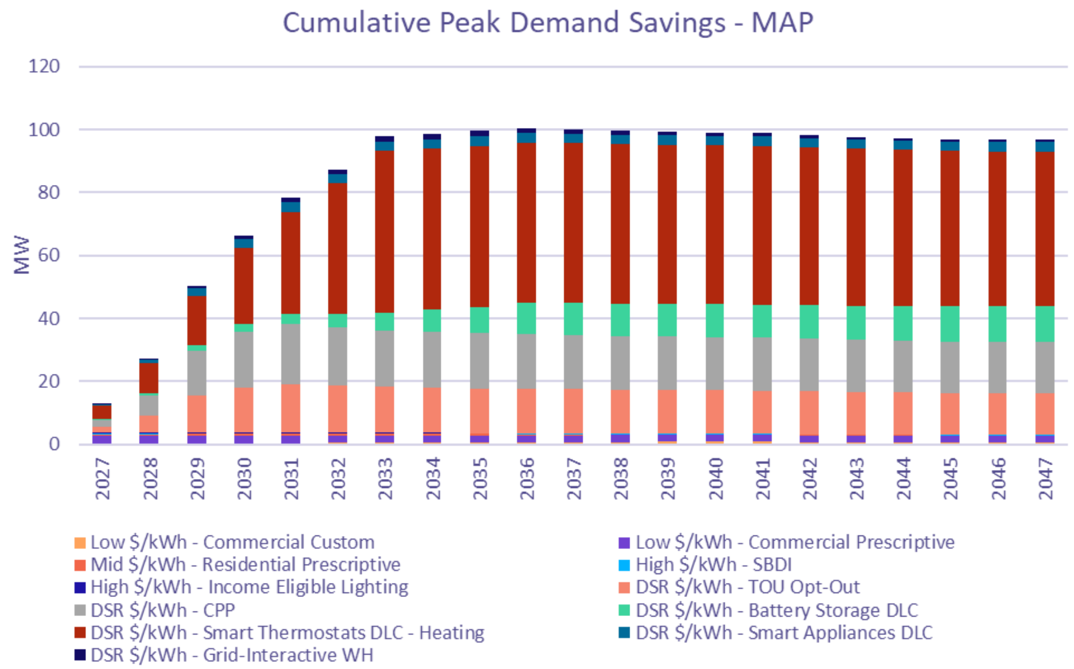


Figure 6-12 – DSM Composition of Selected MAP DSM



4.2.3 Supply-Side Composition of Plans

3. The composition, by supply-side resource, of the capacity supplied to the transmission grid provided by supply-side resources. Existing supply-side resources may be shown as a single resource;

The composition by supply-side resource of Liberty-Empire's capacity supplied by supply-side resources for each resource plan is shown in the following figures. The capacity values are provided in summer ACAP MW.

Figure 6-13 – Supply-Side Resource Composition of Plan 1

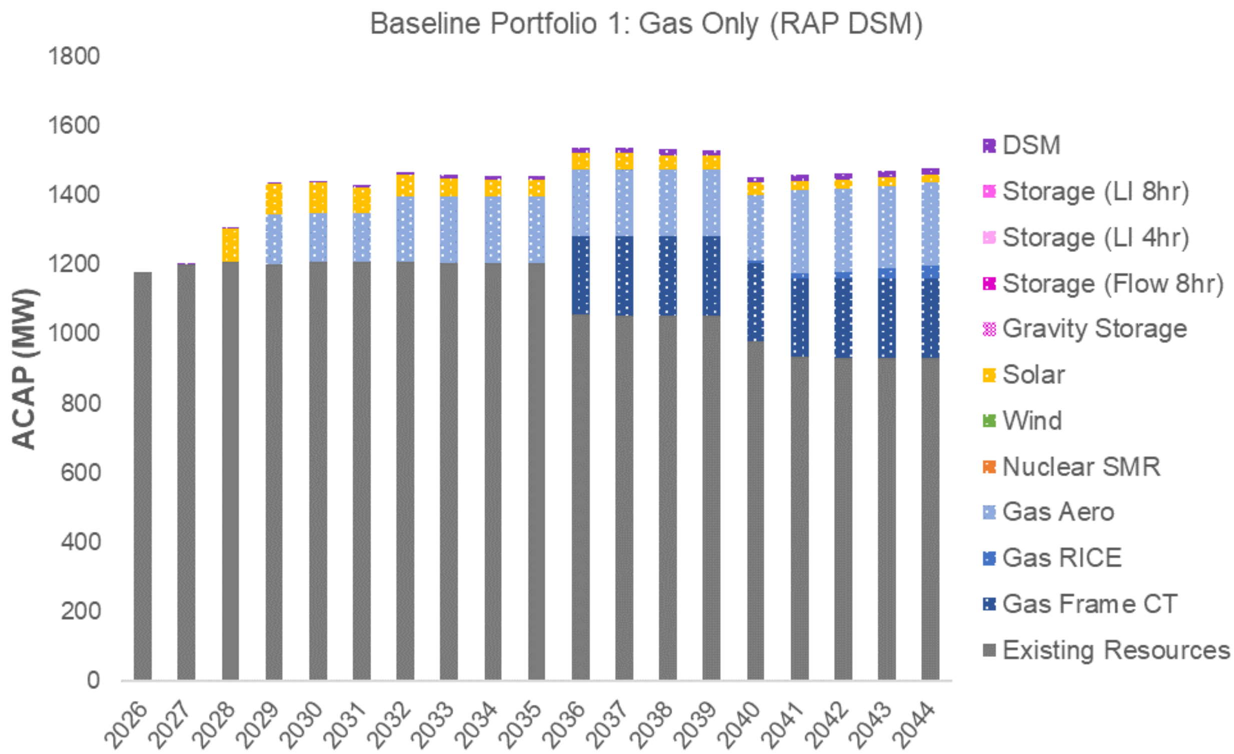


Figure 6-14 – Supply-Side Resource Composition of Plan 1A

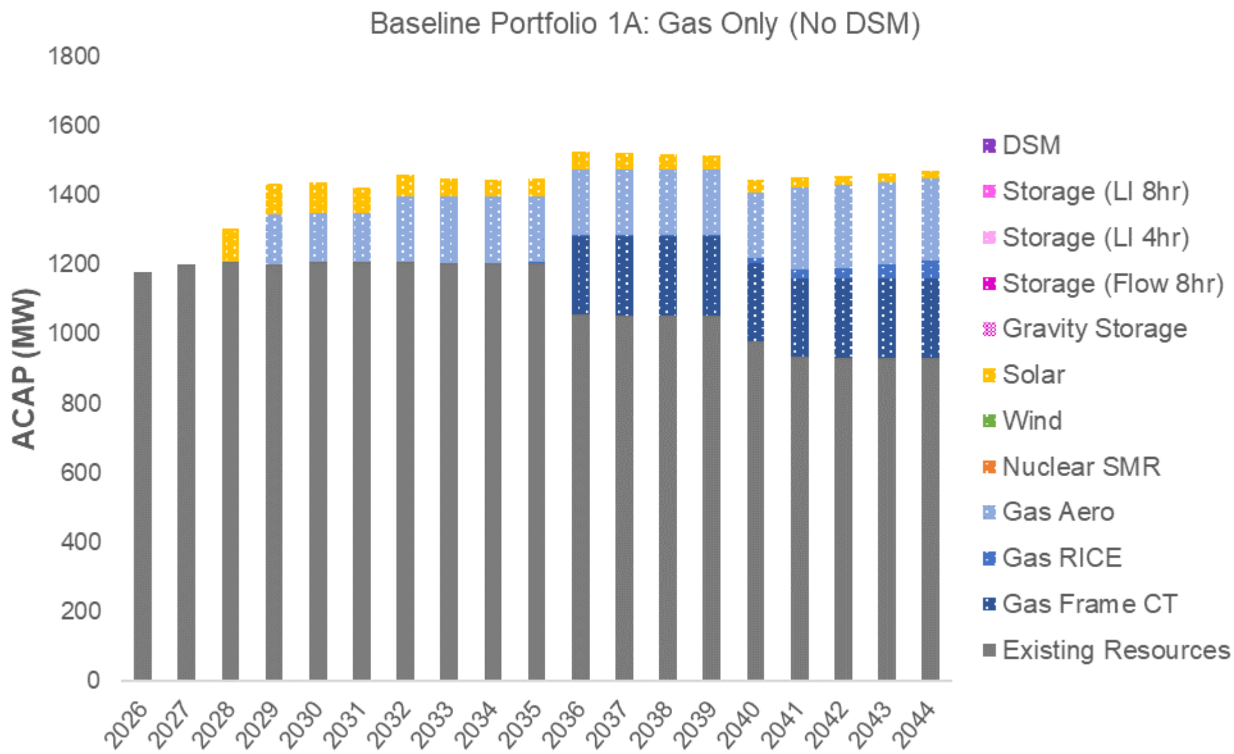


Figure 6-15 – Supply-Side Resource Composition of Plan 2

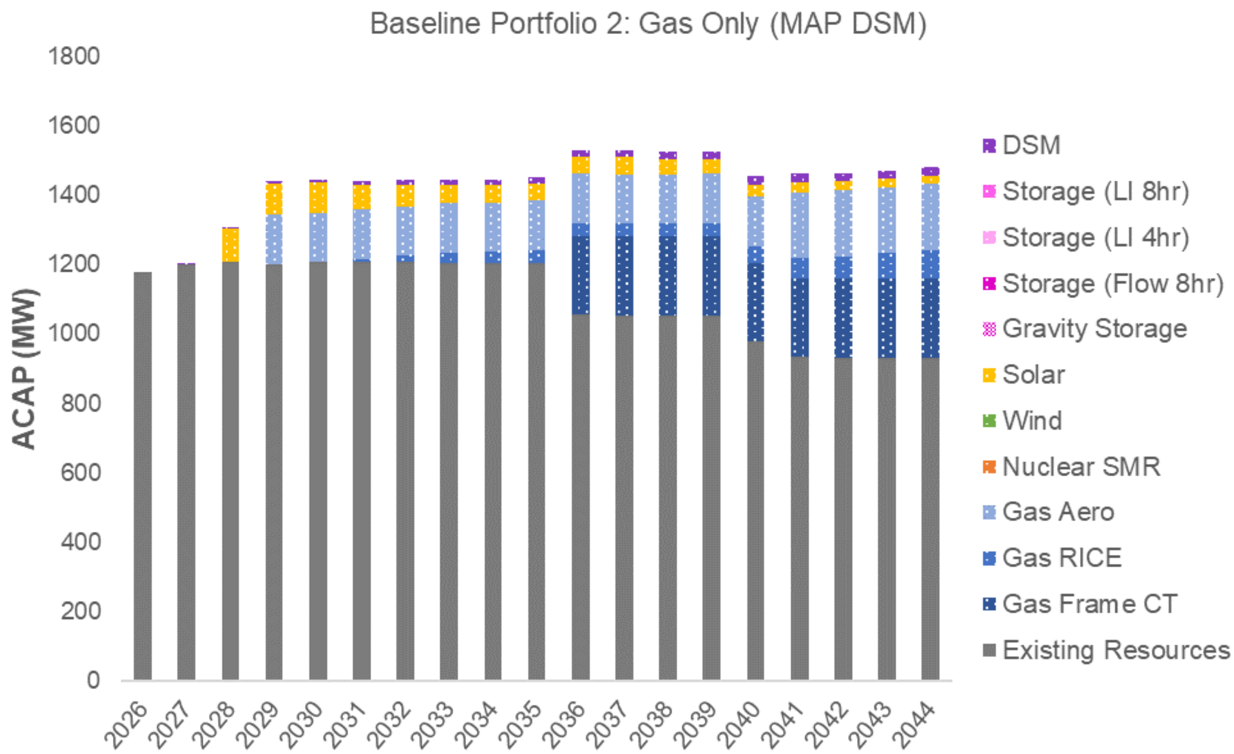


Figure 6-16 – Supply-Side Resource Composition of Plan 3

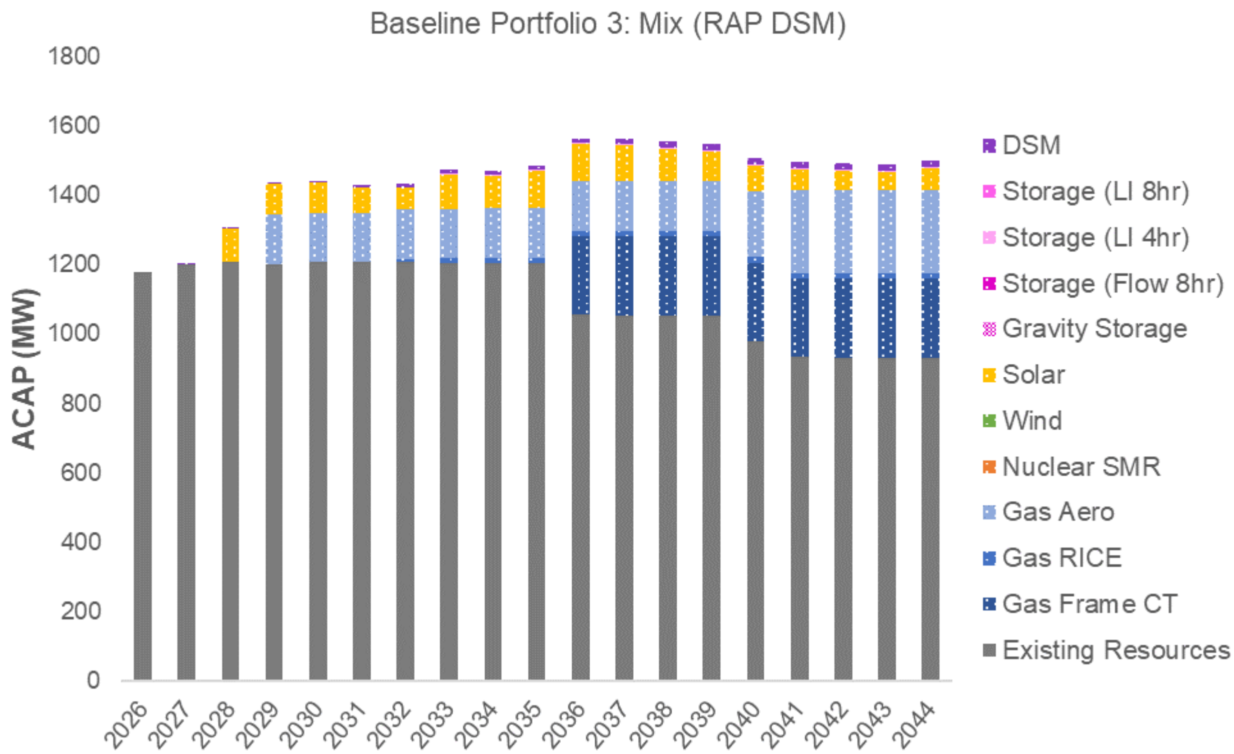


Figure 6-17 – Supply-Side Resource Composition of Plan 4

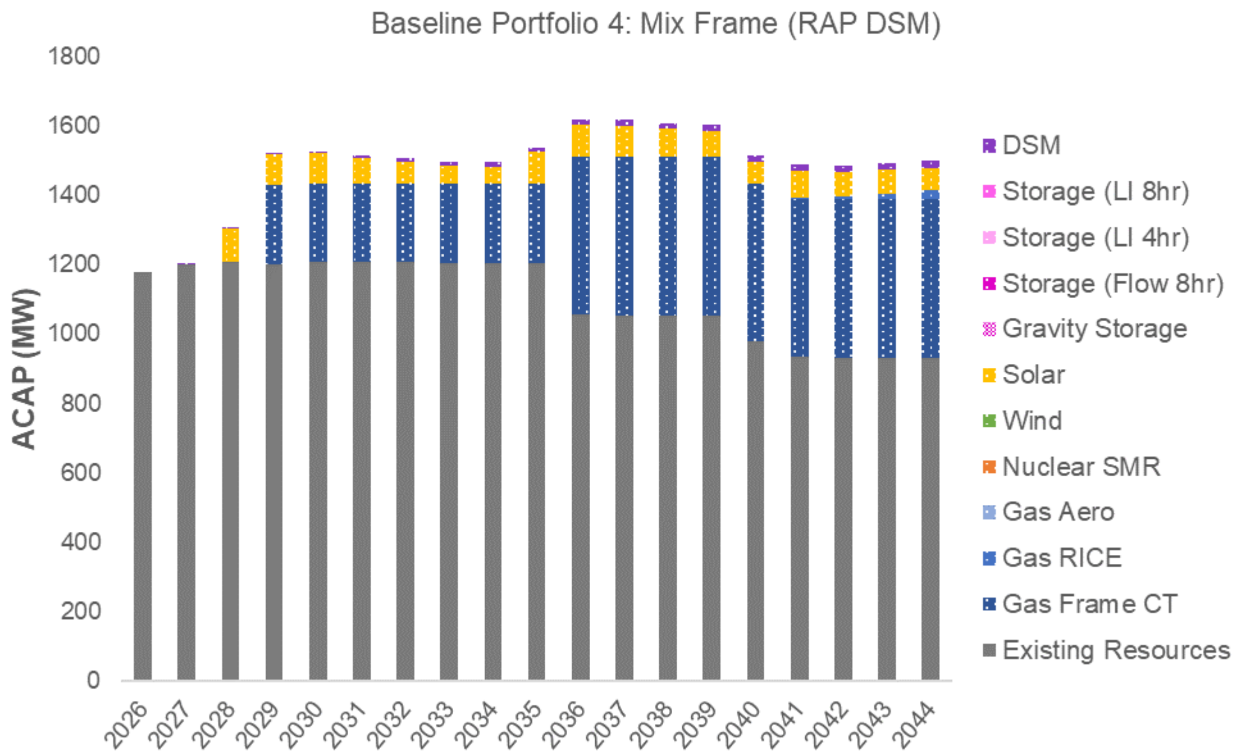


Figure 6-18 – Supply-Side Resource Composition of Plan 5

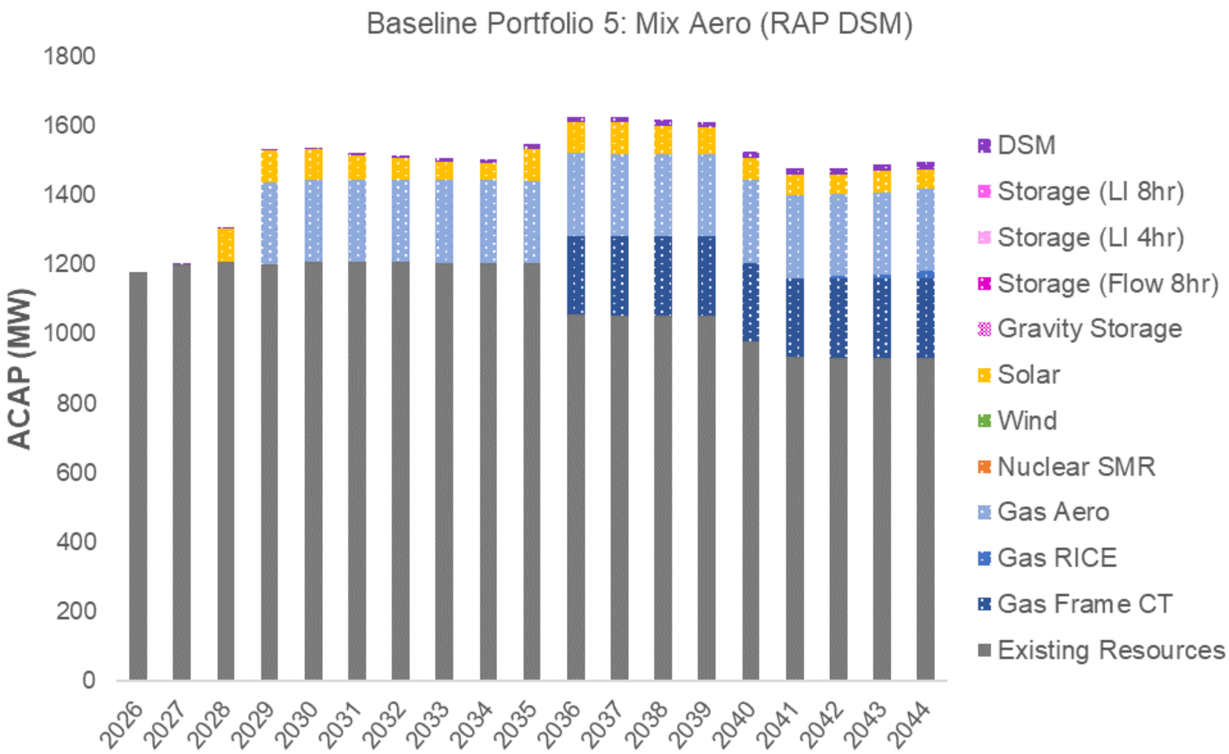


Figure 6-19 – Supply-Side Resource Composition of Plan 6

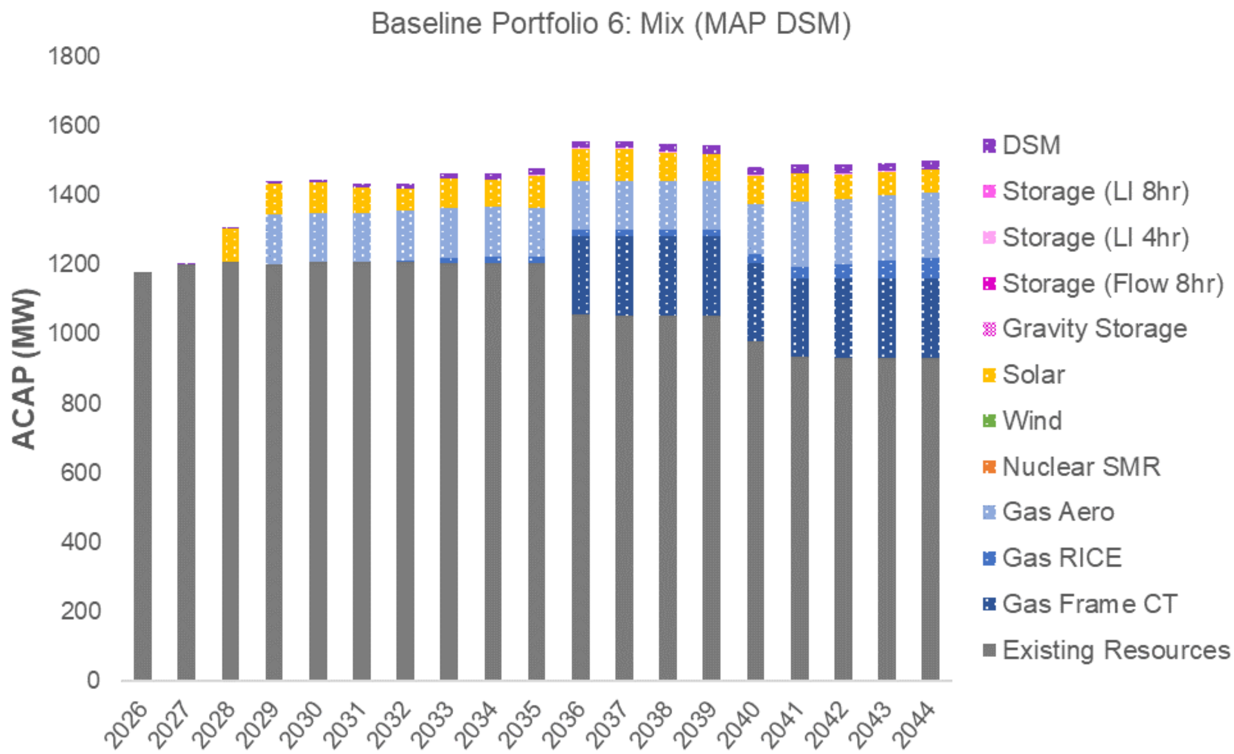
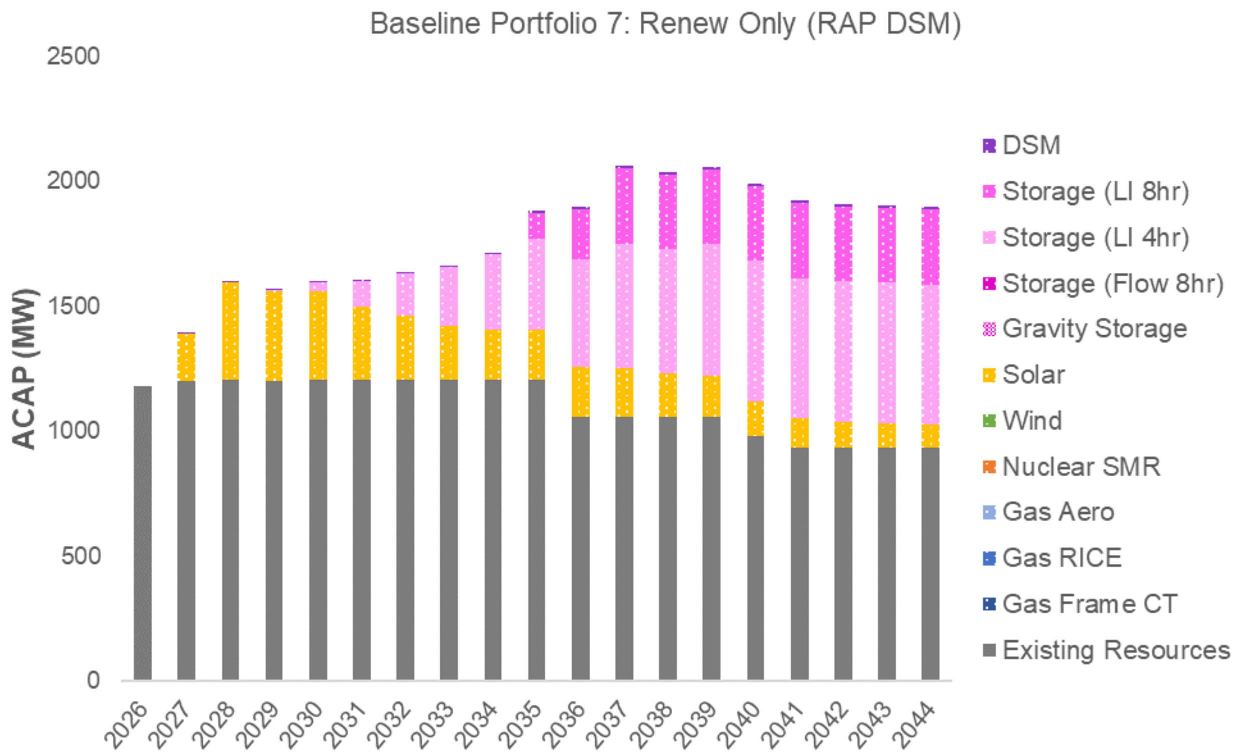


Figure 6-20 – Supply-Side Resource Composition of Plan 7



NP

Figure 6-21 – Supply-Side Resource Composition of Plan 8

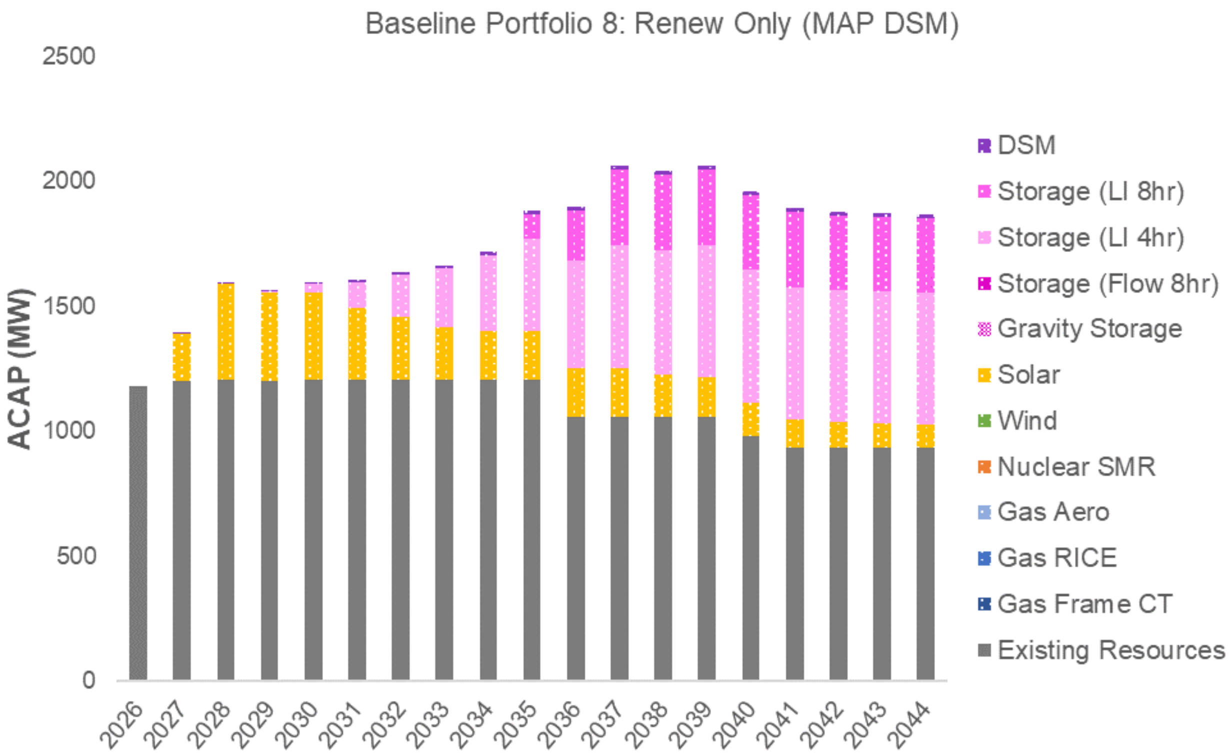


Figure 6-22 – Supply-Side Resource Composition of Plan 9

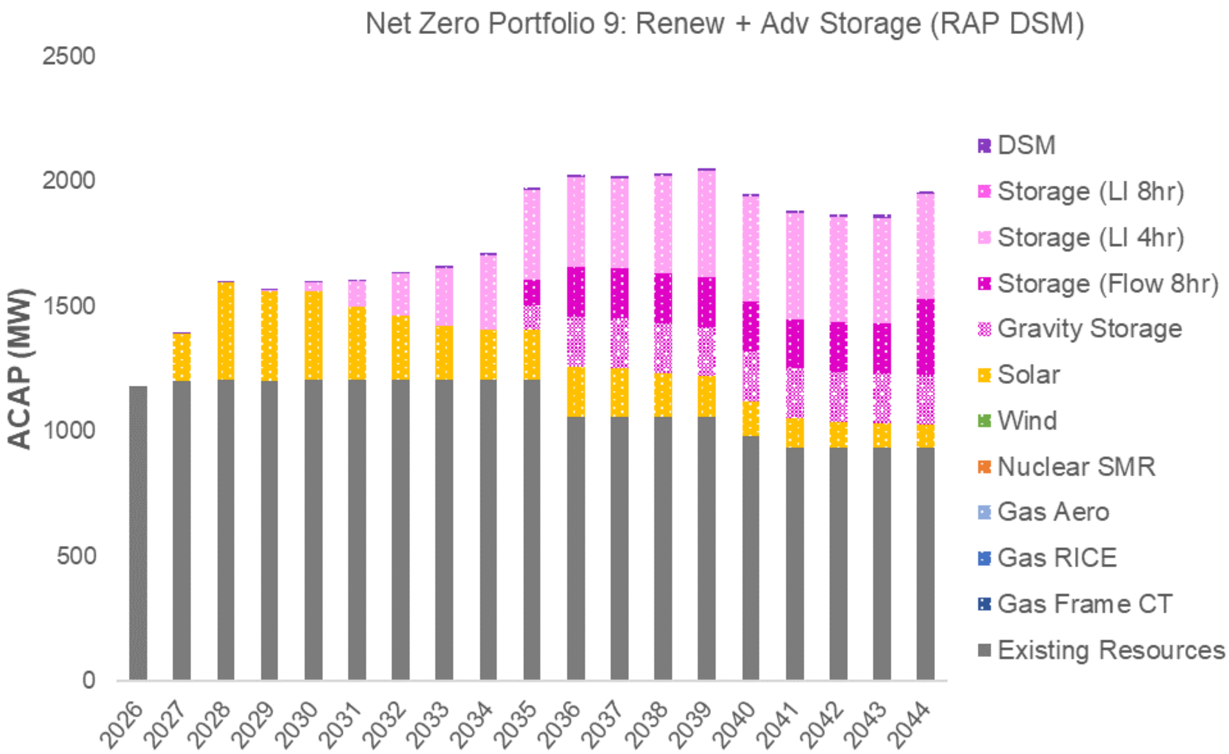


Figure 6-23 – Supply-Side Resource Composition of Plan 10

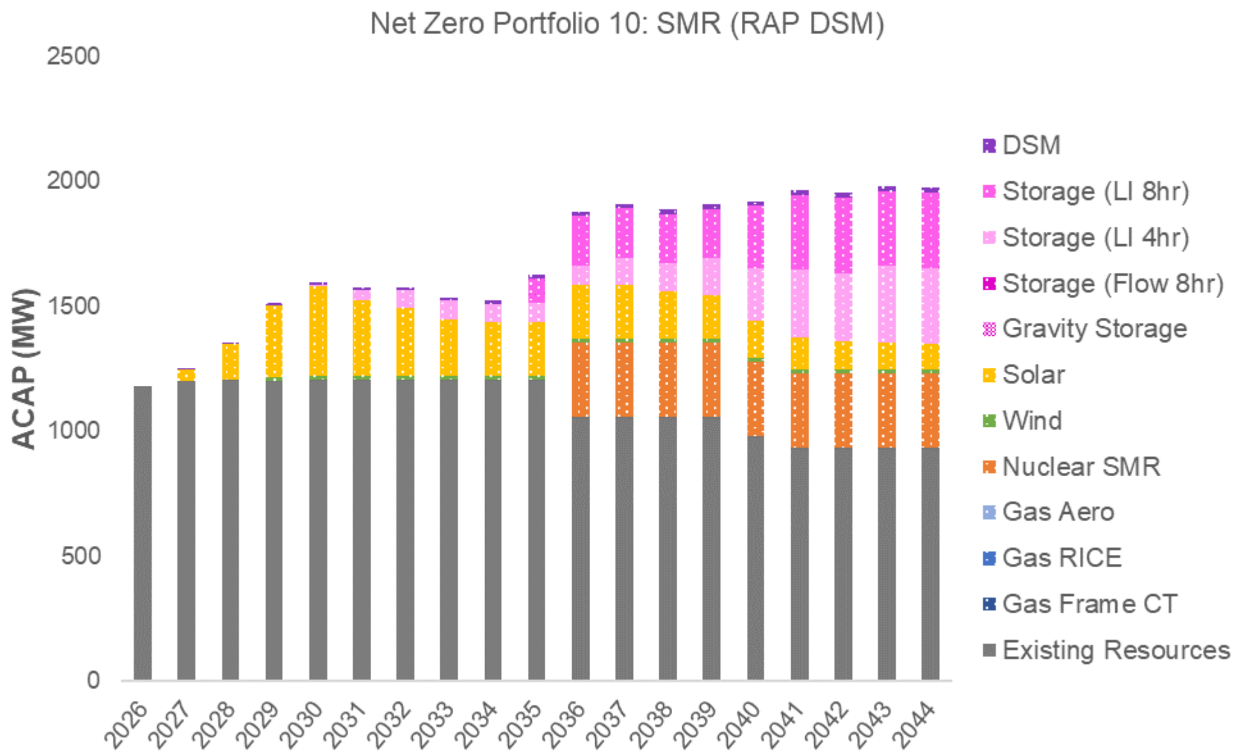


Figure 6-24 – Supply-Side Resource Composition of Plan 11

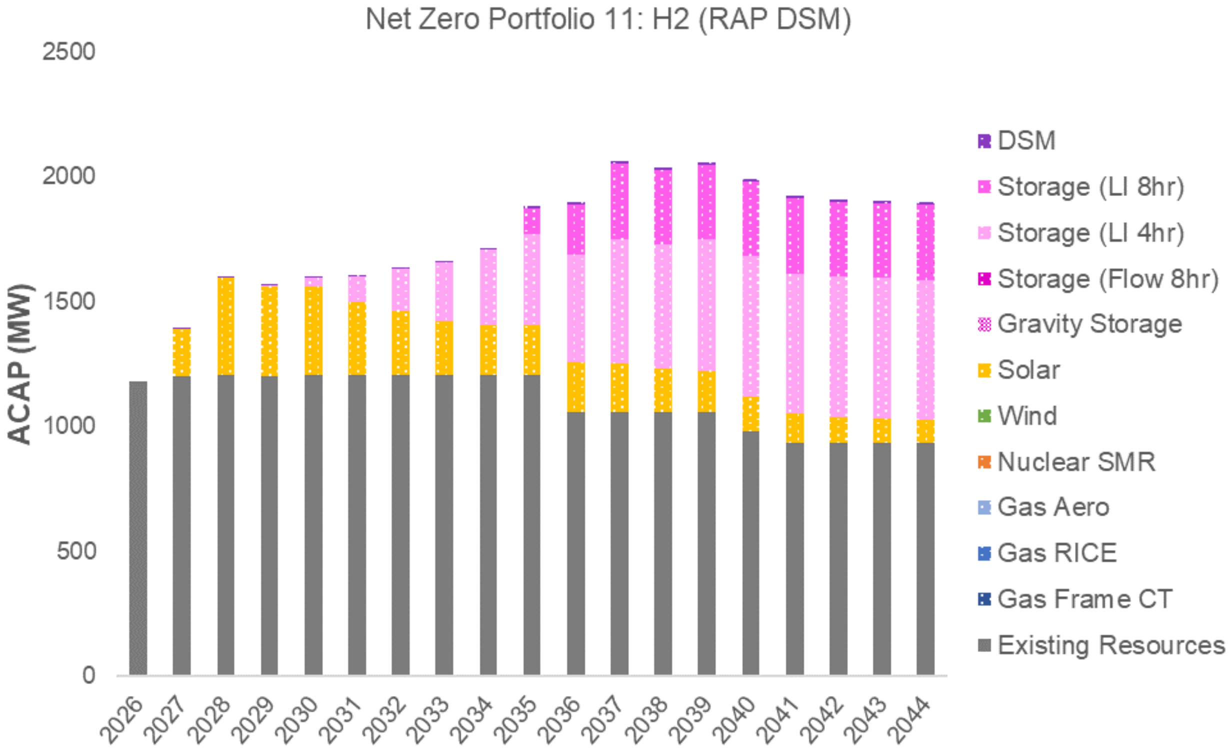
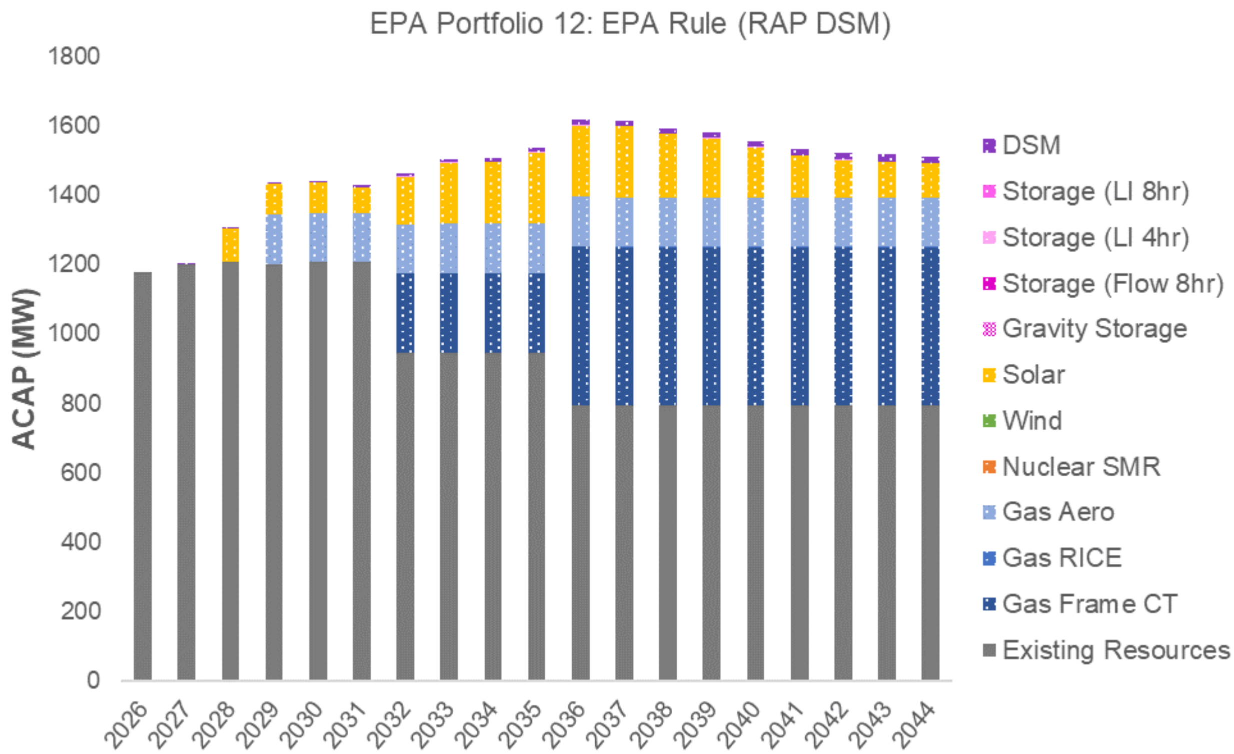


Figure 6-25 – Supply-Side Resource Composition of Plan 12



4.2.4 DSM Impacts on Annual Energy

4. The combined impact of all demand-side resources on the base-case forecast of annual energy requirements;

The combined impact of all demand-side resources on the base annual load forecast of annual energy requirements for each alternative resource plan is shown in Figure 6-26 through Figure 6-30.

NP

Figure 6-26 – Impact of RAP DSM on Annual Energy Requirements (Low-, Mid-, and High-Cost Bundle)

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[redacted]

NP

Figure 6-27 – Impact of MAP DSM on Annual Energy Requirements (Low-, Mid-, and High-Cost Bundle)

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

[redacted]

NP

Figure 6-28 – Impact of RAP DSM on Annual Energy Requirements (Mid-Cost and DSR Bundle)

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

[redacted]

Figure 6-29 – Impact of MAP DSM on Annual Energy Requirements (Mid-Cost and DSR Bundle)

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

[redacted]

Figure 6-30 – Impact of RAP DSM on Annual Energy Requirements (Low-Cost, Mid-Cost, High-Cost, and DSR Bundle)

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

[redacted]

4.2.5 Composition of DSM to Annual Energy

5. The composition, by program and demand-side rate, of the annual energy provided by demand-side resources;

The composition by program and demand-side rate of the annual energy provided by demand-side resources for RAP and MAP DSM is shown in Figure 6-31 and Figure 6-32. The corresponding tables of values for all these figures are provided in Appendix 6C.

Figure 6-31 – Composition of DSM Energy of Selected RAP DSM

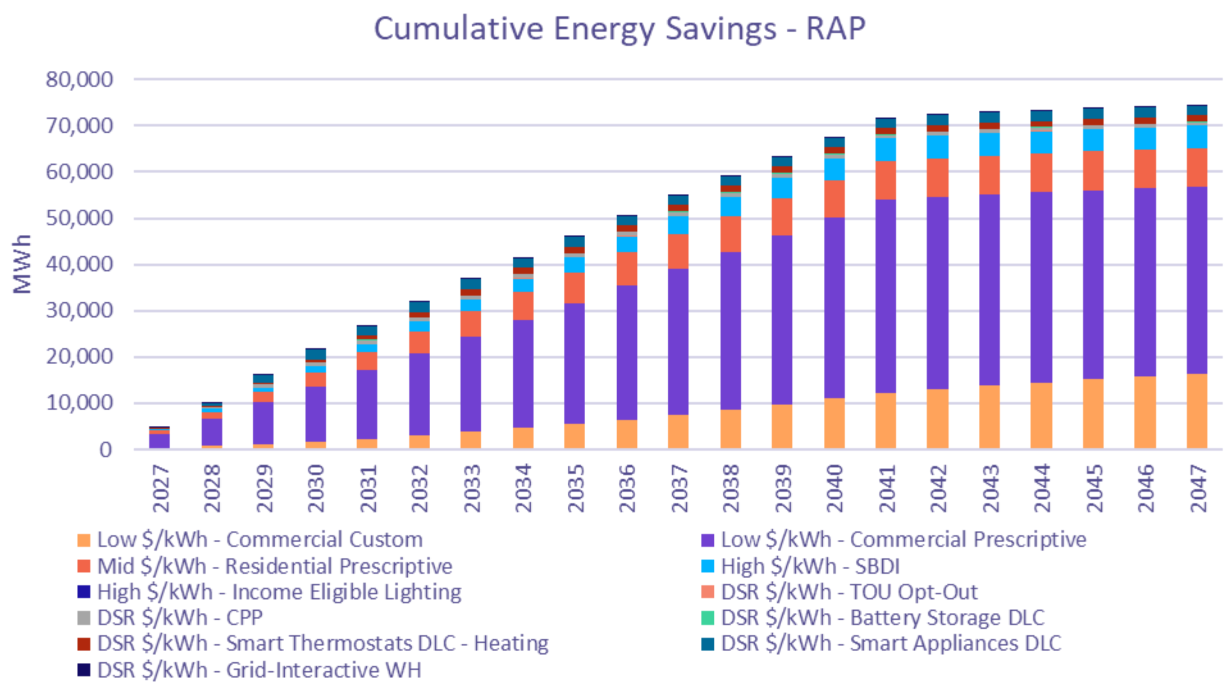
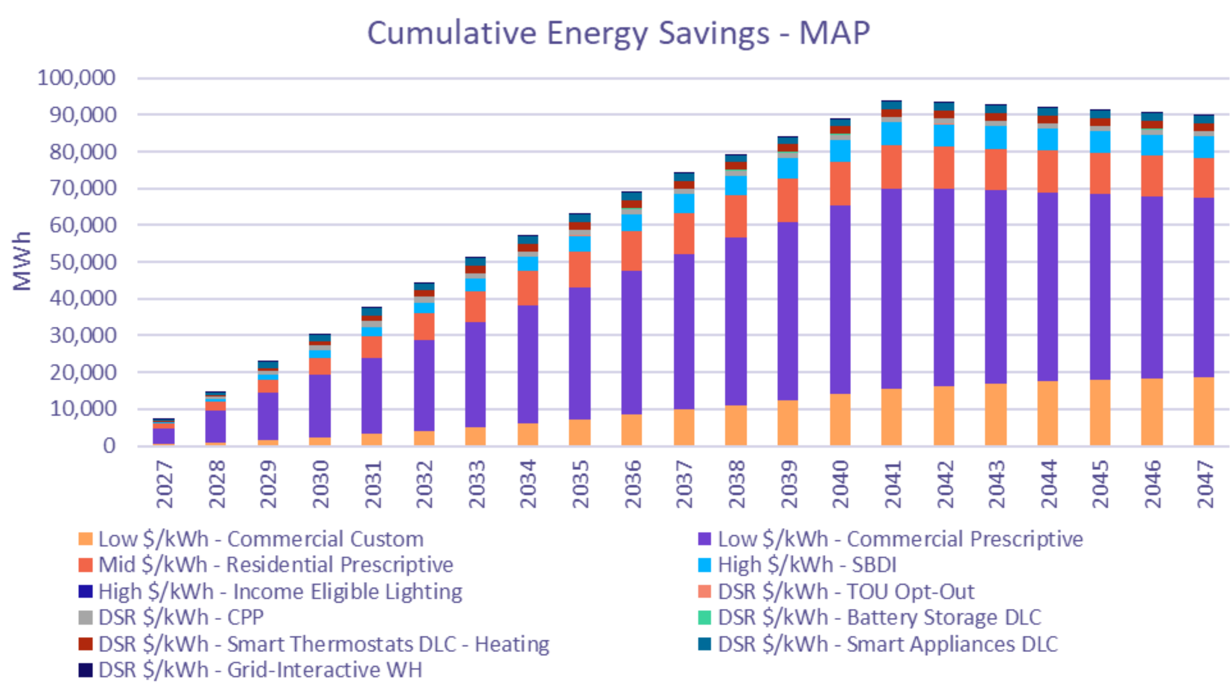


Figure 6-32 – Composition of DSM Energy of Selected MAP DSM



4.2.6 Supply-Side Resource Contribution to Energy

6. The composition, by supply-side resource, of the annual energy supplied to the transmission grid, less losses, provided by supply-side resources. Existing supply-side resources may be shown as a single resource;

The composition by supply-side resources of the annual energy supplied to the transmission grid by supply-side resources is provided for each alternative resource plan in Figure 6-33 through Figure 6-45. All energy profiles assume Base Case market conditions.

Figure 6-33 – Composition of Supply-Side Energy for Plan 1

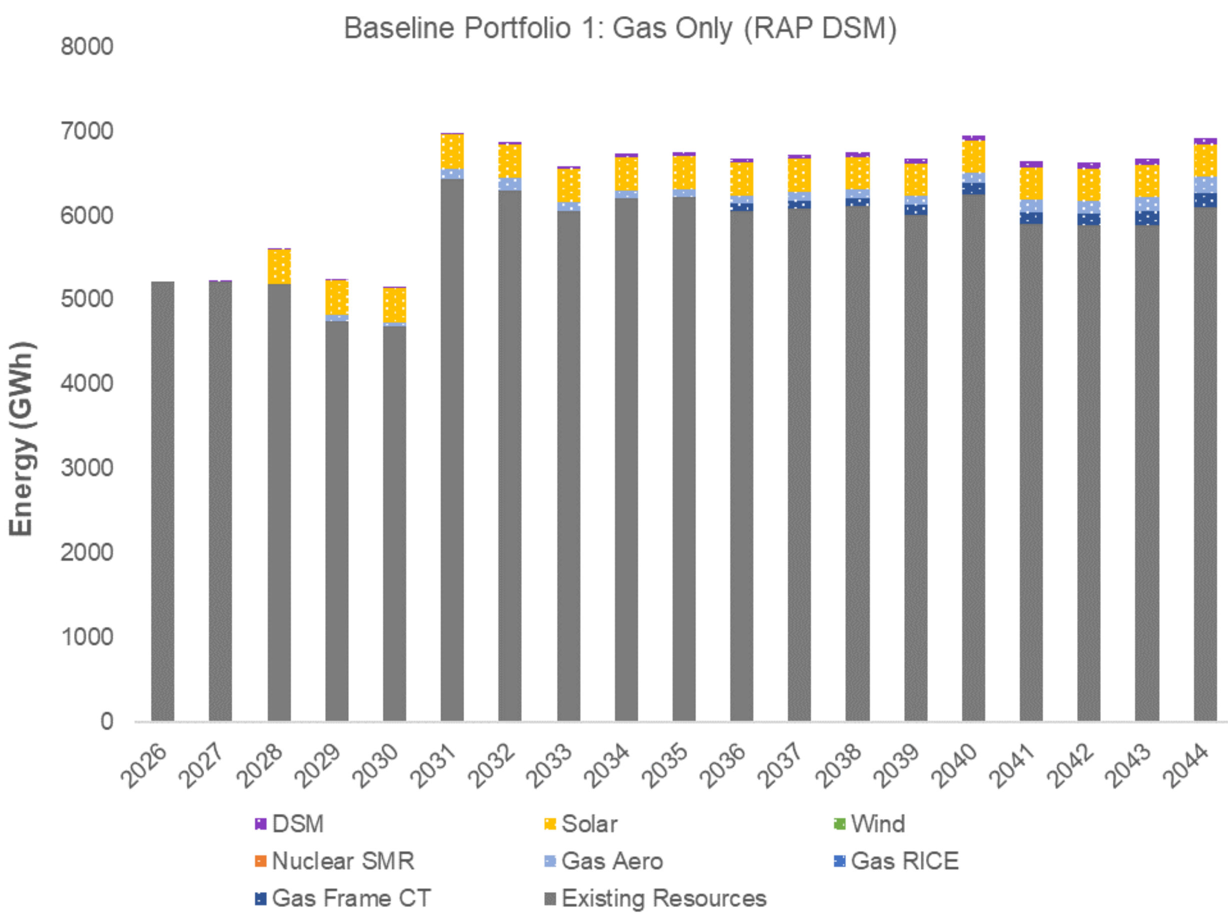


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Figure 6-34 – Composition of Supply-Side Energy for Plan 1A

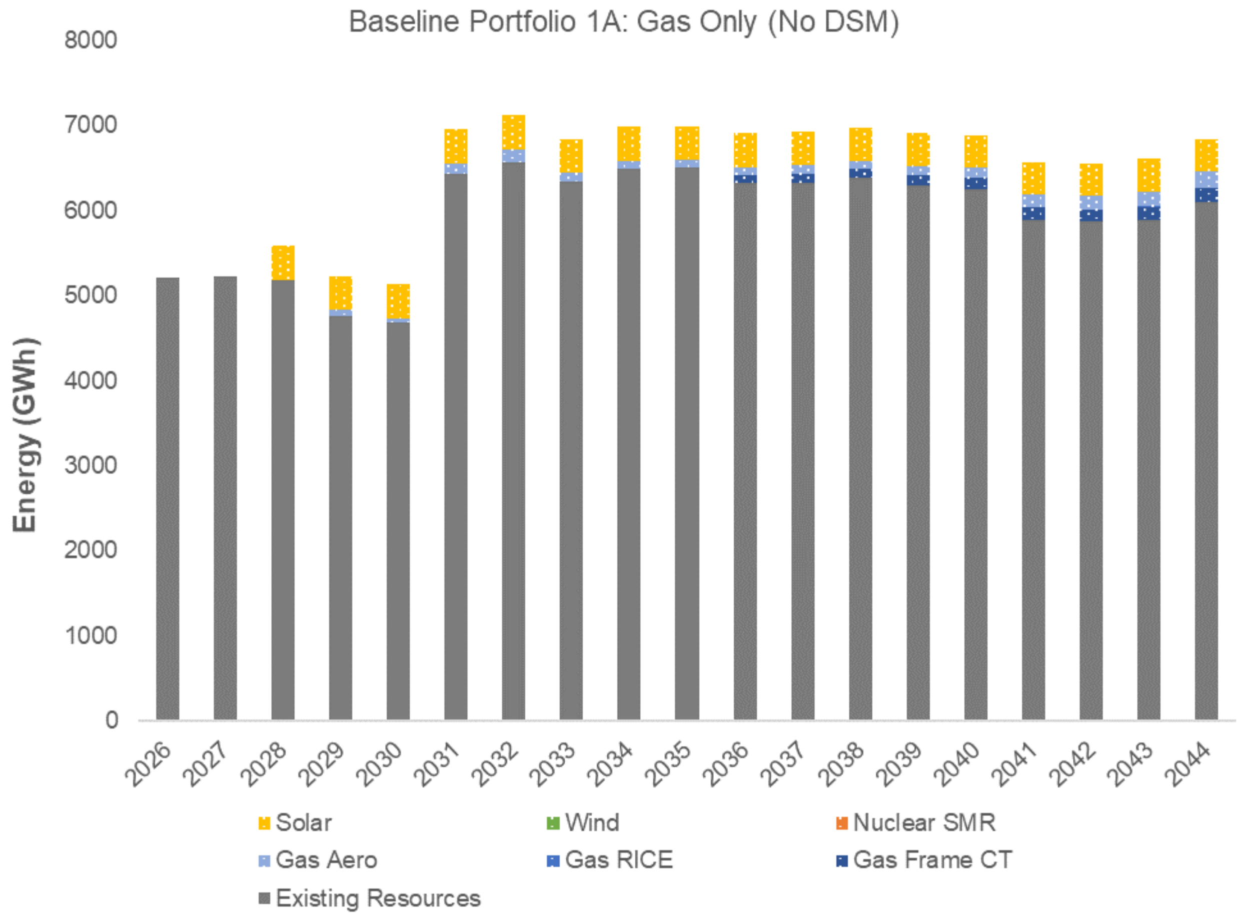


Figure 6-35 – Composition of Supply-Side Energy for Plan 2

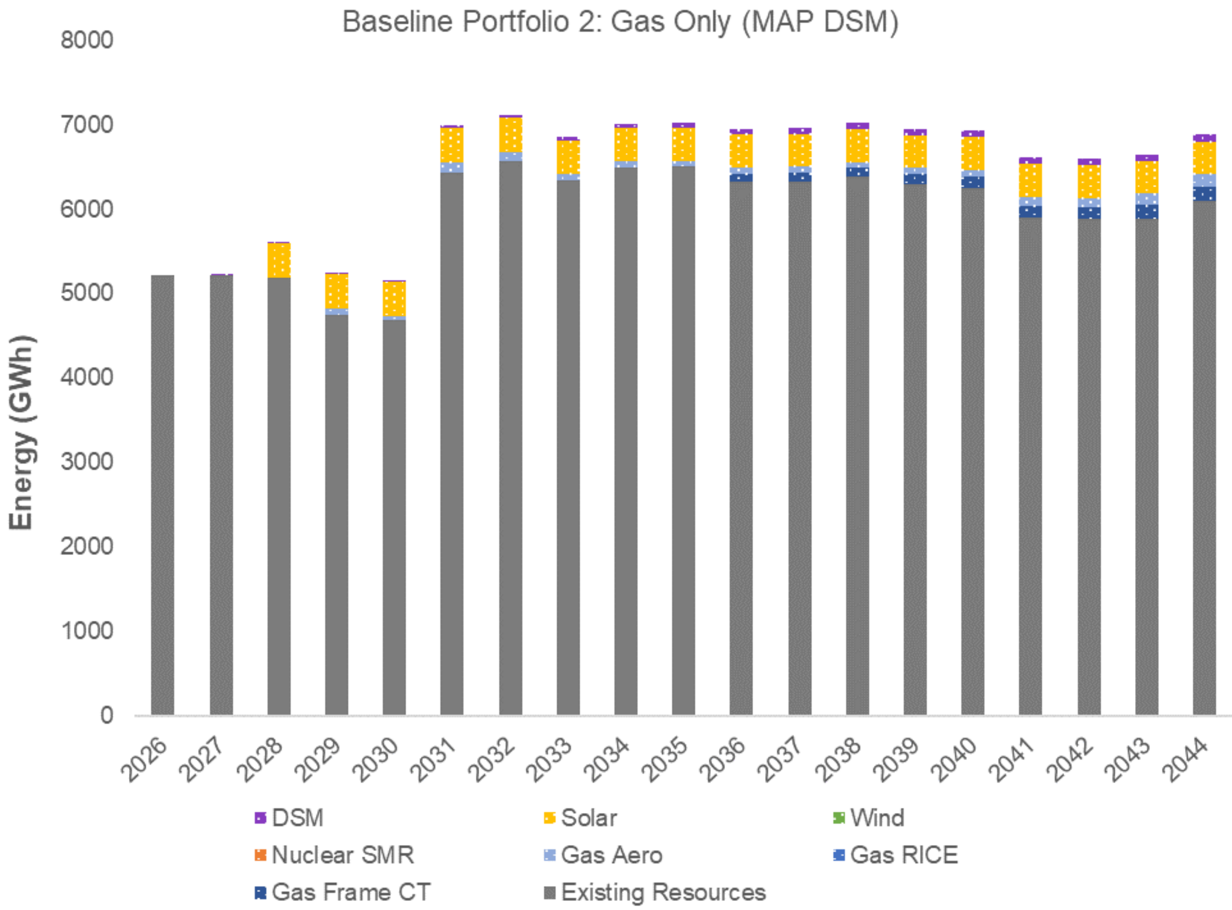


Figure 6-36 – Composition of Supply-Side Energy for Plan 3

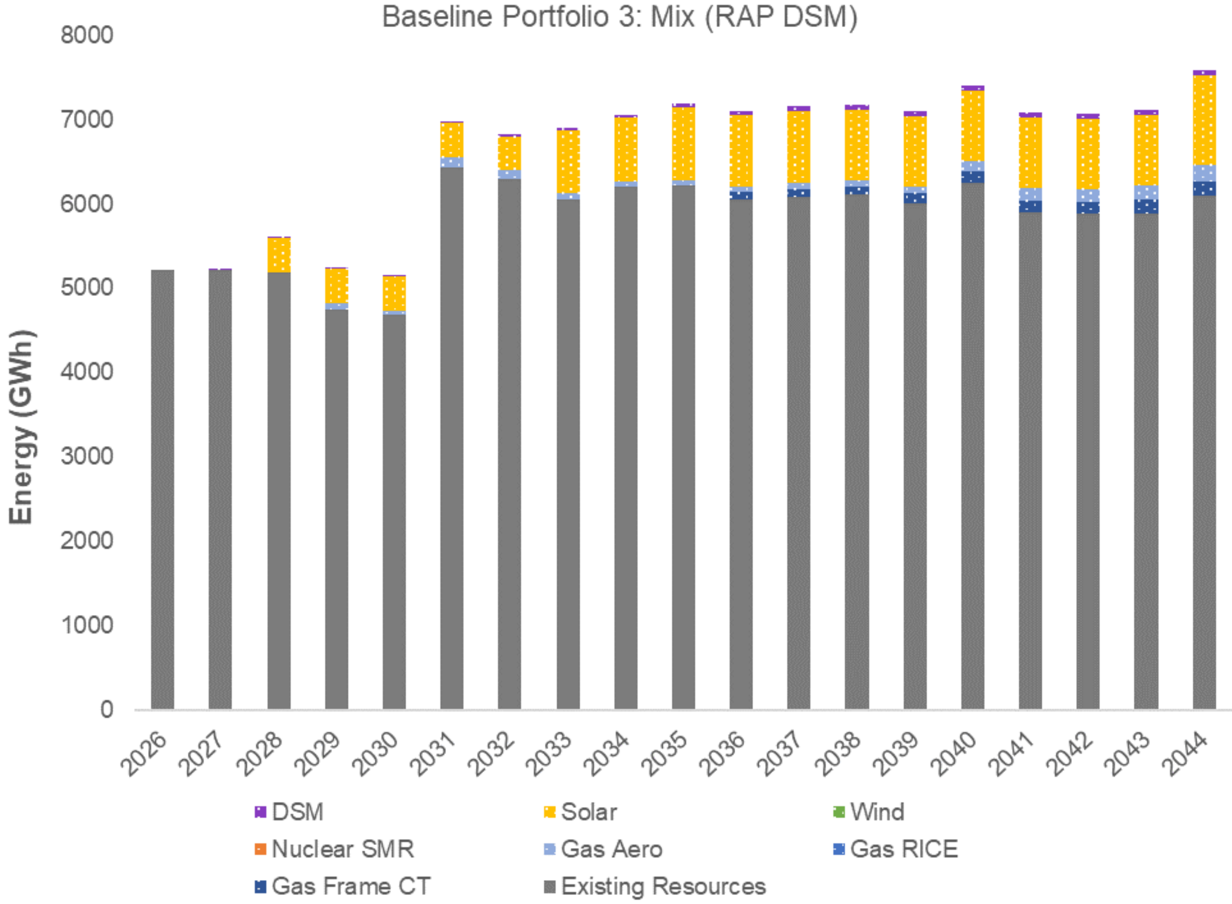


Figure 6-37 – Composition of Supply-Side Energy for Plan 4

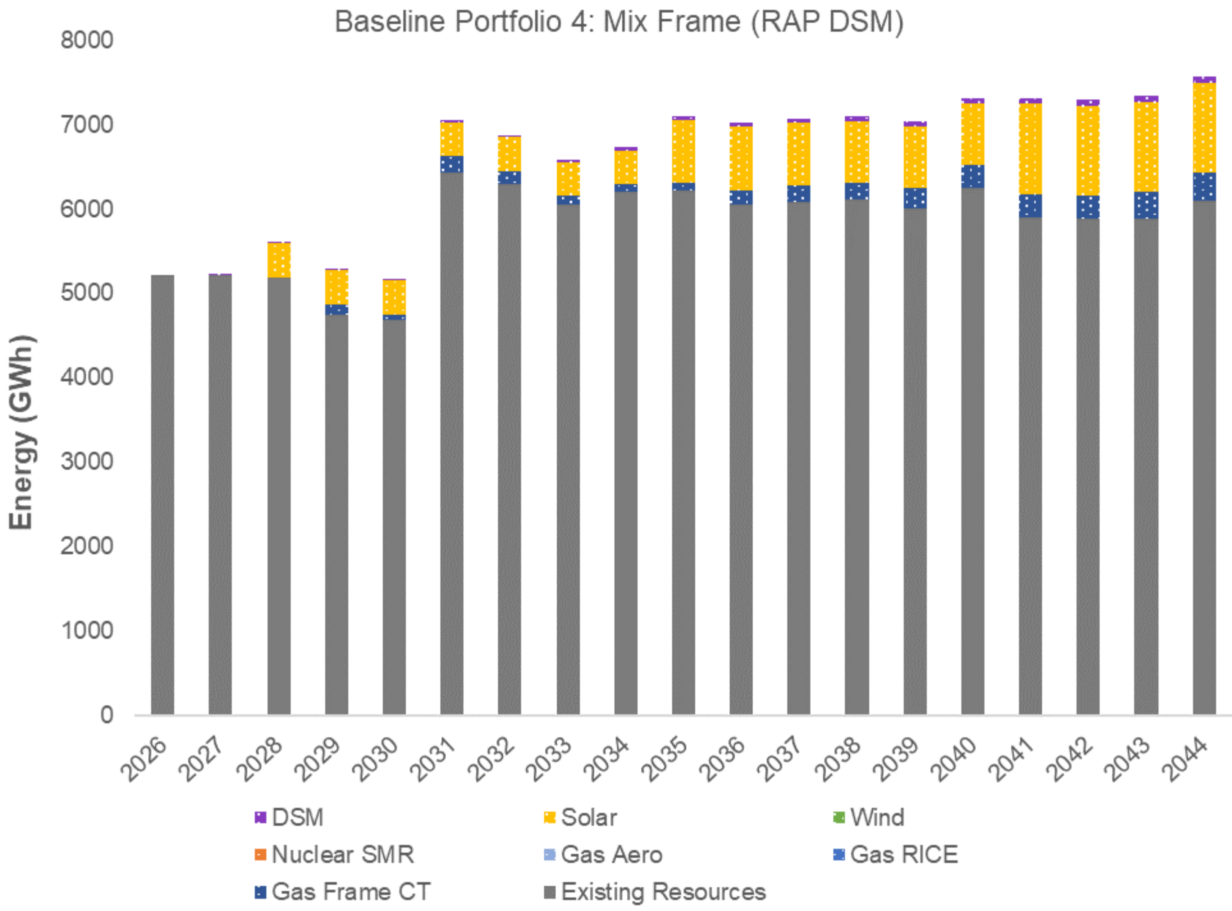


Figure 6-38 – Composition of Supply-Side Energy for Plan 5

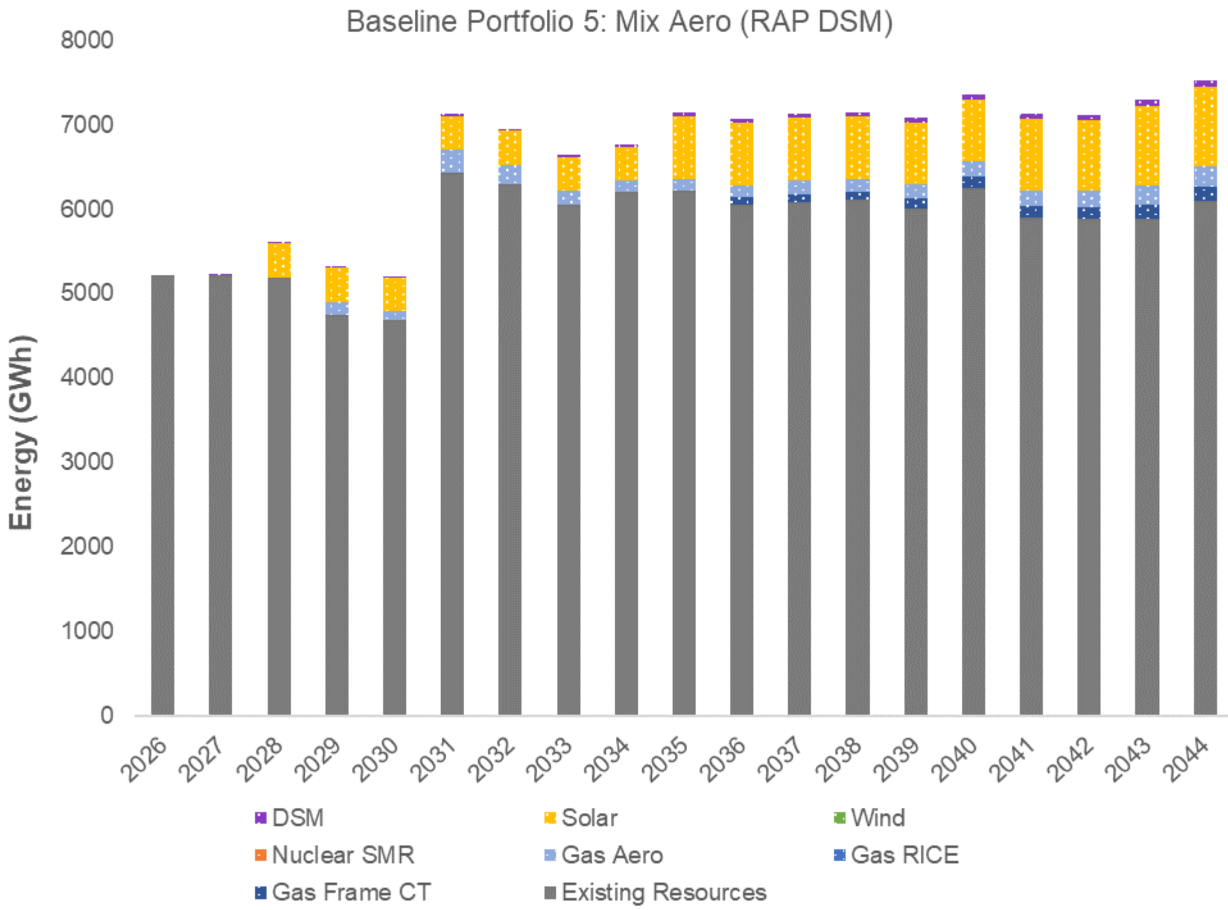


Figure 6-39 – Composition of Supply-Side Energy for Plan 6

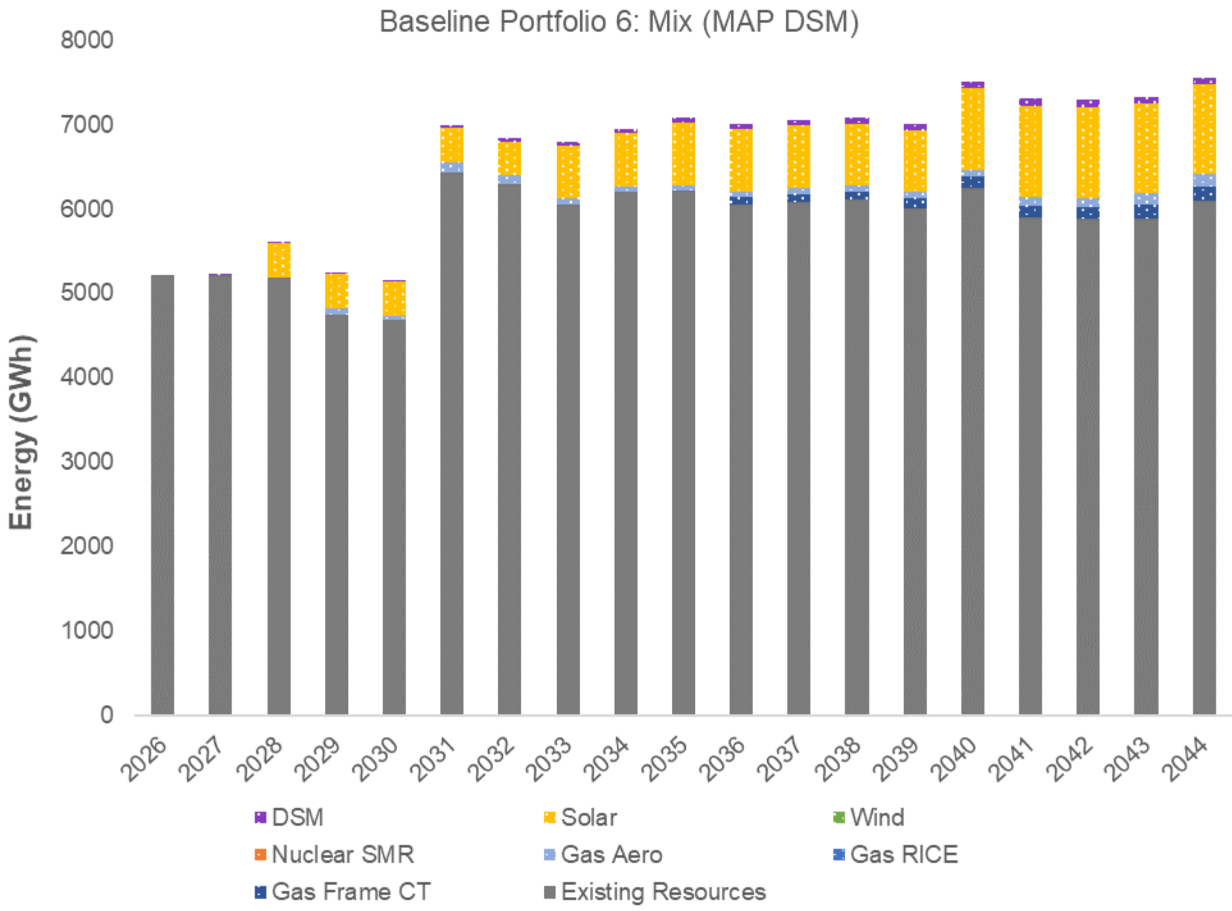


Figure 6-40 – Composition of Supply-Side Energy for Plan 7

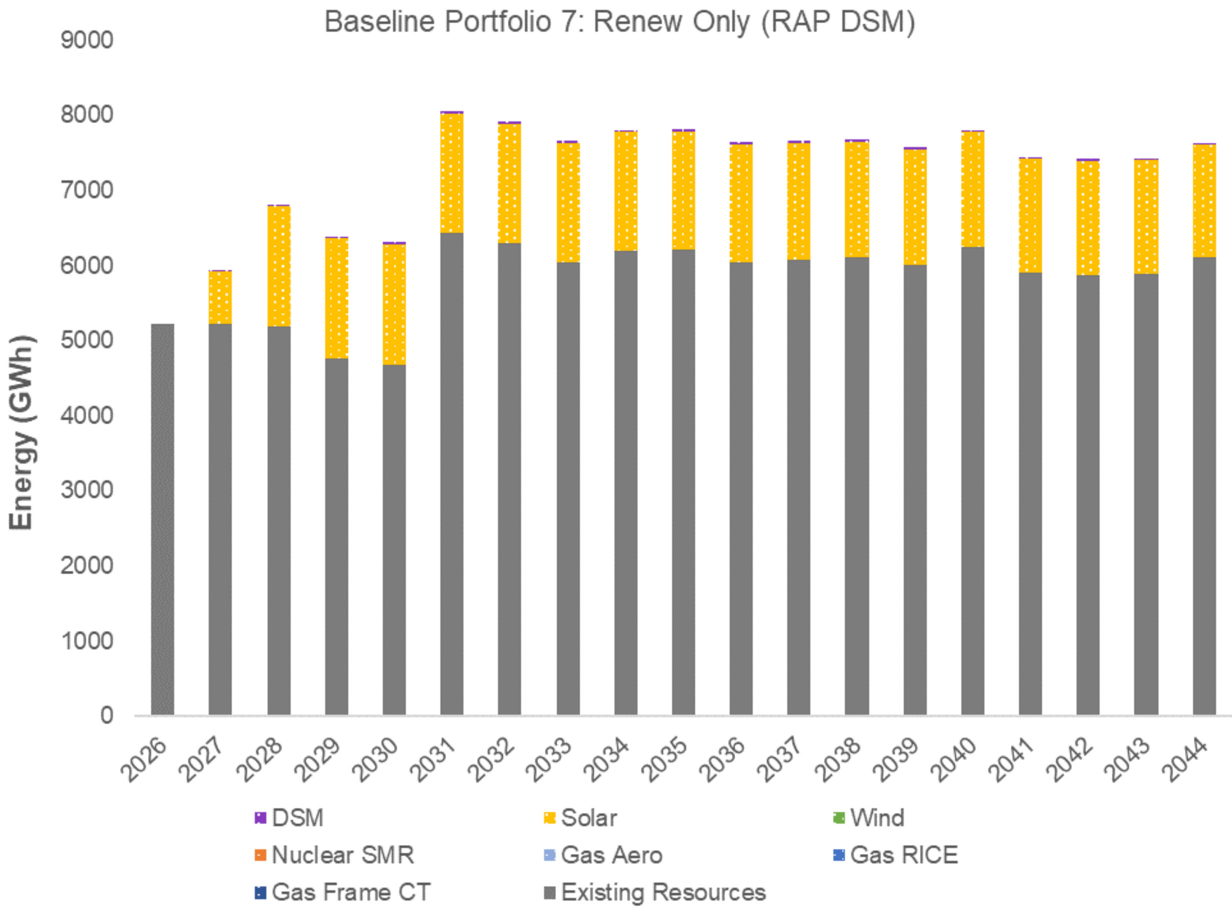


Figure 6-41 – Composition of Supply-Side Energy for Plan 8

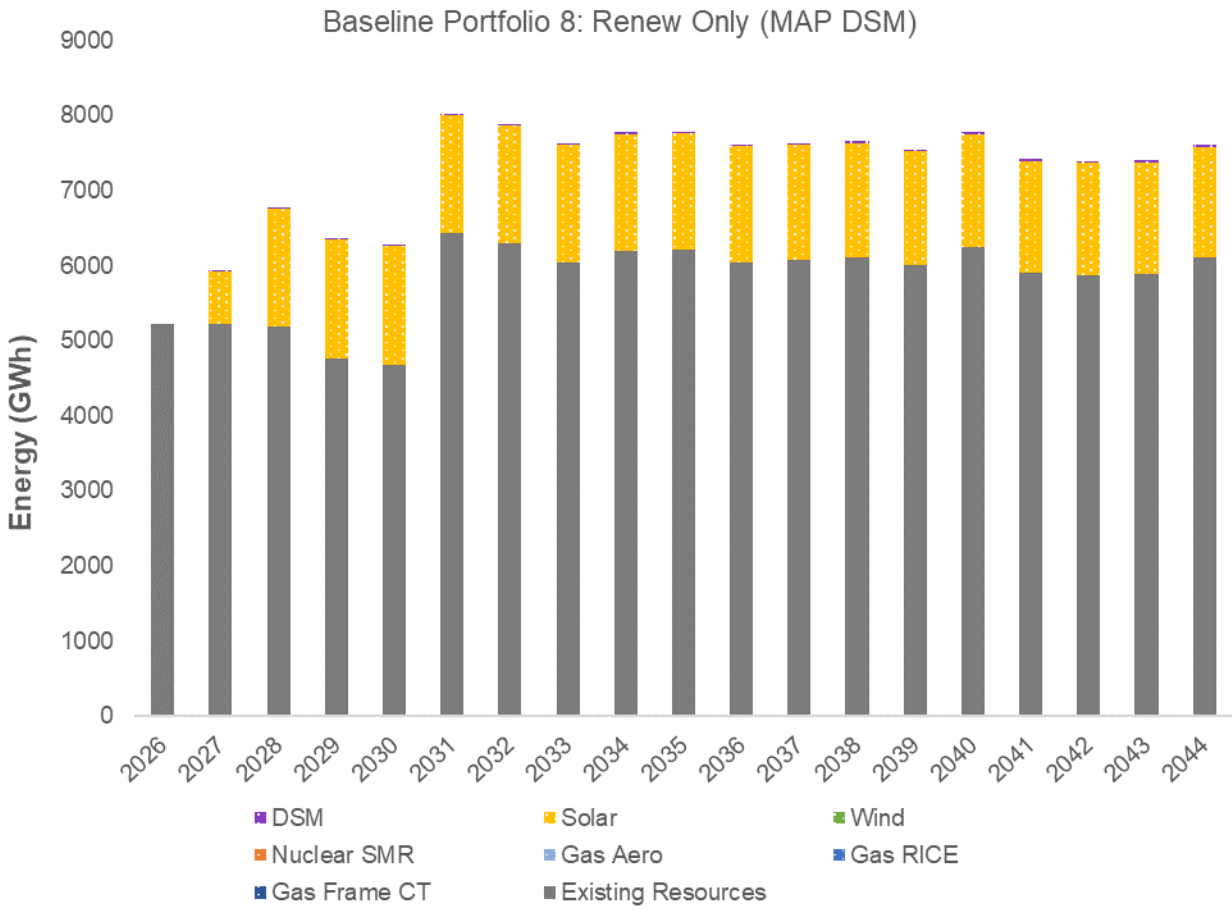


Figure 6-42 – Composition of Supply-Side Energy for Plan 9

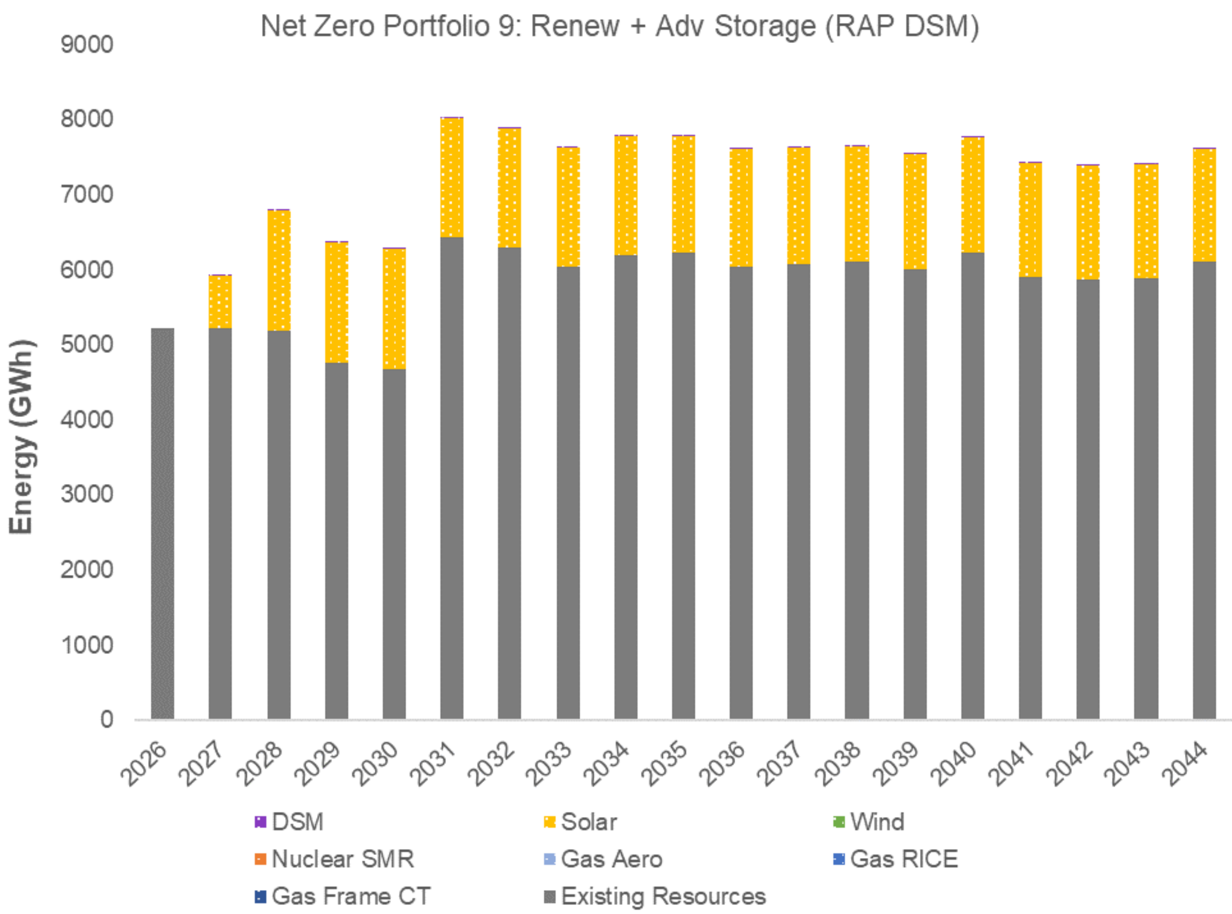


Figure 6-43 – Composition of Supply-Side Energy for Plan 10

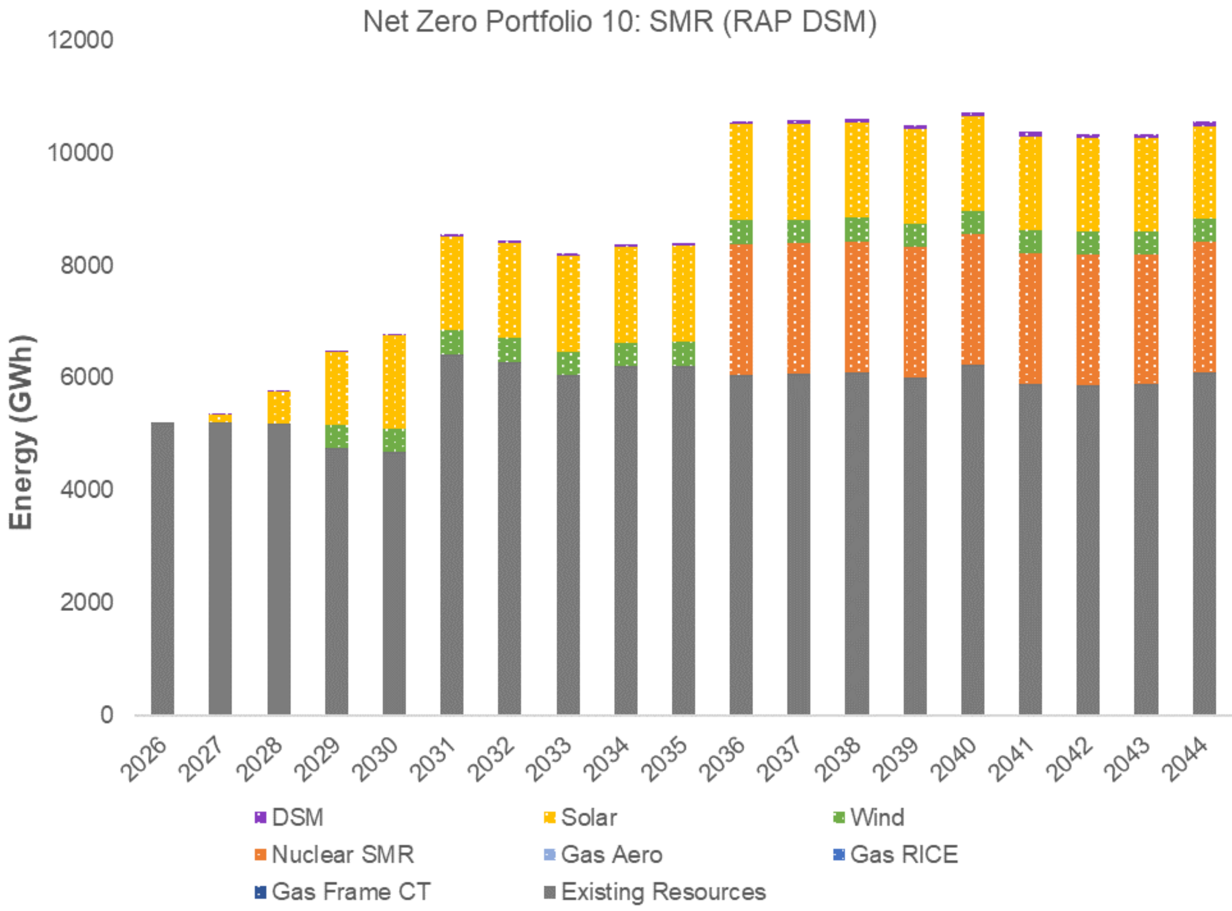


Figure 6-44 – Composition of Supply-Side Energy for Plan 11

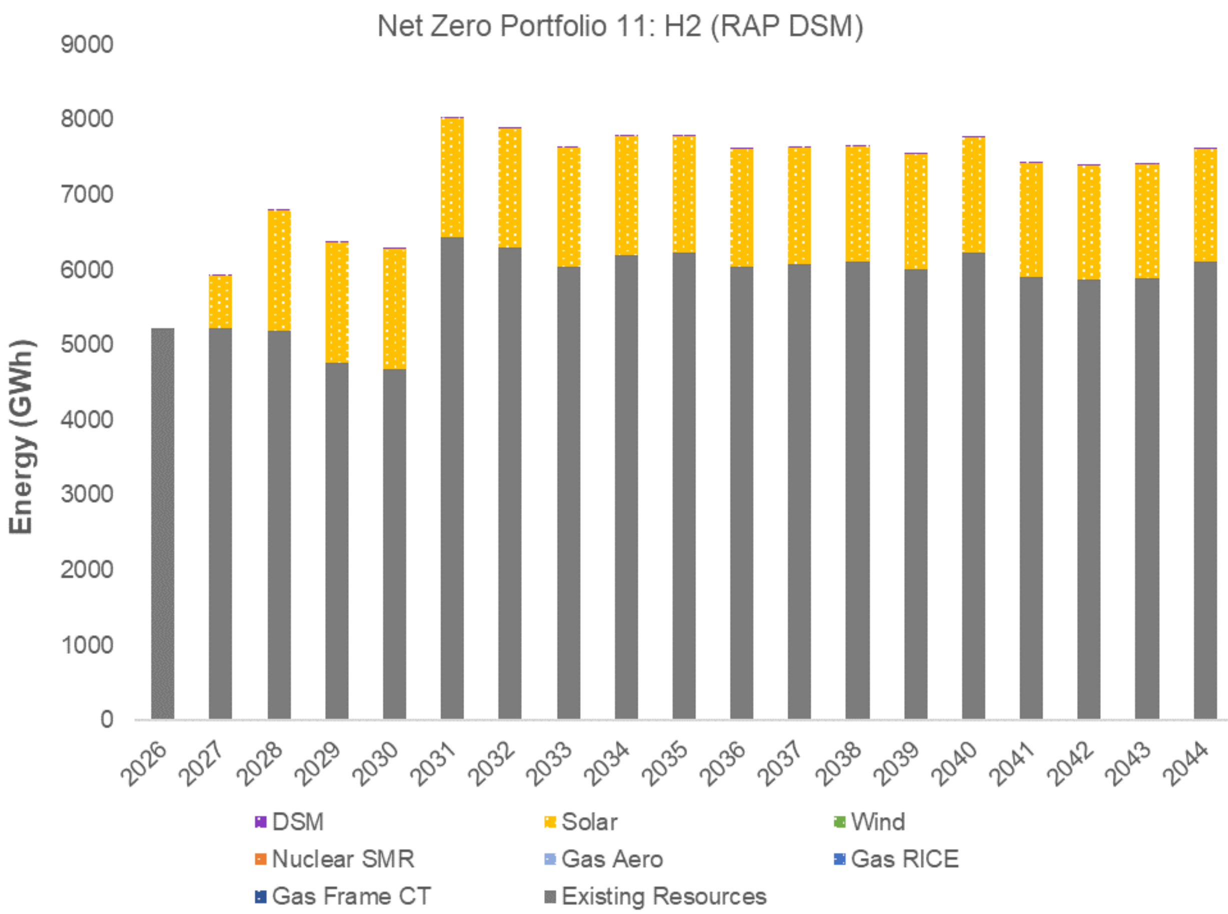
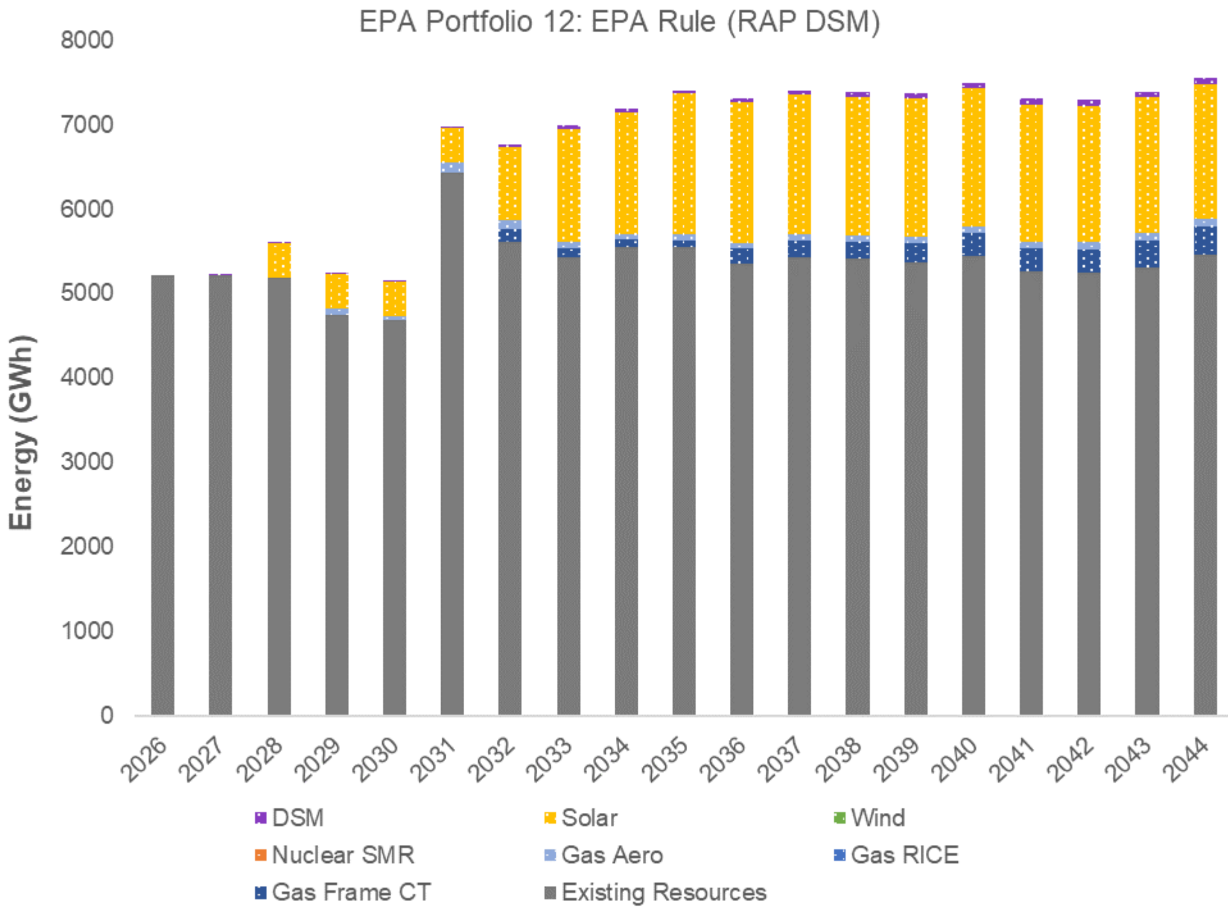


Figure 6-45 – Composition of Supply-Side Energy for Plan 12



4.2.7 Annual Emissions of Plans by Pollutant

7. Annual emissions of each environmental pollutant identified pursuant to 4 CSR 240-22.040(2)(B);

The annual emissions for CO_2, NO_X, and SO_2 for each alternative resource plan are provided in Figure 6-46 through Figure 6-49.

Figure 6-46 represents scope 1, 2, and 3 CO_2 emissions, while Figure 6-47 represents scope 1 and 2 CO_2 emissions only. For Liberty-Empire, emissions associated with the owned portion of Plum Point and Iatan 1 and 2 are scope 3, while those from other portfolio resources are scope 1 and 2.

Figure 6-46 – Annual CO_2 Emissions (Scope 1, 2, and 3)

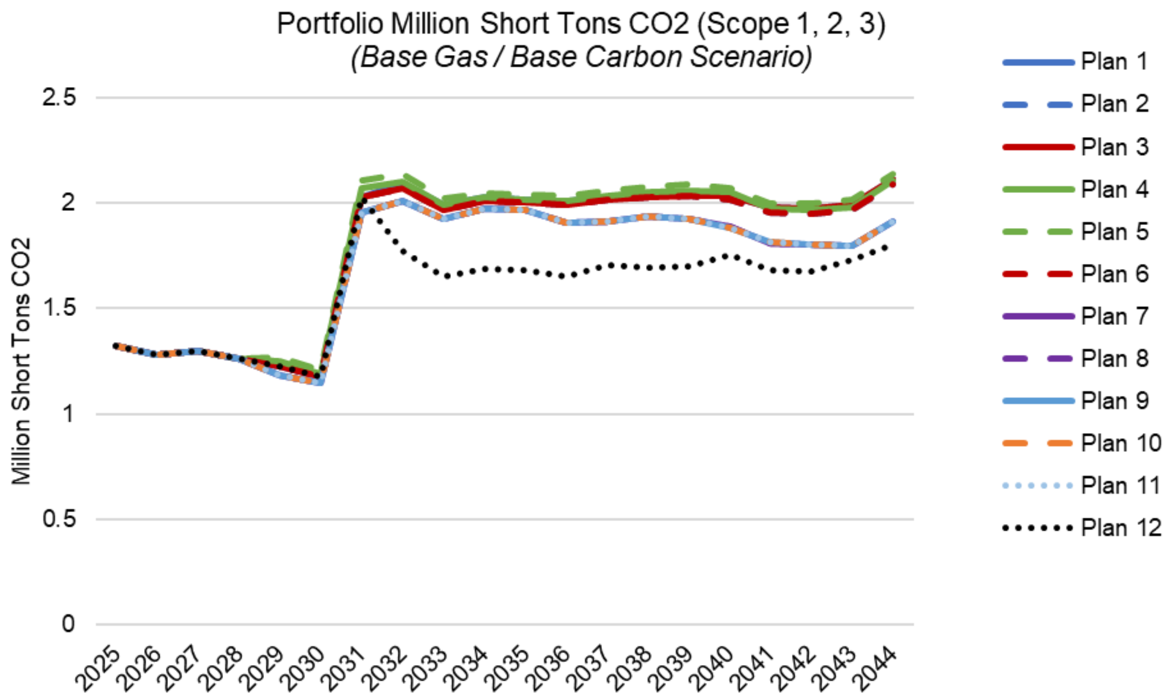


Figure 6-47 – Annual CO_2 Emissions (Scope 1 and 2 only)

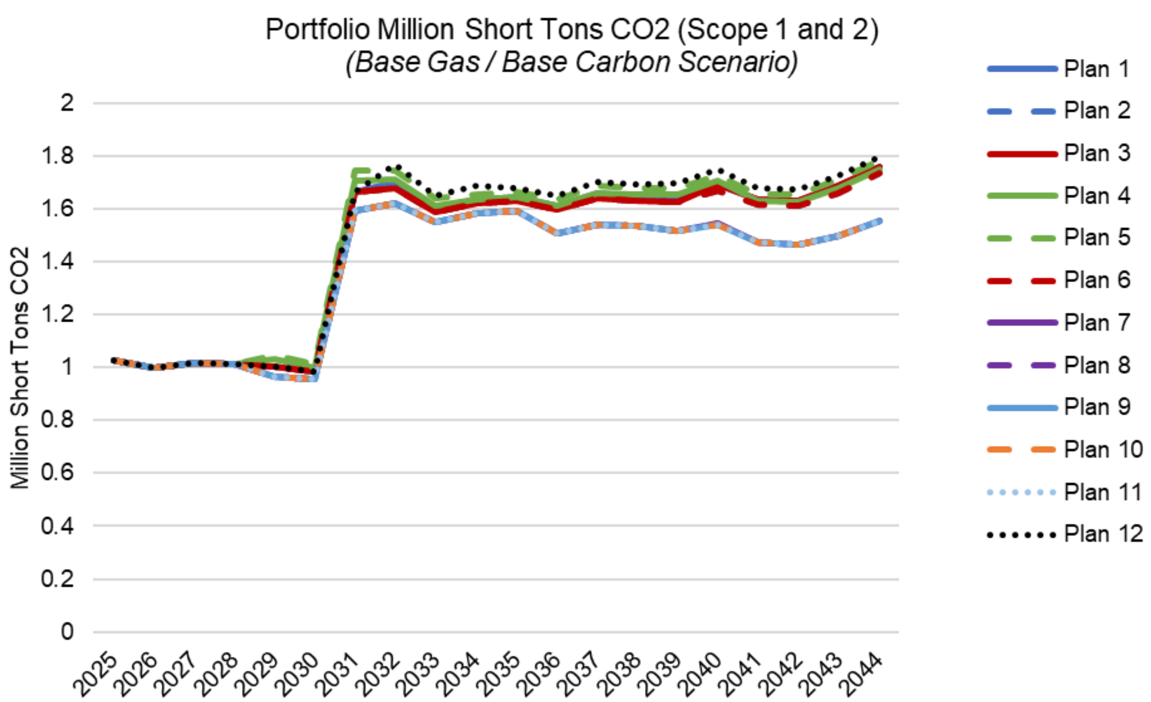


Figure 6-48 – Annual NOx Emissions

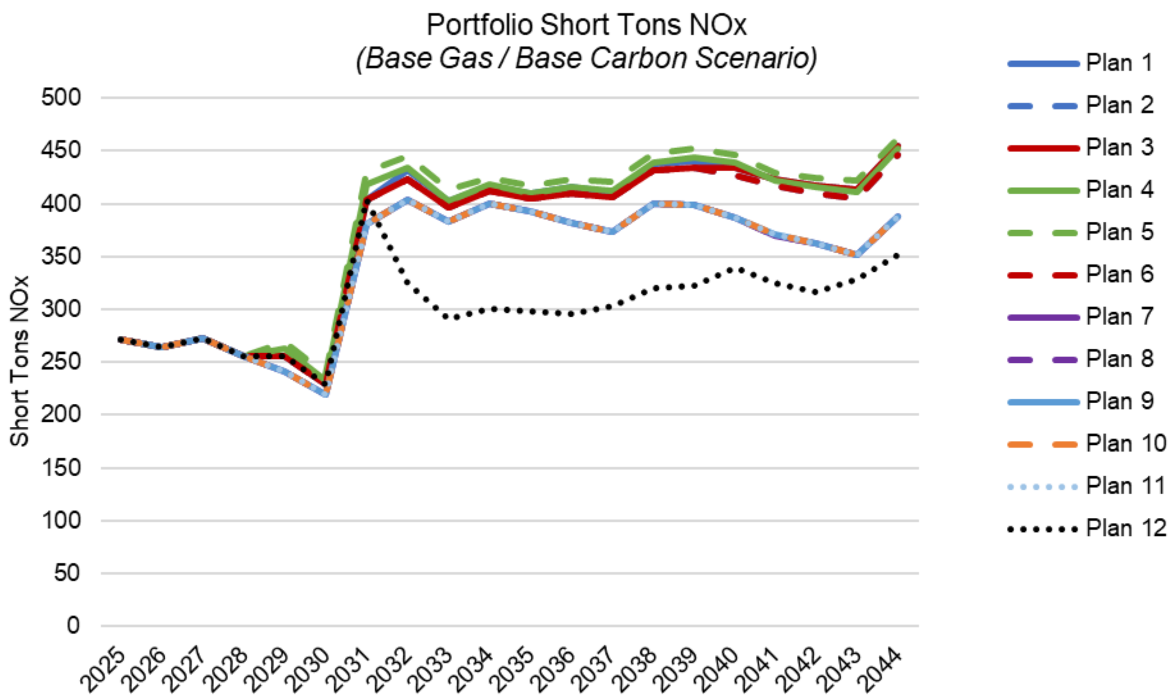
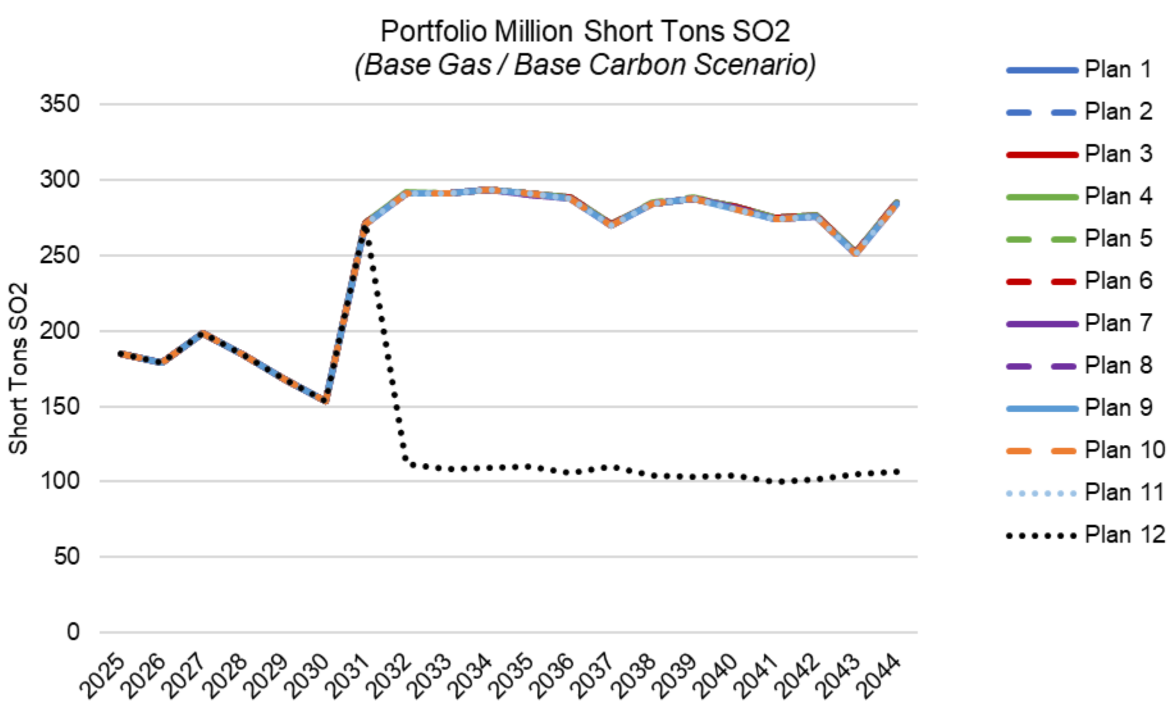


Figure 6-49 – Annual SO2 Emissions



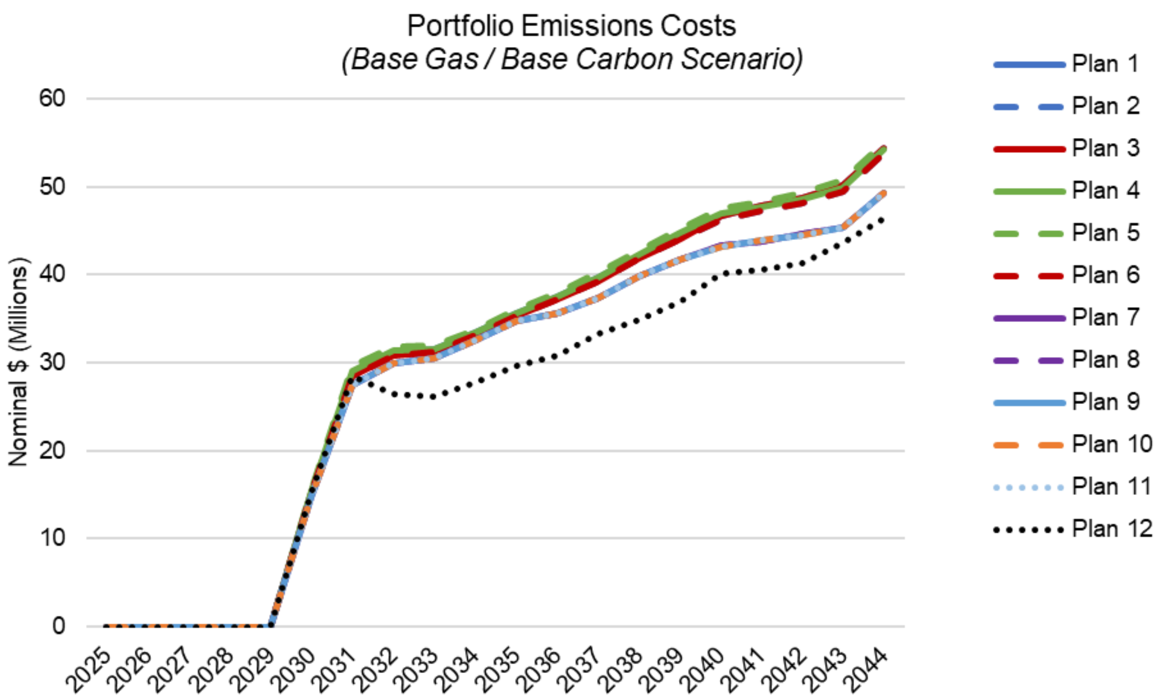
NP

4.2.8 Annual Probable Environmental Cost for Each Plan

8. Annual probable environmental costs; and

The total annual probable environmental costs for each alternative resource plan are shown in Figure 6-50.

Figure 6-50 – Annual Probable CO_2 Costs for Each Alternative Resource Plan



4.2.9 Forecast of Capacity Balance Tables

9. Public and highly-confidential forms of the capacity balance spreadsheets completed in the specified format;

The following tables provide the capacity balance forecast for each alternative resource plan for summer and winter.[15]

[15] Winter years represent January onward until spring, covering Liberty-Empires traditional peak occurring at the start of the year (for example, winter of 2030 includes January 2030 onward to spring 2030).

NP

Table 6-20 – Summer Forecast of Capacity Balance for Plan 1

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

[redacted]

NP

Table 6-21 – Winter Forecast of Capacity Balance for Plan 1

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

[redacted]

Table 6-22 – Summer Forecast of Capacity Balance for Plan 1A

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

[redacted]

NP

Table 6-23 – Winter Forecast of Capacity Balance for Plan 1A

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

[redacted]

Table 6-24 – Summer Forecast of Capacity Balance for Plan 2

Confidential in its Entirety

[redacted]

NP

Table 6-25 – Winter Forecast of Capacity Balance for Plan 2

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

[redacted]

Table 6-26 – Summer Forecast of Capacity Balance for Plan 3

****Confidential In Its Entirety****

[redacted]

Table 6-27 – Winter Forecast of Capacity Balance for Plan 3

****Confidential In Its Entirety****

[redacted]

Table 6-28 – Summer Forecast of Capacity Balance for Plan 4

Confidential In Its Entirety

[redacted]

Table 6-29 – Winter Forecast of Capacity Balance for Plan 4

Confidential In Its Entirety

[redacted]

NP

Table 6-30 – Summer Forecast of Capacity Balance for Plan 5

****Confidential In Its Entirety****

[redacted]

NP

Table 6-31 – Winter Forecast of Capacity Balance for Plan 5

****Confidential In Its Entirety****

[redacted]

Table 6-32 – Summer Forecast of Capacity Balance for Plan 6

****Confidential In Its Entirey****

[redacted]

Table 6-33 – Winter Forecast of Capacity Balance for Plan 6

****Confidential In Its Entirety****

[redacted]

Table 6-34 – Summer Forecast of Capacity Balance for Plan 7

****Confidential In Its Entirety****

[redacted]

NP

Table 6-35 – Winter Forecast of Capacity Balance for Plan 7

****Confidential In Its Entirety****

[redacted]

NP

Table 6-36 – Summer Forecast of Capacity Balance for Plan 8

****Confidential In Its Entirety****

[redacted]

NP

Table 6-37 – Winter Forecast of Capacity Balance for Plan 8

****Confidential In Its Entirety****

[redacted]

Table 6-38 – Summer Forecast of Capacity Balance for Plan 9

****Confidential In Its Entirety****

[redacted]

Table 6-39 – Winter Forecast of Capacity Balance for Plan 9

****Confidential In Its Entirety****

[redacted]

Table 6-40 – Summer Forecast of Capacity Balance for Plan 10

****Confidential In Its Entirety****

[redacted]

Table 6-41 – Winter Forecast of Capacity Balance for Plan 10

****Confidential In Its Entirety****

[redacted]

NP

Table 6-42 – Summer Forecast of Capacity Balance for Plan 11

****Confidential In Its Entirety****

[redacted]

Table 6-43 – Winter Forecast of Capacity Balance for Plan 11

****Confidential In Its Entirety****

[redacted]

NP

Table 6-44 – Summer Forecast of Capacity Balance for Plan 12

****Confidential In Its Entirety****

[redacted]

NP

Table 6-45 – Winter Forecast of Capacity Balance for Plan 12

****Confidential In Its Entirety****

[redacted]

4.2.10 Performance Measure Results for Each Plan

(C) The analysis of economic impact of alternative resource plans, calculated with and without utility financial incentives for demand-side resources, shall provide comparative estimates for each year of the planning horizon—

1. For the following performance measures for each year:

A. Estimated annual revenue requirement;

B. Estimated annual average rates and percentage increase in the average rate from the prior year; and

C. Estimated company financial ratios and credit metrics; and

The following tables provide the performance measures of each alternative resource plan.

NP

Table 6-46 – Plan 1 Performance

Confidential in its Entirety

Calculated without Utility Financial Incentives for DSM

[redacted]

Confidential in its Entirety

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-47 – Plan 1A Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-48 – Plan 2 Performance

Confidential in its Entirety

Calculated without Utility Financial Incentives for DSM

[redacted]

Confidential in its Entirety

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-49 – Plan 3 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

NP

Table 6-50 – Plan 4 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-51 – Plan 5 Performance

Confidential in its Entirety

Calculated without Utility Financial Incentives for DSM

[redacted]

Confidential in its Entirety

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-52 – Plan 6 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-53 – Plan 7 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-54 – Plan 8 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

NP

Table 6-55 – Plan 9 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-56 – Plan 10 Performance

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

Calculated without Utility Financial Incentives for DSM

[redacted]

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

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-57 – Plan 11 Performance

Confidential in its Entirety

Calculated without Utility Financial Incentives for DSM

[redacted]

Confidential in its Entirety

Calculated with Utility Financial Incentives for DSM

[redacted]

Table 6-58 – Plan 12 Performance

Confidential in its Entirety

Calculated without Utility Financial Incentives for DSM

[redacted]

Confidential in its Entirety

Calculated with Utility Financial Incentives for DSM

[redacted]

2. If the estimated company financial ratios in subparagraph (4)(C)1.C. 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 in subparagraphs (4)(C)1.A.-(4)(C)1.C. of the alternative resource plans that are associated with the necessary changes in legal mandates and cost recovery mechanisms.

Liberty-Empire does not anticipate below investment grade financial ratios based on the alternative plans presented.

4.2.11 Rate Change Modeling Methodology

(D) A discussion of how the impacts of rate changes on future electric loads were modeled and how the appropriate estimates of price elasticity were obtained;

Liberty-Empire included prices in the residential, small commercial, and large commercial, and municipal models. These models employ Statistically Adjusted End-Use ("SAE") variables. The SAE models include the following price elasticities:

- In the residential model and municipal models, the price elasticity used is -0.10.
- In the commercial models, the price elasticity used is -0.15.

Liberty-Empire shows that price is included as a variable in the class model descriptions located in Volume 3 Sections 6.1.2.1, 6.1.2.2, and 6.1.2.3. Volume 3 Figure 3-3 shows the historical and forecast price indices. The forecast uses historical prices and price elasticities help to explain historical sales and assumes a “flat” price forecast. The flat price forecast assumes price remain constant in real dollars.

4.2.12 Incremental Costs of Increasing Renewable Resources

(E) A discussion of the incremental costs of implementing more renewable energy resources than required to comply with renewable energy legal mandates;

Many of the alternative resource plans build renewable energy resources above what is required for Liberty-Empire to meet the Missouri RES standard. Liberty-Empire found that adding renewables to its portfolio can provide cost savings for customers relative to meeting customer obligations with thermal resources only. In fact, the preferred plan represents a diverse mix of new resources, including new renewable and gas resources, as discussed in Volume 7.

4.2.13 Incremental Costs of Increasing DSM

(F) A discussion of the incremental costs of implementing more energy efficiency resources than required to comply with energy efficiency legal mandates;

No target for energy efficiency currently exists.

4.2.14 Incremental Costs of Implementing Excess Resources

(G) A discussion of the incremental costs of implementing more energy resources than required to comply with any other energy resource legal mandates; and

No other legal mandates currently exist.

4.2.15 IRP Analysis Software

(H) A description of the computer models used in the analysis of alternative resource plans.

Liberty-Empire used a combination of multiple modeling tools to analyze the alternative resource plans. These models included:

- CRA's integrated energy market models (including the Aurora market model and the Natural Gas Fundamentals model), which develop fuel and electric power price projections.

- CRA's suite of resource planning models (including the Aurora market model and CRA's PERFORM model), which performs hourly dispatch simulation, production cost analysis, and financial revenue requirement projections.

<u>CRA Market Models</u>

Liberty-Empire relied on the following models to develop inputs for natural gas, coal, and SPP power prices:

- CRA's Natural Gas Fundamentals ("NGF") model, which provides a bottom-up forecast of North American gas production and prices with a focus on shale gas supply and other unconventional resources. Key NGF outputs include a long-term price forecast for domestic natural gas, as well as breakeven costs and production data for major gas basins across the United States. NGF is a national model, useful for macroeconomic scenarios. CRA also licenses the Gas Pipeline Competition Model ("GPCM") model from RBAC Inc. for regional basis analysis.

- The Aurora model, which CRA licenses from Energy Exemplar, performs regional long-term capacity expansion analysis and produces hourly SPP market prices at a zonal level based on a fundamental dispatch of the market. Market inputs for the Aurora model include fuel prices, emission prices, regional load forecasts, existing resource parameters, announced regional capacity additions and retirements, and costs and operational parameters for new technology resource options.

Aurora is recognized in the industry for its flexibility and breadth of technical capability. It incorporates extensive details in generating unit operating characteristics and constraints, transmission constraints, generation analysis, unit commitment/operating conditions, and market system operations. The Aurora model considers:

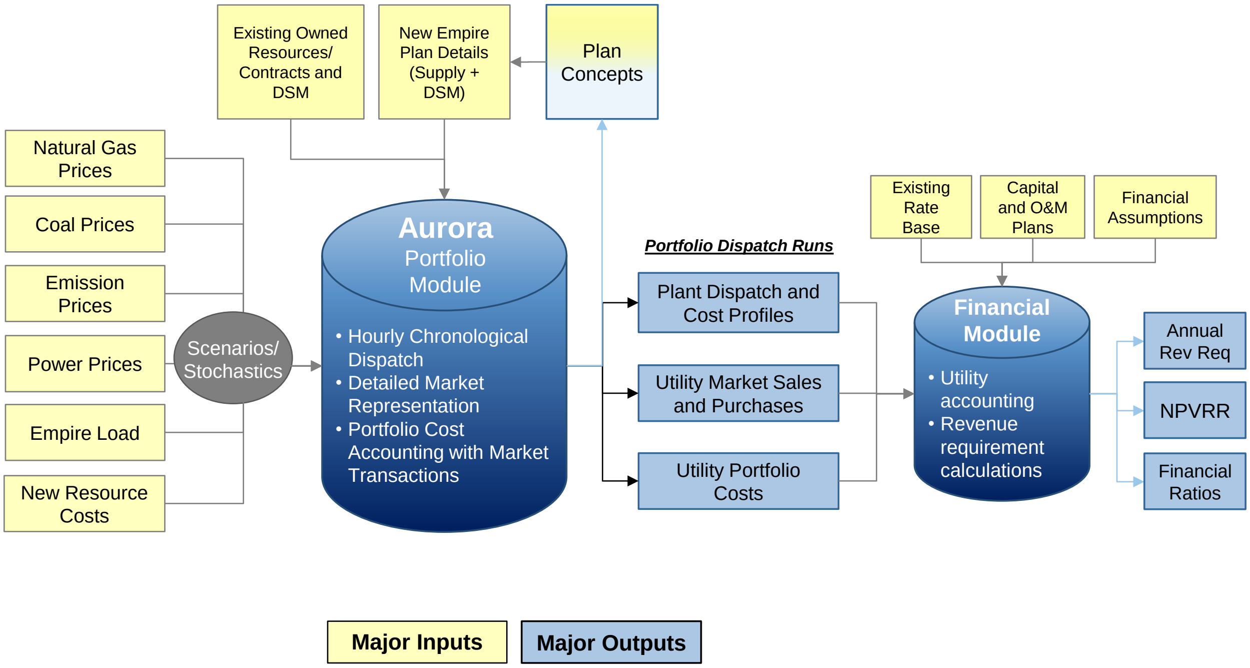
- Individual power plant characteristics, including heat rates, start-up costs, ramp rates, and other technical characteristics of plants;
- Transmission line interconnections, ratings, losses, and wheeling rates;
- Forecasts of resource additions and fuel costs over time;
- Forecasts of loads for each utility or load-serving entity in the region; and
- The cost and availability of fuels that supply the plants.

The heart of Aurora is an hourly chronological dispatch algorithm that minimizes costs (or bids) while simultaneously adhering to various operating constraints, including generating unit characteristics, transmission limits, and customer demand. Aurora performs an hourly unit commitment and dispatch, recognizing these constraints to forecast hourly energy prices, unit generation, revenues and fuel consumption, and transmission flows.

CRA Resource Planning Models

CRA's resource planning models include licensed and proprietary tools that evaluate portfolio options and calculate unit-specific generation and cost profiles, market purchases and sales in the SPP market, Liberty-Empire portfolio costs, and revenue requirements. An overview of the modeling process is provided in Figure 6-51. Additional details on each component are provided below.

Figure 6-51 – CRA Resource Planning Model Overview



CRA's resource planning tools comprise:

- The Aurora portfolio tool, which performs portfolio optimization and portfolio cost accounting, and
- CRA's proprietary financial module ("PERFORM") performs utility accounting and revenue requirement calculations.

Aurora

The Aurora model was used in Liberty-Empire's IRP to develop and evaluate alternative resource plans. Aurora takes key assumptions and drivers of the resource portfolio decision as inputs. As shown in Figure 6-51, these inputs include fuel prices, emission prices, SPP power prices, Liberty-Empire's load growth forecasts, and costs for new resource parameters, as described in detail in Volume 4. The model also requires information regarding Liberty-Empire's existing portfolio resources and contracts, such as capacity, operational characteristics, and costs.

After defining all of these input assumptions, portfolio optimization analysis was conducted with the Aurora model's portfolio optimization tool to develop least-cost portfolio concepts under various planning and resource acquisition strategy constraints. These constraints defined which resource options were available, as well as the minimum and maximum reserve margin and block size for candidate resources. The portfolio optimization framework evaluated both supply-side and demand-side resources. The portfolio optimization algorithm in Aurora seeks to minimize the present value of portfolio costs through a selection of candidate resource options.

After the specific portfolio plans were constructed, each was evaluated through a full chronological dispatch analysis for the base case and all stochastic input combinations of critical uncertain factors in Aurora's portfolio module. This exercise performs an hourly, chronological dispatch of Liberty-Empire's portfolio within the SPP power market, accounting for all variable costs of operation, all contracts or PPAs, and all economic purchases and sales with the surrounding market. Aurora produces projections of asset-level dispatch and the total variable costs associated with serving load. It also produces estimates for other key metrics, such as carbon dioxide emissions over time and capacity and fuel type generation, as this volume summarized earlier.

Financial Module / PERFORM

CRA's proprietary financial module uses the Aurora output to build a full annual revenue requirement, inclusive of capital investments, fixed operating and maintenance costs, and financial accounting of depreciation, taxes, and utility return on investment. The model requires a series of inputs, including book and tax values for existing generation assets, depreciation schedules, fixed operations and maintenance costs and major maintenance capital expenditures, debt and equity costs, tax rates, and a discount rate. The model produces annual and present value estimates of revenue requirements. The full set of portfolio modeling is undertaken for all portfolio options for the base case and all stochastic input combinations.

Additional Models

Due to the importance of additional revenue streams associated with storage resources (see Volume 4 for a discussion on storage resource value), Liberty-Empire also used CRA's Energy Storage Operations ("ESOP") model to evaluate real-time energy and ancillary services value for flexible resources prior to inclusion in the portfolio optimization analysis. ESOP considers the operation of flexible assets at five-minute granularity. Based on exogenously specified energy and ancillary services prices, the model optimizes the dispatch of resources to maximize revenue while taking into account detailed operational constraints such as efficiency, battery life cycle, maximum charge/discharge ratings, and storage capacity.

SECTION 5 UNCERTAIN FACTORS

(5) The utility shall describe and document its selection of the uncertain factors that are critical to the performance of the alternative resource plans. The utility shall consider at least the following uncertain factors:

Pursuant to 20 CSR 4240-22.060(5), Liberty-Empire developed a list of potential uncertain factors to use to evaluate the resilience to risk of the alternative plans, including but not limited to those prescribed by the IRP rule. Liberty-Empire compiled information concerning the uncertain factors listed in the rule from subject matter experts within the company and its consultants. The subject matter experts and consultants developed wide but reasonable scenario ranges for each identified factor. Some of the uncertain factor scenarios were grouped into a single uncertain factor to simplify the analysis. Figure 6-52 lists the uncertain factors and factor groupings developed by Liberty-Empire.

Figure 6-52 – List of Uncertain Factors

Uncertain Factor	Scenarios	Group
Load Growth	3	"Load"
Planning Reserve Margin	2	
Capital Cost Trajectories	3	"Cost of New Build" (CapEx, Interest Rate, Interconnection Cost, Tax Credits, FOM, CF)
Interest Rates	3	
Interconnection Costs	3	
Tax Credits	3	
FOM	3	
Renewable CF	3	
Carbon Prices	3	"Carbon / Emission"
SO2 and NOx Prices	3	
Natural Gas Prices	3	"NG Price"
Forced Outage Rates	3	"FOR"
Power / Capacity Prices	9 (based on market modeling)	"Power / A/S / ELCC" (Carbon / Emissions & NG Price permutations)
Solar & Storage ELCC	9 (based on market modeling)	
A/S Value	9 (based on market modeling)	

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 to determine whether an uncertain factor was critical. If the average PVRR values across the portfolios changed by more than 1% 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 6-53. Note that the variables related to the power market outcomes (i.e., power prices, ELCC, and ancillary service value) depend on the underlying combination of carbon price and natural gas fuel price scenarios and were therefore tested along with those uncertain factors.

Figure 6-53 – Uncertain Factor Testing Approach

Case	CO2, SO2, NOx	Gas Prices	Load	FOR	CapEx	Interest Rate	Interconnection	FOM	Renew CF
0 - Base	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**	**Base**
1 - Low Emission Price	Low	Base	Base	Base	Base	Base	Base	Base	Base
2 - High Emission Price	High	Base	Base	Base	Base	Base	Base	Base	Base
3 - Low Gas Price	Base	Low	Base	Base	Base	Base	Base	Base	Base
4 - High Gas Price	Base	High	Base	Base	Base	Base	Base	Base	Base
5 - Low Load	Base	Base	Low	Base	Base	Base	Base	Base	Base
6 - High Load	Base	Base	High	Base	Base	Base	Base	Base	Base
7 - Low FOR	Base	Base	Base	Low	Base	Base	Base	Base	Base
8 - High FOR	Base	Base	Base	High	Base	Base	Base	Base	Base
9 - Low Cap Cost	Base	Base	Base	Base	Low	Base	Base	Base	Base
10 - High Cap Cost	Base	Base	Base	Base	High	Base	Base	Base	Base
11 - Low Interest Rate	Base	Base	Base	Base	Base	Low	Base	Base	Base
12 - High Interest Rate	Base	Base	Base	Base	Base	High	Base	Base	Base
13 - Low IC Cost	Base	Base	Base	Base	Base	Base	Low	Base	Base
14 - High IC Cost	Base	Base	Base	Base	Base	Base	High	Base	Base
15 - Low FOM	Base	Base	Base	Base	Base	Base	Base	Low	Base
16 - High FOM	Base	Base	Base	Base	Base	Base	Base	High	Base
17 - Low Renew CF	Base	Base	Base	Base	Base	Base	Base	Base	Low
18 - High Renew CF	Base	Base	Base	Base	Base	Base	Base	Base	High

Based on the analysis described above, Table 6-59 summarizes the uncertain factors that were individually tested and deemed critical, as well as the final groupings used in the risk analysis described in Section 6.

Table 6-59 – Uncertain Factor Evaluation Results

<table>
<tr><th>Uncertain Factor</th><th>Include in CUF Analysis?</th><th>Final CUF Grouping</th></tr>
<tr><td>Load</td><td>Yes</td><td rowspan="2">“Load”</td></tr>
<tr><td>Planning Reserve Margin</td><td>Yes</td></tr>
<tr><td>Capital Cost Trajectories</td><td>Yes</td><td rowspan="6">“Cost of New Builds”</td></tr>
<tr><td>Interest Rates</td><td>Yes</td></tr>
<tr><td>Interconnection Costs</td><td>Yes</td></tr>
<tr><td>Tax Credits</td><td>Yes</td></tr>
<tr><td>FOM</td><td>No</td></tr>
<tr><td>Renewable Capacity Factor</td><td>No</td></tr>
<tr><td>Carbon Prices</td><td rowspan="2">Yes</td><td rowspan="2">“Emissions”</td></tr>
<tr><td>SO_2, NO_X Prices</td></tr>
<tr><td>NG Prices</td><td>Yes</td><td>“NG Price”</td></tr>
<tr><td>Forced Outage Rates</td><td>No</td><td>“FOR”</td></tr>
<tr><td>Power / Capacity Prices</td><td rowspan="3">Yes</td><td rowspan="3">“Power / A/S / ELCC”
(dependent on Emissions and NG Prices)</td></tr>
<tr><td>Solar and Storage ELCC</td></tr>
<tr><td>A/S Value</td></tr>
</table>

5.1 Load Growth

(A) The range of future load growth represented by the low-case and high-case load forecasts;

As specified at 20 CSR 4240-22.030(7) and 20 CSR 4240-22.030(8), the development of the low, base, high, and high-high load growth scenarios are described in more detail in Volume 3. For the CUF analysis, Liberty-Empire applied Itron's high-high load growth scenario as its upper (high) load sensitivity. The high-high scenario captures the assumptions of the high scenario, plus additional load, resulting in an overall wider range of load outcomes. Further, the load growth uncertain factor was applied in combination with the planning reserve margin uncertain factor. Under the low and base load growth scenarios, Liberty-Empire applied the base case planning reserve margin scenario, and under the high-high load growth scenario, Liberty-Empire applied the high case planning reserve margin scenario. Load (and PRM) was found to change the portfolio-average PVRR by more than 1% and was therefore deemed a critical uncertain factor to include in the risk analysis.

5.2 Interest Rate Levels

(B) Future interest rate levels and other credit market conditions that can affect the utility's cost of capital and access to capital;

Future interest rate scenarios were based on an analysis of historical 10-year treasury rates. When interest rates were tested in the modeling, the portfolio-average PVRR was found to change by more than 1%. Thus, interest rates were deemed a critical uncertain factor and included in the risk analysis.[16]

5.3 Legal Mandates

(C) Future changes in legal mandates;

Potential changes to legal mandates were modeled as various carbon regulation scenarios. Additional detail on the carbon regulation scenarios can be found in Volume 4 Section 5.4.1. Carbon regulation was found to change PVRR by more than 1%, was deemed a critical uncertain factor, and was included in the risk analysis. Conversely, Liberty-Empire does not believe any changes in RPS or other foreseeable legal mandates would affect the modeled alternative resource plans.

5.4 Fuel Prices

(D) Relative real fuel prices;

Additional detail on the natural gas price scenarios can be found in Volume 4 Section 5.1. Natural gas prices were found to change PVRR by more than 1% and were deemed a critical uncertain factor.

5.5 Siting and Permitting Costs

(E) Siting and permitting costs and schedules for new generation and generation-related transmission facilities for the utility, for a regional transmission organization, and/or other transmission systems;

[16] Interest rates are grouped into the 'Cost of New Build' category along with capital costs, interconnection costs, and tax credits, as shown in Table 6-59.

Siting and permitting costs were incorporated into the high, base, and low capital cost / cost of new build scenarios. Capital costs were found to change PVRR by more than 1% and were deemed a critical uncertain factor.

5.6 Construction Costs

> *(F) Construction costs and schedules for new generation and generation-related transmission facilities for the utility, for a regional transmission organization, and/or other transmission systems;*

Construction costs were incorporated into the high, base, and low capital cost / cost of new build scenarios. Capital costs were found to change PVRR by more than 1% and were deemed a critical uncertain factor.

5.7 Purchased Power Availability

> *(G) Purchased power availability, terms, cost, optionality, and other benefits;*

Because Liberty-Empire is a member of SPP, the availability of purchased power was not considered a risk. However, the *cost* of purchased power was modeled in developing nine potential power market outcomes that represented permutations of the three carbon regulation scenarios (high, base, and low) and the three natural gas price scenarios (high, base, and low).

5.8 Emission Allowance Prices

> *(H) Price of emission allowances, including at a minimum sulfur dioxide, carbon dioxide, and nitrogen oxides;*

Additional detail on the emission price scenarios can be found in Volume 4 Section 5.4. Emission prices were found to change PVRR by more than 1% and were therefore determined a critical uncertain factor to be included in the risk analysis.

5.9 Fixed O&M

Fixed operation and maintenance costs for new and existing generation facilities;

Fixed O&M scenarios did not change PVRR by more than 1% and were excluded from the risk analysis.

5.10 Forced Outage

(J) Equivalent or full- and partial-forced outage rates for new and existing generation facilities;

Forced outage rate scenarios did not change PVRR by more than 1% and were excluded from the risk analysis.

5.11 Future Load Impacts of DSM

(K) Future load impacts of demand-side programs and demand-side rates;

The analysis for RAP and MAP portfolios during the portfolio optimization process captures uncertainty around DSM costs and potential.

5.12 Future Costs for DSM

(L) Utility marketing and delivery costs for demand-side programs and demand-side rates; and

The analysis for RAP and MAP portfolios during the portfolio optimization process captures uncertainty around DSM costs and potential.

5.13 Other Uncertain Factors

(M) Any other uncertain factors that the utility determines may be critical to the performance of alternative resource plans.

In addition to the uncertain factors described previously in this section, Liberty-Empire also included interconnection costs and variables associated with the nine modeled power market outcomes (representing permutations of the three carbon regulation scenarios (high, base and low) and the three natural gas price scenarios (high, base and low)) as uncertain factors. While interconnection costs were not found to change the portfolio-average PVRR by more than 1%, this factor was included as a critical uncertain factor due to current dynamics related to the generator interconnection process, including an increase in interconnection requests and the potential for process reform in SPP. The grouping of variables associated with the nine modeled power market outcomes were found to change PVRR by more than 1% and were deemed to be critical.

SECTION 6 CRITICAL UNCERTAIN FACTORS ASSESSMENT

(6) The utility shall 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 developed pursuant to 4 CSR 240-22.060(3) and analyze the risks associated with alternative resource plans. This assessment shall explicitly describe and document the probabilities that utility decision-makers assign to each critical uncertain factor.

As described in Section 5, the uncertain factors determined to impact the expected performance of the alternative resource plans included: load growth, carbon prices, gas prices, and a grouping of factors related to the cost of new builds**.** 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.

Each critical uncertain factor was evaluated for its impact on the PVRR of each alternative plan, illustrated by "tornado diagrams."[17] Tornado diagrams effectively depict the influence of these driving factors on the PVRR, thereby providing insight into where a risk aversion strategy should be focused. The major driver of PVRR uncertainty for all plans is capital cost uncertainty, followed by environmental cost uncertainty. The following figures illustrate the cumulative probability of the influence of critical uncertain factors on each of the alternative resource plans in terms of 20-year PVRR values.[18]

[17] Tornado diagrams are useful for deterministic sensitivity analysis, comparing the relative importance of uncertain variables. Each variable considered is estimated for what the low, base, and high outcomes would be. The sensitivity variable is modeled as an uncertain value while all other variables are held at baseline values.

[18] Across all alternative resource plans, the PVRR of the high emissions uncertain factor is negative relative to the base case. As discussed more in Section 7.1, the high emissions case is modeled using the EPA GHG rule to enforce carbon restrictions, rather than a higher emissions price. Implementation of carbon restrictions through accelerated coal retirements and limited operation of new gas units results in a scenario with no carbon emissions cost and higher energy price, leading to higher energy sales and lower energy purchases. These combined effects result in a lower overall PVRR versus base case.

Figure 6-54 – Plan 1 Tornado Diagram ($ millions)

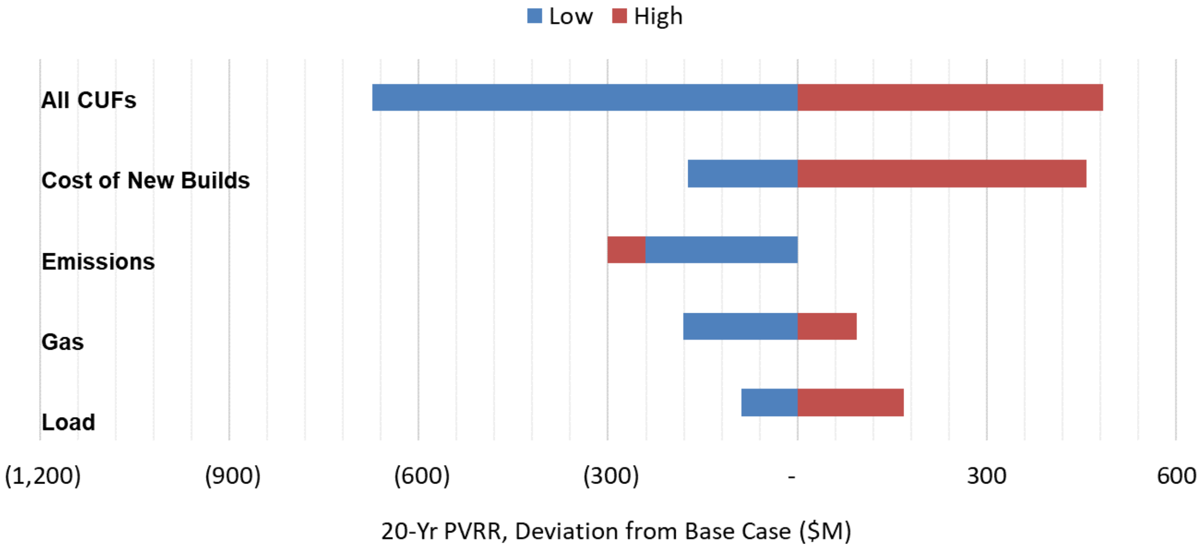


Figure 6-55 – Plan 2 Tornado Diagram ($ millions)

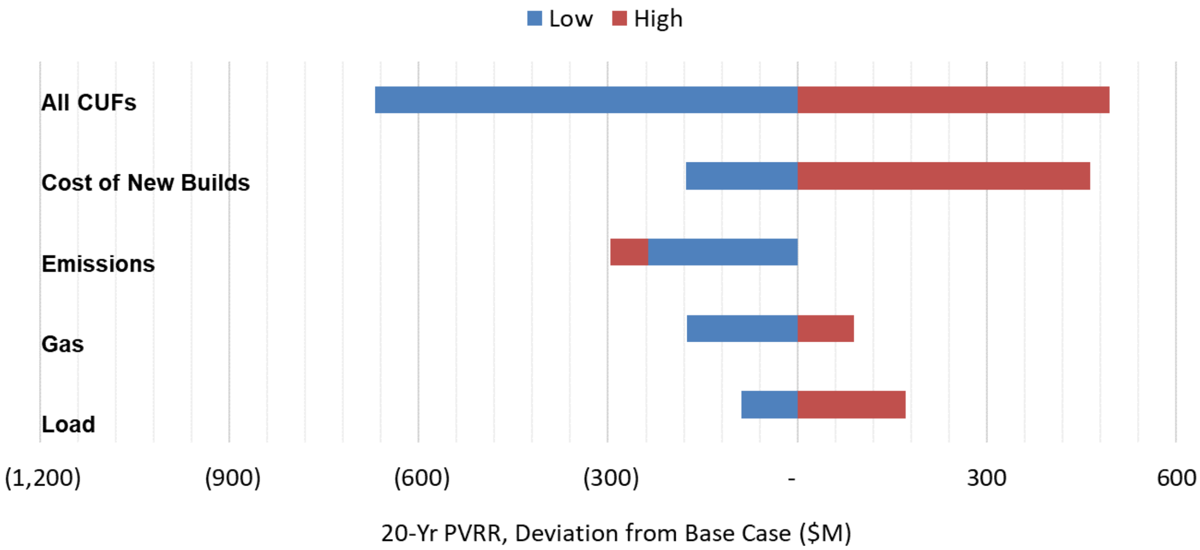


Figure 6-56 – Plan 3 Tornado Diagram ($ millions)

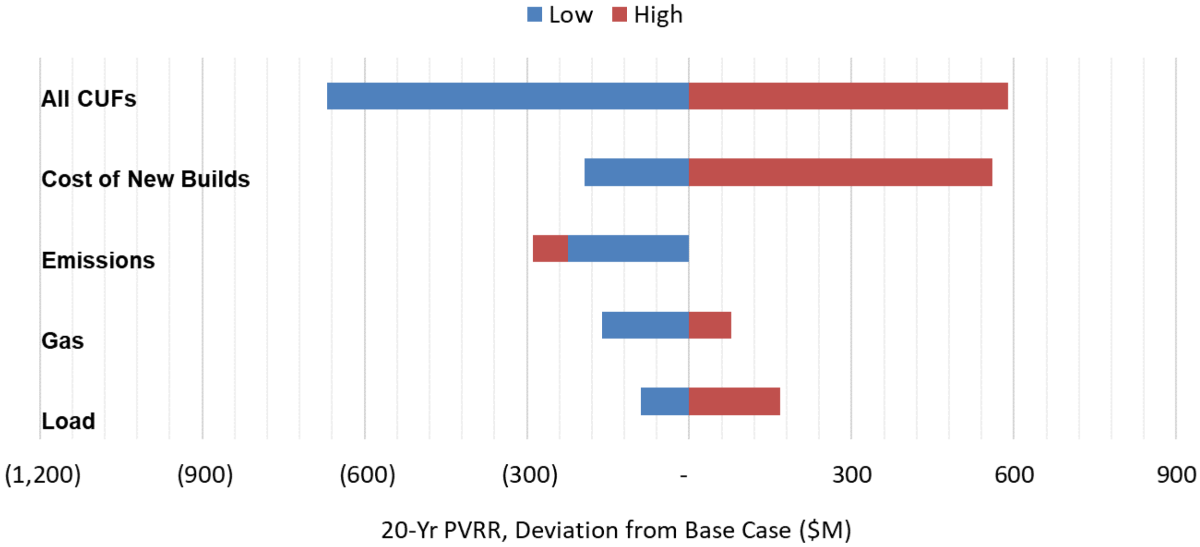


Figure 6-57 – Plan 4 Tornado Diagram ($ millions)

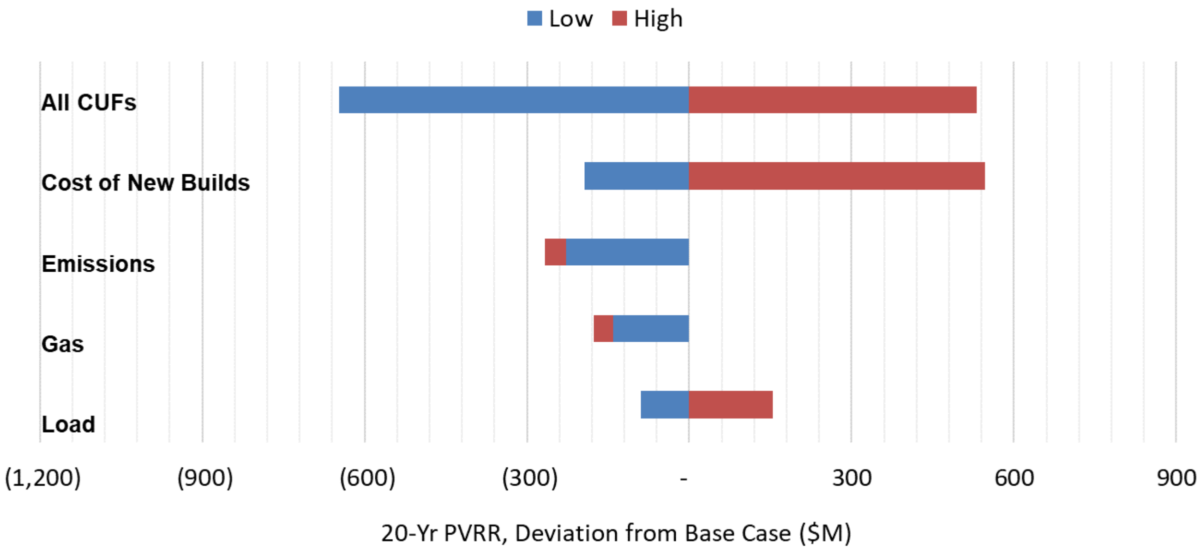


Figure 6-58 – Plan 5 Tornado Diagram ($ millions)

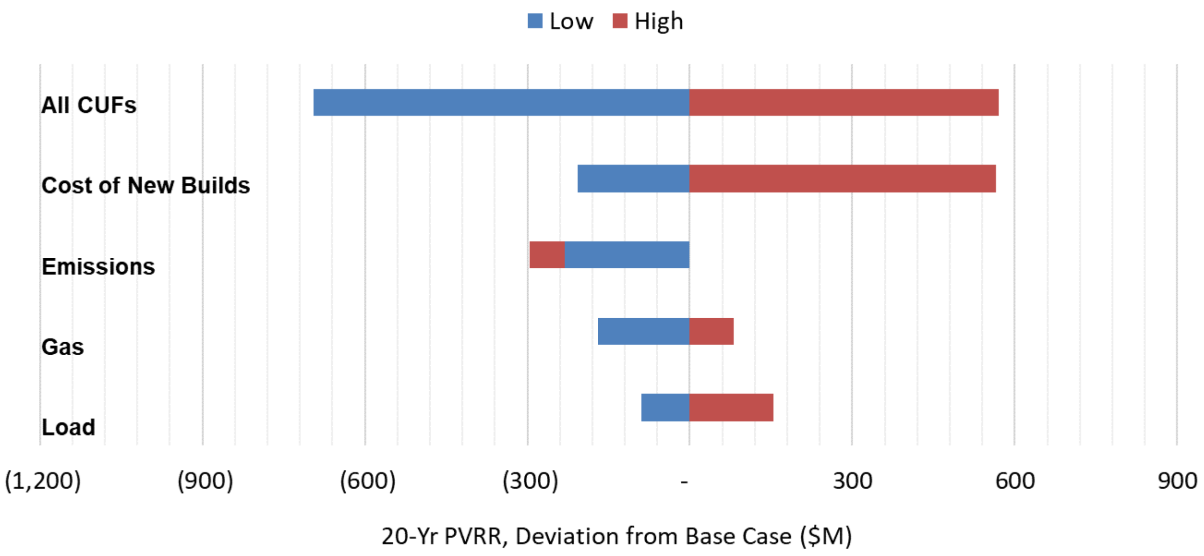


Figure 6-59 – Plan 6 Tornado Diagram ($ millions)

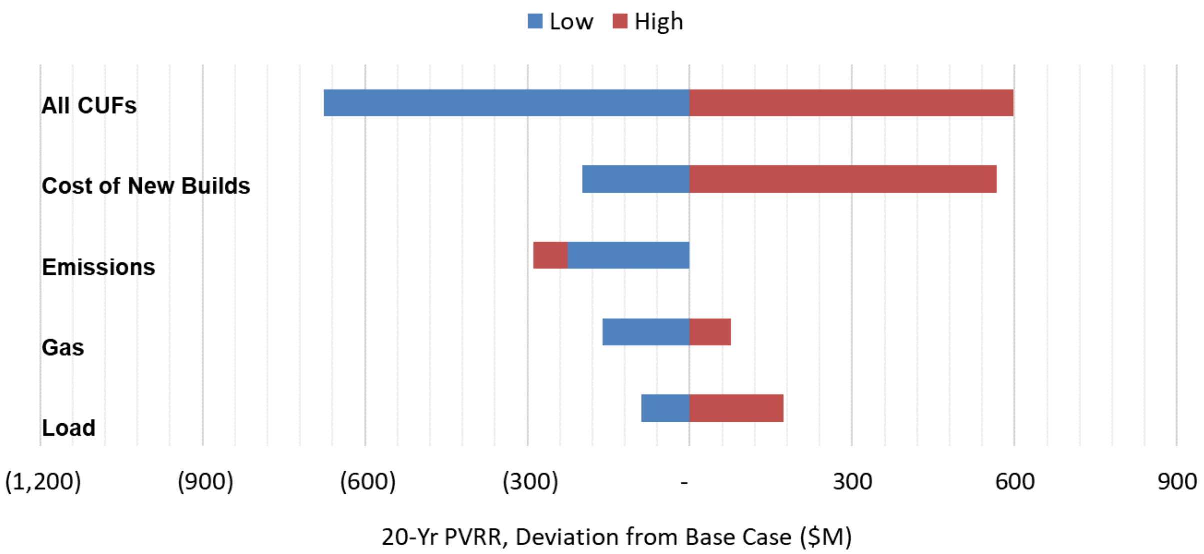


Figure 6-60 – Plan 7 Tornado Diagram ($ millions)

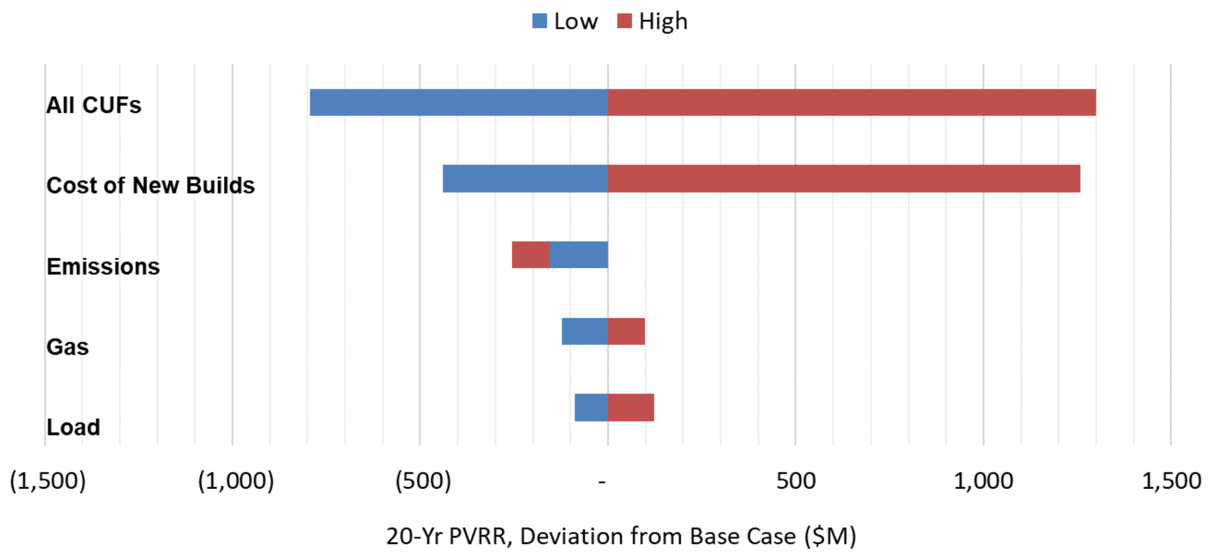


Figure 6-61 – Plan 8 Tornado Diagram ($ millions)

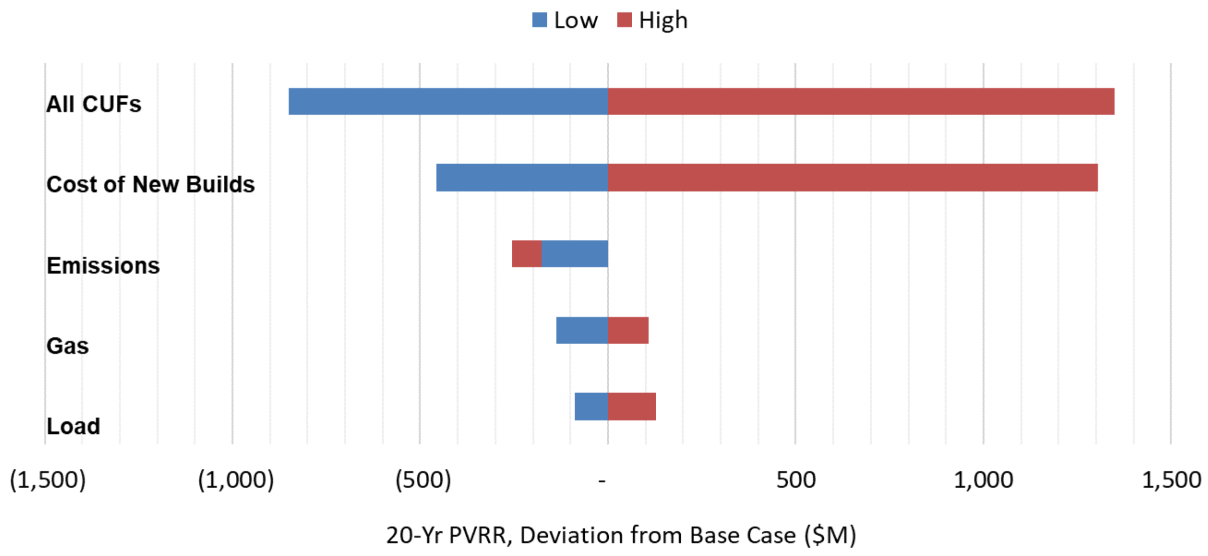


Figure 6-62 – Plan 9 Tornado Diagram ($ millions)

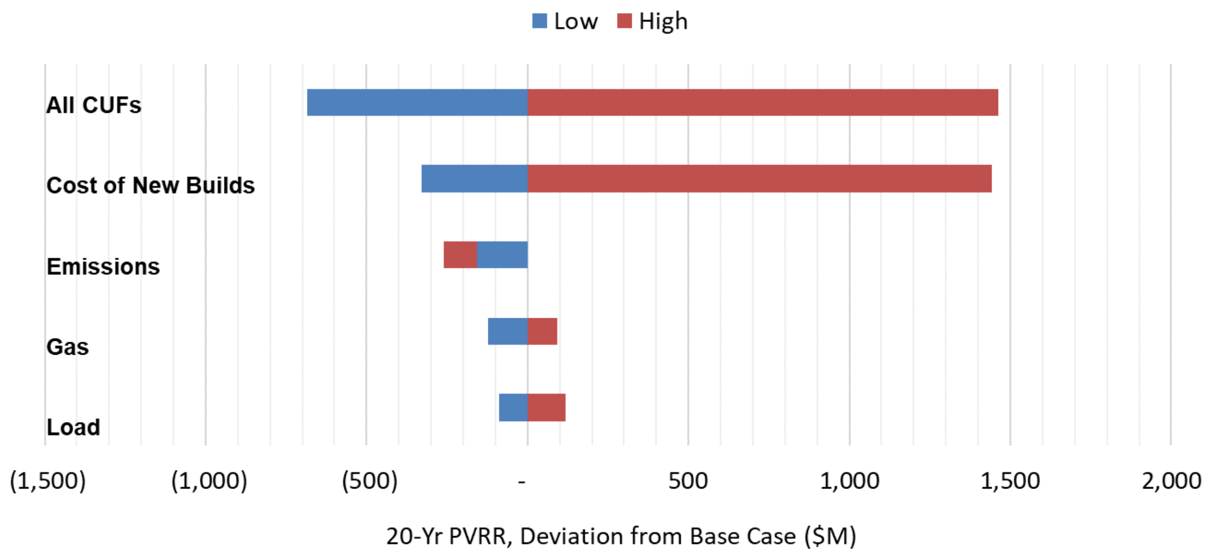


Figure 6-63 – Plan 10 Tornado Diagram ($ millions)

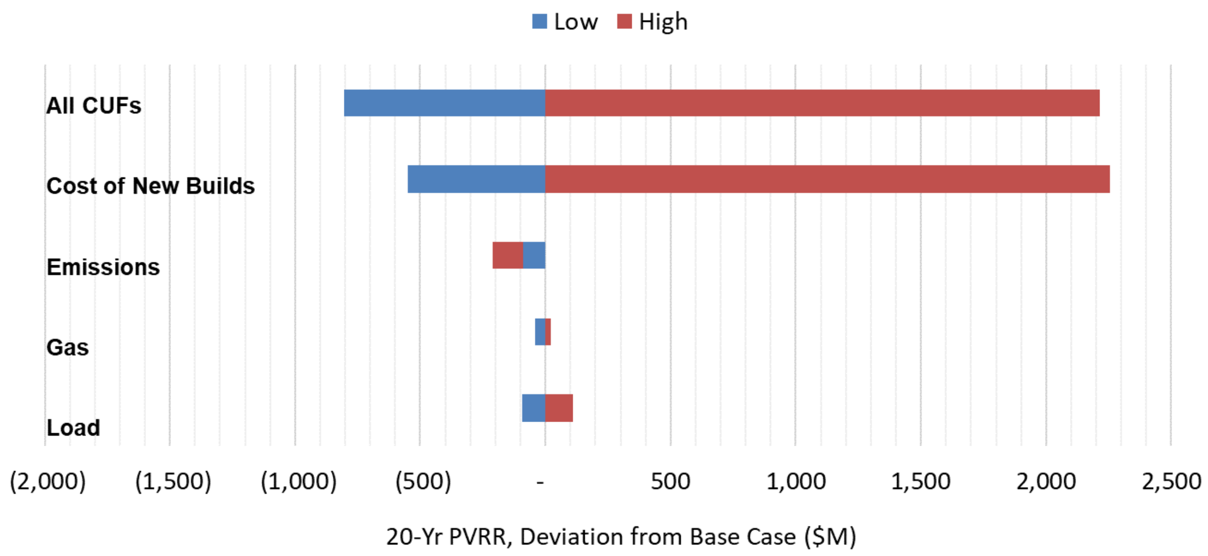


Figure 6-64 – Plan 11 Tornado Diagram ($ millions)

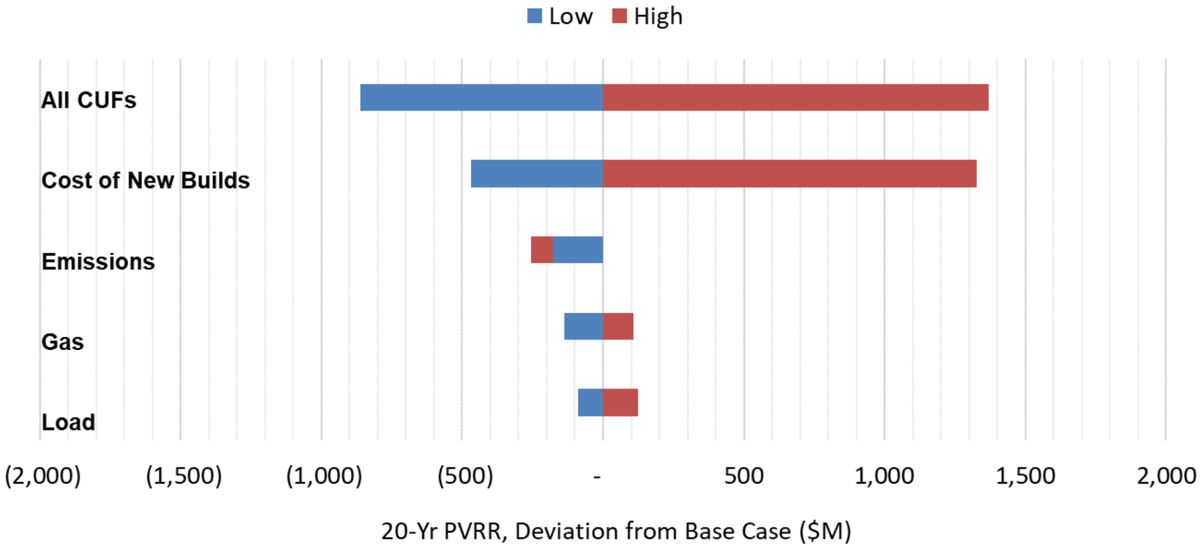
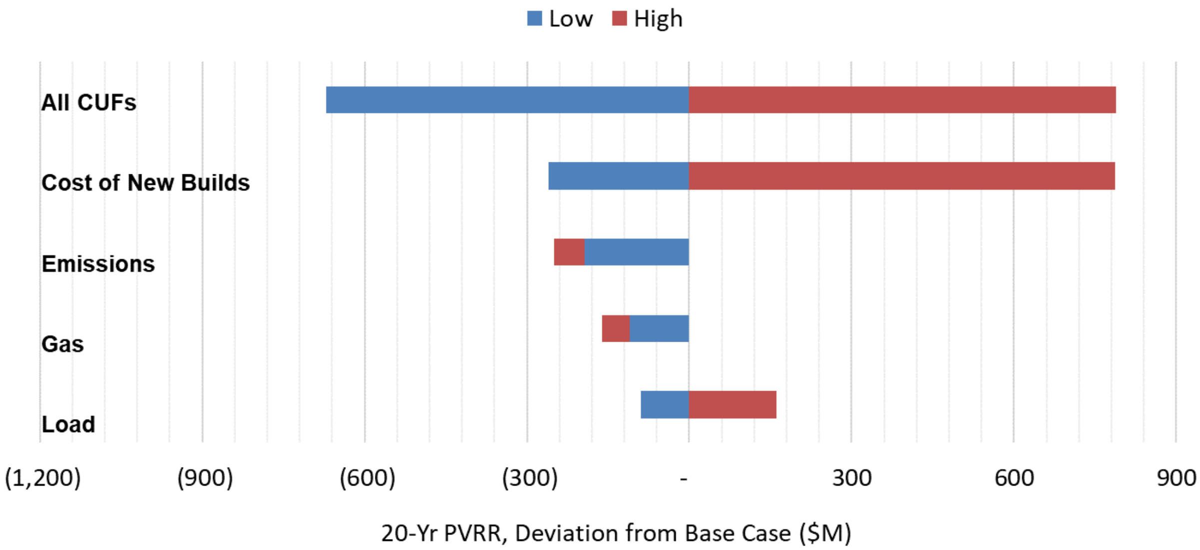


Figure 6-65 – Plan 12 Tornado Diagram ($ millions)

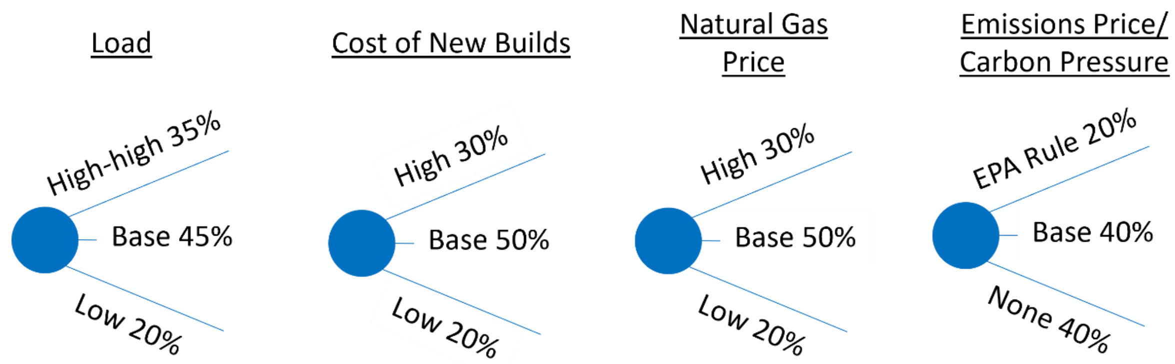


SECTION 7 CRITICAL UNCERTAIN FACTOR PROBABILITIES

(7) The utility decision-makers shall assign a probability pursuant to section (5) of this rule to each uncertain factor deemed critical by the utility. The utility shall compute the cumulative probability distribution of the values of each performance measure specified pursuant to 4 CSR 240-22.060(2). Both the expected performance and the risks of each alternative resource plan shall be quantified. The utility shall describe and document its risk assessment of each alternative resource plan.

Given the 12 alternative plans and four critical uncertain factors, Liberty-Empire evaluated the risk resilience of each portfolio by assessing the "expected value" or weighted average of each portfolio's PVRR across all critical uncertain factor scenarios, with each scenario being weighted according to the subjective probabilities assigned by the utility decision-makers. The subjective probabilities for the critical uncertain factors used to assess the alternative resource plans are provided in Figure 6-66.

Figure 6-66 – Uncertainty Tree



The subjective probabilities 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. Additional discussion of the rationale behind these weightings can be found in Section 7.1.

(A) The expected performance of each resource plan shall be measured by the statistical expectation of the value of each performance measure.

The expected value performance of each resource plan is provided in Table 6-69.

Table 6-60 – Expected Values of Alternative Plan Performance Measures

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

[redacted]

(B) The risk associated with each resource plan shall be characterized by some measure of the dispersion of the probability distribution for each performance measure, such as the standard deviation or the values associated with specified percentiles of the distribution.

Table 6-61 presents the standard deviation of performance measures between iterations for each alternative resource plan. Risk does not influence certain performance measures and, therefore, these measures have zero standard deviation values.

Table 6-61 – Standard Deviation of Alternative Plan Performance Measures

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

[redacted]

Figure 6-67 provides the expected value PVRR for each plan, compared to the calculated Base Case PVRR, to provide an illustration of the total risk associated with each plan. The calculated PVRR is represented by the solid-filled bottom bars, while the risk values are represented by the red "whisker" lines.

Figure 6-67 – PVRR with Risk Value for Alternative Resource Plans – 20-Year NPV ($ millions)

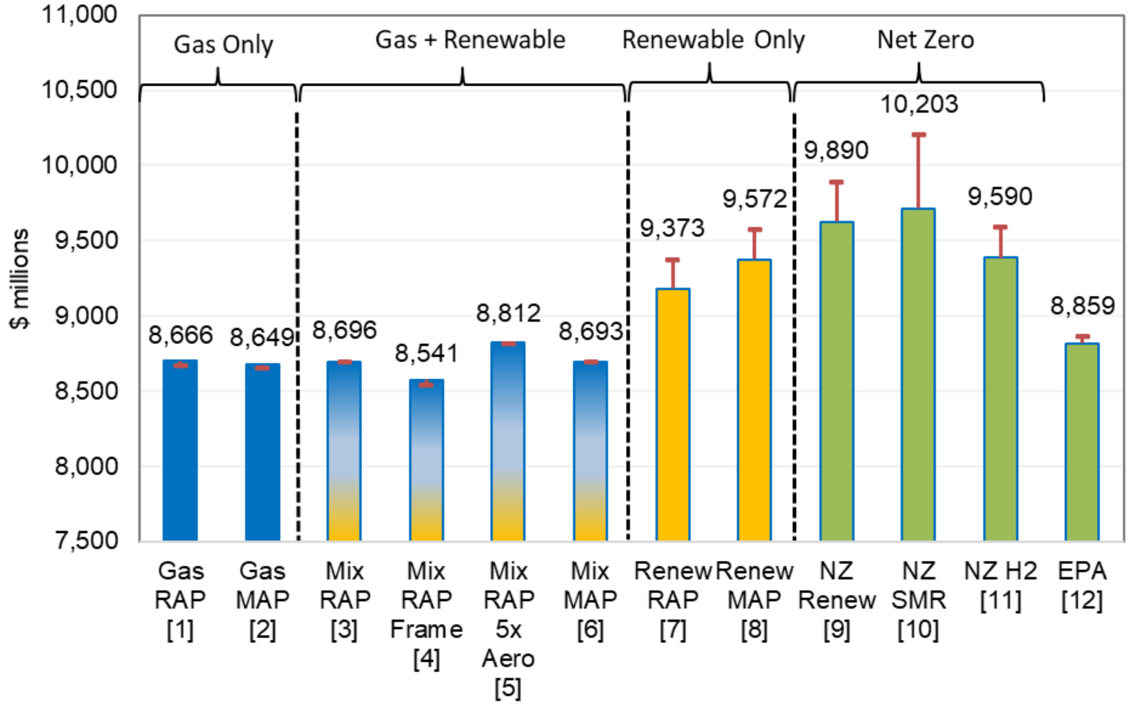
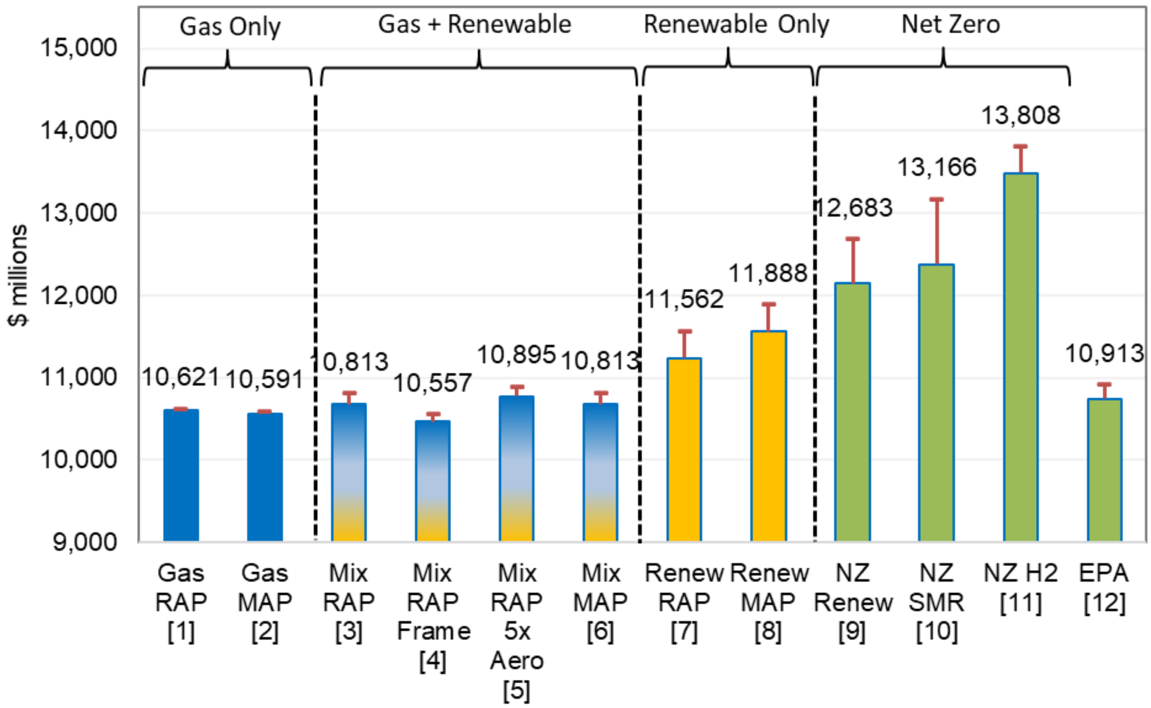


Figure 6-68 – PVRR with Risk Value for Alternative Resource Plans – 30 Year NPV ($ millions)



(C) The utility shall provide—

1. A discussion of the method the utility used to determine the cumulative probability—

Liberty-Empire considered each of the critical uncertain factors to act independently. The uncertainty tree approach determined the cumulative probability of the uncertainties considered for each plan and resulted in 81 combinations or endpoints for each plan

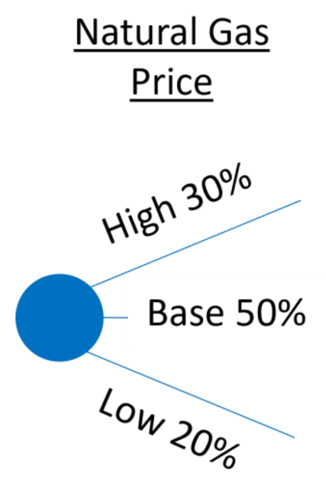
7.1 Development of Uncertain Factors

A. An explanation of how the critical uncertain factors were identified, how the ranges of potential outcomes for each uncertain factor were determined, and how the probabilities for each outcome were derived; and

Section 5 described the identification of uncertain factors and critical factors. Natural gas, carbon, capital costs, and load were found to change the PVRR of various portfolios materially.

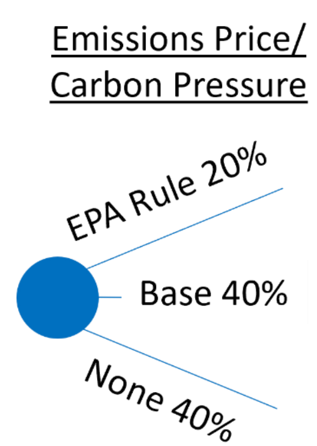
Liberty-Empire identified a range of uncertainty for each uncertain factor. Volume 4, Section 5.1 provides additional detail on the natural gas price scenarios. Figure 6-69 illustrates the subjective probabilities assigned to the natural gas price uncertainty factor. The high natural gas price case was weighted slightly higher than the low natural gas price case. This is because natural gas prices could be driven toward the high side due to many factors, including lower investment in natural gas infrastructure due to an increased focus on decarbonization, restrictions on resources or drilling or other supply-side shocks, or environmental regulations on producers. Low natural gas prices would require both lax regulation and abundant supply.

Figure 6-69 – Natural Gas Price Subjective Probabilities



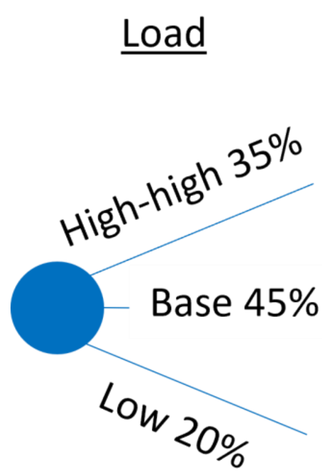
Additional detail on the carbon regulation scenarios can be found in Volume 4 Section 5.4.1. Given the history of federal proposals to regulate carbon emissions, the base case includes carbon regulation beginning in 2031 to significantly expand zero carbon emitting generation resources. The high case, based on the EPA GHG Standards, is assigned a 20% weighting as the ultimate implementation of the rule has received pushback and remains uncertain. The low scenario, where federal carbon pressure does not materialize, or regulation is made without a carbon price, includes a zero price on carbon emissions and is weighted at 40%.

Figure 6-70 – Environmental Cost Subjective Probabilities



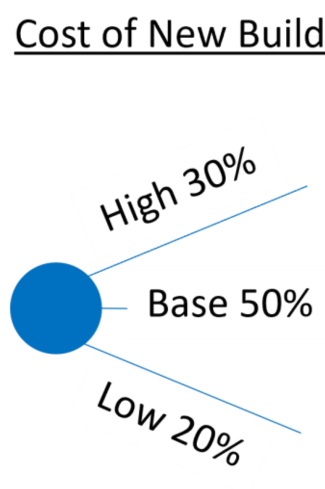
Load forecast uncertainties were discussed in Section 8 of Volume 3. Figure 6-71 illustrates the subjective probabilities assigned to the load scenarios. The high and low scenarios were created in compliance with the Commission's rule to create two additional normal weather load forecasts. A high-high scenario was also developed to capture high economic growth and high electric vehicle growth, representing an even wider range, and was implemented as the high load case for the CUF analysis. These three forecasts are created by adjusting the economic inputs in the forecast model, capturing economic uncertainty. Long-term load growth is highly uncertain and can be driven by various factors, including macroeconomic trends, distributed solar installations, and electric vehicle penetration. Given the greater upward uncertainty around other factors influencing load growth, a 35% weighting was assigned to the high-high case and a weighting of 20% was assigned to the low case.

Figure 6-71 – Load Subjective Probabilities



Finally, critical uncertain factors related to the cost of new builds, including capital cost, generator interconnection cost, interest rates, and federal tax credit provisions were developed for the high and low probabilities. Liberty-Empire's base case projections represent Liberty-Empire's view of the most reasonable cost outlooks for supply-side resource options. The lower band includes lower starting values for capital costs for all technologies, quicker declines in costs over time for technologies like solar and storage, and lower interconnection costs. The higher costs include higher capital costs for resources, higher interconnection costs, tax credit law with reduced monetization and without future extensions, and higher interest rates. All capital cost inputs were based on the market scan approach described in Volume 4 and were reviewed by a third-party engineering firm, Black and Veatch. Figure 6-72 illustrates this portion of the uncertainty tree.

Figure 6-72 – Cost of New Builds Subjective Probabilities



7.2 Analysis of Uncertain Factors

B. Analyses supporting the utility's choice of ranges and probabilities for the uncertain factors;

Sections 5, 6, and 7 provide the support underlying Liberty-Empire's ranges and probabilities for uncertain factors.

2. Plots of the cumulative probability distribution of each distinct performance measure for each alternative resource plan;

The following figures plot the cumulative probability distribution of each distinct performance measure for each alternative resource plan. These plots are sometimes referred to as risk profiles.

Figure 6-73 – Cumulative Probability of PVRR (20-Year) ($ millions)

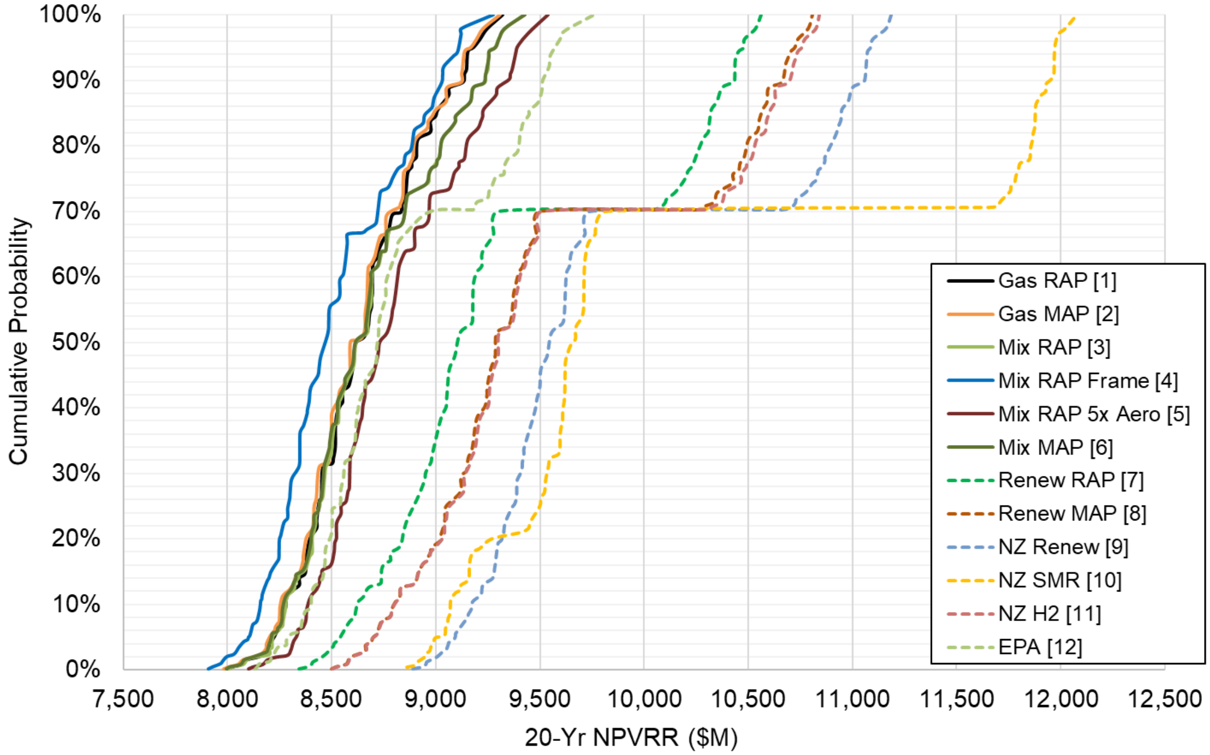
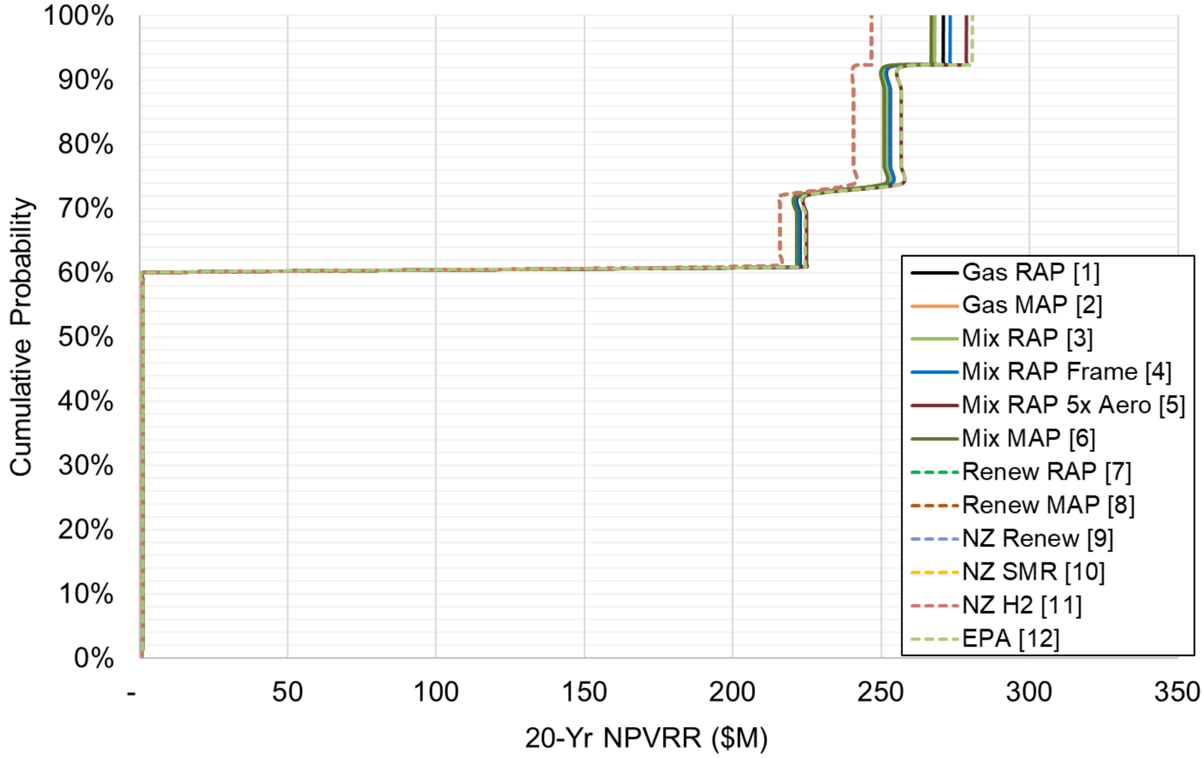


Figure 6-74 – Cumulative Probability of Probable Environmental Costs (20-Year) ($ millions)



NP

Figure 6-75 – Cumulative Probability of Levelized Average Rates (20-Year) (cents/kWh)

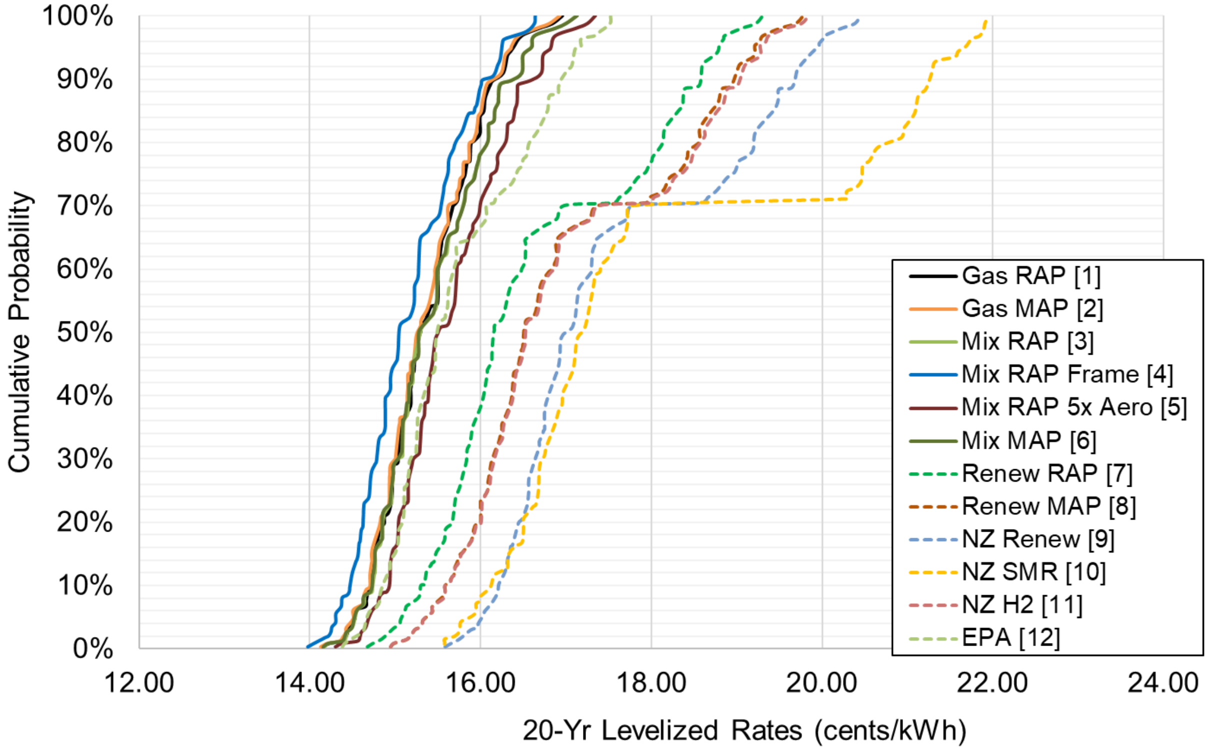


Figure 6-76 – Cumulative Probability of Max Rate Increases Plans 1-9, 11, & 12 (20-Year) (%)

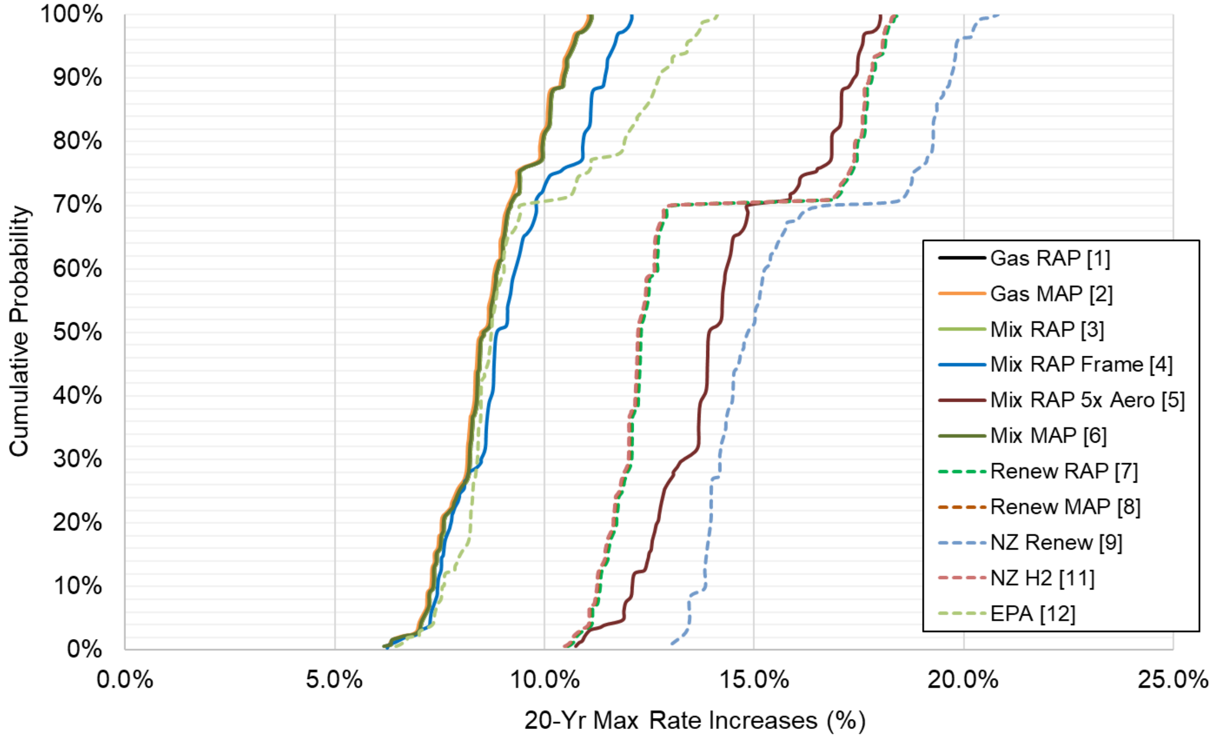
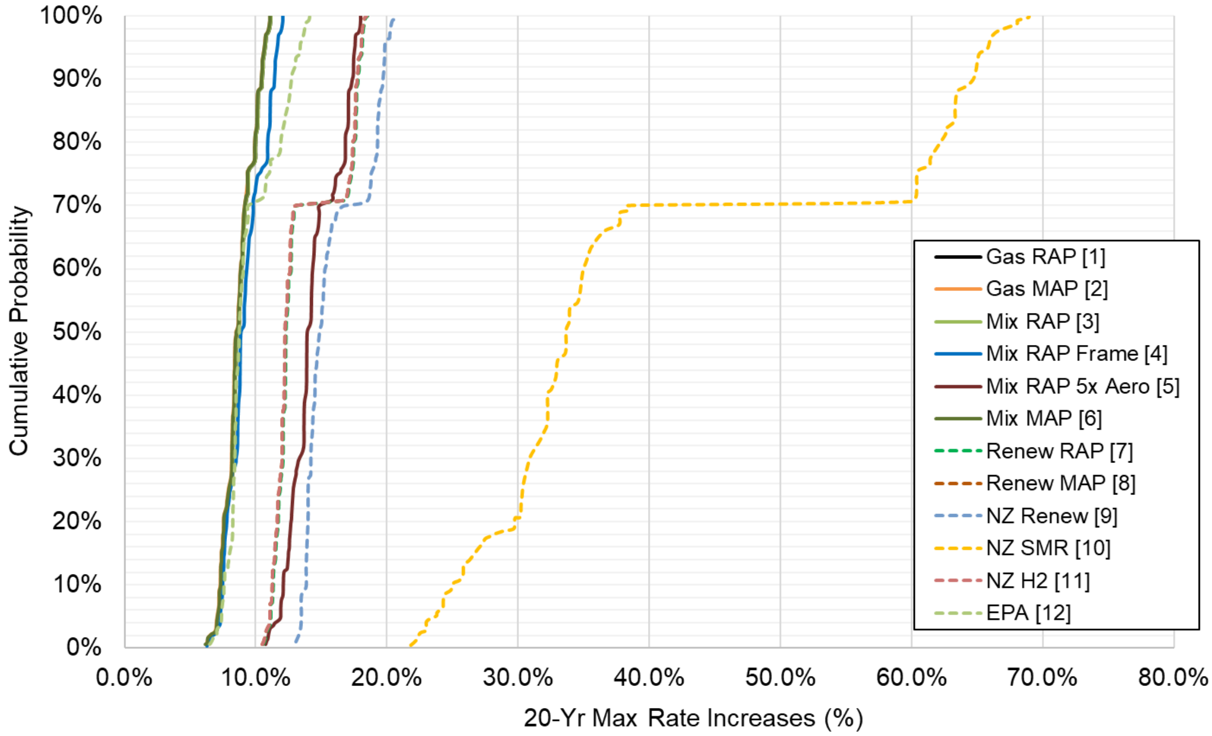


Figure 6-77 – Cumulative Probability of Max Rate Increases All Plans (20-Year) (%)



> *3. For each performance measure, a table that shows the expected value and the risk of each alternative resource plan; and*

Table 6-71 provides the expected values of performance measures for each alternative resource plan, and Table 6-72 indicates the risk as the standard deviation of performance measure values for each alternative resource plan.

7.3 Determination of Annual Unserved Hours in Plans

> *4. A plot of the expected level of annual unserved hours for each alternative resource plan over the planning horizon.*

Liberty-Empire engaged, Astrapé Consulting (now part of PowerGem), to perform a resource adequacy study that included post expansion plan reliability verification for selected portfolios including the preferred resource plan.

As shown in Appendix 6F, Loss of Load Expectation ("LOLE"), Loss of Load Hours

("LOLH") and Expected Unserved Energy ("EUE") for three study years (2029, 2032, 2040) were calculated and reported for five selected portfolios. This shows expected reliability of the portfolio in the short term and long term.

SECTION 8 CONTEMPORARY ISSUES

4 CSR 240-22.080(4)(C) No later than November 1, an order containing a list of special contemporary issues shall be issued by the commission for each utility to analyze and document in its next triennial compliance filing or annual update report. The commission shall not be limited to only the filed suggested special contemporary issues. If the commission determines that there are no special contemporary issues for a utility to analyze, an order shall be issued by the commission stating that there are no special contemporary issues.

8.1 Special Contemporary Issues

Rule 20 CSR 4240-22.080(4) requires Missouri utilities to consider and analyze special contemporary issues in their IRP triennial compliance filings or annual IRP updates. Such special contemporary issues are contained in a Commission order with input from staff, public counsel, and interveners that are evolving new issues, which may not otherwise have been addressed by the utility or are continuations of unresolved issues from the preceding triennial compliance filing or annual update filing. In File No. EO-2025-0079, the Commission issued an order on October 23, 2024, effective November 2, 2024, establishing nine (9) special contemporary planning issues for Liberty-Empire to analyze and document in its 2025 triennial Integrated Resource Plan. The responses to these nine issues (a-i) are provided below.

8.1.1 Future Resource Adequacy Scenarios Based on Various Types of Demand-Side Options

(a) Model and explicitly present future resource adequacy scenarios based on the following assumptions

1. Incorporation of the utility's Commission-approved and/or anticipated demand-side programs and the utility's Commission-approved demand-side rates;

2. Only utility's Commission-approved demand-side rates;

3. Alternative demand-side rates options that may be needed to meet near-term resource adequacy;

4. Indicate whether or not naturally occurring savings and/or federally sponsored DSM savings are included in the modeling. If yes, these savings should be identified and separated as well.

5. Include an explicit section within the DSM volume and the executive summary where low, medium, and high time-of-use (TOU) differentials are modeled and presented with expected demand savings articulated separate and aside from other demand side management practices.

Liberty-Empire engaged Applied Energy Group ("AEG") to conduct a Demand-Side Management ("DSM") Potential Study to assess the future potential for savings through its programs and to identify refinements that will enhance savings. Resource adequacy scenarios were incorporated into this assessment.

Details of the Commission-approved and anticipated demand-side programs and Commission-approved demand side rate forecasts have been presented in Volume 5 and include the associated supporting files. More specifically, Volume 5 presents kWh and kW realistic achievable potential ("RAP") for approved/anticipated demand-side programs in Tables 5-24 through 5-27, on pages 57-60 (Section 3, Sub-section 3.7). These tables also include line-item detail on demand-side rate initiatives such that differentiation between TOU rate options and alternative demand-side rate options (e.g. – critical peak pricing) are discernible. Similar information for alternative forecasted scenarios, such as maximum achievable potential ("MAP"), have been included in the associated workpapers filed by the Company.

Naturally occurring DSM savings are included in the forecasts of baseline potential and are included in the baseline forecasts detailed in Table 5-39, page 72 (Section 3, Sub-section 3.9). The forecasts of kWh and kW DSM potential are over-and-above these baseline forecasts. As demand-side rates and demand response programs require an action to induce savings, the naturally occurring savings and demand side rates or demand response are not included in the Company's estimate of kWh and kW potential. Additionally, the forecasts of kWh and kW potential do not include measures or programs which are solely federally-sponsored. However, some measures included in the forecast may be eligible for federal incentives. It is important to note special considerations were made for federal incentives on heat pumps. The measure was ultimately deemed not cost-effective and was consequently removed from DSM potential estimates as evidenced by the measure list detailed in Table 5-20, page 53 (Section 3, Sub-section 3.7).

Volume 5 includes sections describing demand-side rate options and considerations. These include Section 1, Sub-section 1.3 and Section 2. Forecasted kWh and kW potential details for various TOU rate options, including critical peak pricing, have been detailed in Volume 5 as part of Tables 5-24 through 5-27, pages 57-60, and the forecasted savings for these initiatives is presented separately from other demand-side management practices. Further information regarding forecasted scenarios of demand-side rate options has been included in the associated workpapers filed by the Company.

8.1.2 Data Center Best Practices

> *(B) Conduct a literature review of best practices on how other utilities are accounting for the addition of data centers in their IRPs and how risks can be minimized*.

Given their substantial energy demand, variable development timelines, and evolving grid requirements, data centers present unique challenges for integration. Liberty-Empire's literature review reveals that utilities across the industry employ diverse strategies to address the addition of data center loads in IRPs. In load forecasting, risk is managed by developing reasonable projections of the size and timing of customer additions.

Empire used two sources of information to ascertain the best practices in forecasting large customers and data centers. These sources are listed below.

- IRP Filing. Empire reviewed the 2024 Virginia Electric and Power Company (Dominion) and NVEnergy IRP filings to understand their method for forecasting data centers. Both Dominion and NVEnergy include a large number of data centers in their IRP forecasts.
- Itron Expertise. Empire contracted with Itron to develop the IRP load forecast. Itron works with many electric utilities on a variety of projects including developing their IRP forecasts. Additionally, Itron surveys its client base to understand the

best practices in electric forecasting. Itron's broad experience provides both qualitative and quantitative assessments of the industry's best practices.

In 2024, Dominion and NV Energy filed IRPs. Both companies included significant data center growth. Virginia Electric and Power Company is a Dominion Energy company and filed its IRP in 2024. This plan includes a significant number of data centers in their long-term forecast. Data centers are added into the forecast based on forward-looking customer intelligence derived from customer relationships. As data center projects progress, customers enter a series of contracts with binding financial commitments. Dominion develops the data center forecast based on these contractual commitments.

In 2024, NV Energy's IRP included large commercial and industrial customer forecasts by business type (e.g., Casino, Mine, Data Center). For these business types, customers are forecasted individually and added to the general forecast. The customer forecasts are based on discussions with the companies' Major Account, Economic Development, and Major Projects groups, and customer input related to expected business activity and associated sales and demand impacts. Both Dominion and NV Energy's IRP filings show that data center additions are largely based on specific customer interactions from account manager relationships.

Additionally, Itron works with several companies developing and assisting them in their long-term and financial forecasting functions. Itron's services range from fully developing long-term forecasts for internal planning and IRP filings to special studies helping companies understand the components of the forecasting process. Itron's experience and insights into data center forecasting are both qualitative and quantitative. Qualitatively, Itron's customer relationships provide anecdotal evidence about how large customers and data center are added. During Itron's 2024 Annual Energy Forecasting meeting, the issue of data center forecasting was discussed and provides additional qualitative insights into the best practices. Quantitatively, Itron conducts annual surveys to measure forecasting best practices. In conjunction with its 2024 survey, Itron collected data about data center forecasting.

In 2024, Itron's annual forecasting meeting consisted of 71 attendees representing 45 electric companies. During this meeting, Salt River Project (SRP) presented their large customer forecasting methodology which captures data center, semiconductor manufacturing, and mining growth. The presentation included a roundtable discussion addressing how companies are forecasting large customer load growth. The predominant large customer forecasting method is working with account representatives to understand customer needs and project development phases. In this method, forecaster's judgment is coupled with account representative information to determine the size and timing of new large projects. In a few cases, utilities shared project development rubrics are used to monitor customer development from conception to interconnection. These rubrics provide quantitative benchmarks that can guide the forecaster's judgment.

In Itron's 2024 survey, Itron asked utilities if they experience data center growth. 53 electric companies reported data center growth. To ascertain the best practices in forecasting data center growth, Itron conducted a follow-up survey. The survey resulted in 19 responses. The survey questions and the responses are shown below.

> **Question:** How do you develop your data center forecast?
>
> **Answer:** 86% of respondents rely on account representatives or marketing departments to identify potential new customer load. Only 14% develop a forecasting model or obtain an external forecast of potential data centers.
>
> **Question:** How do you incorporate your large customer/data center additions into your long-term IRP forecast?
>
> **Answer:** 26% of respondents add the entire data center forecast into the long-term forecast. The remaining respondents reduce the data center forecast prior to integrating it into the long-term forecast. 53% of respondents use a predetermined threshold criteria to eliminate unlikely projects. 21% assign probability of occurrence values and integrate the expected value of the data center forecast.
>
> **Question:** How do you determine the probability of occurrence or threshold?
>
> **Answer:** The challenge of large customer and data center forecasts is determining the likelihood that the customer successfully integrates into the electric system. The final question asked companies how the likelihood is determined. 68% of respondents rely on professional judgement and 26% use defined rubric.

Itron's qualitative and quantitative assessment of data center forecasting is that forecasts are judgmental based on customer specific information. Judgement is used to determine the size, timing, and likelihood of the future interconnections.

Itron's qualitative and quantitative results are consistent with the Dominion and NVEnergy IRP filings. The data center forecast judgmental based on customer information provided by customer relationships. Once a utility understands the potential customer additions, the size and timing of the additions may be reduced based on the utility's judgement of whether and when the project will connect to the system.

8.1.3 Large Load Growth Scenarios

> *(c) Model large load growth scenarios stemming from: 1) data centers with a demand of 30 megawatts or greater; 2) potential re-shoring of industries, specifically manufacturing or materials refinement; and 3) electrification of buildings and vehicles as a result of federal mandates changes in the marketplace, or evolving consumer preference.*

As a part of the 2025 IRP process Liberty-Empire assessed large load growth owing to data centers, industrial re-shoring, building electrification, and electric vehicles. Moreover, Liberty-Empire modeled additional portfolios to assess resources required to serve an incremental 300 MW of data center load by 2031.

Liberty-Empire's models accounted for the possibility of large load growth in a high-high load scenario. This SCI directs Liberty-Empire to model large growth scenarios for 4 cases – data centers, industrial onshoring, building electrification policy, and electric vehicle policy. Of these 4 cases, industrial onshoring is subsumed in the high case scenario. The high case scenario imagines strong economic growth represented by the employment drivers. The forecast employment growth rate (2023-2054) is 0.50%. The high case assumes a 0.76% growth rate, slightly over 50% higher than the expected case. Any onshoring manufacturing activity will be captured with stronger than expected employment growth. Empire developed 3 additional load forecast scenarios to address the remaining cases.

Data Center Impact

Empire did not add any new data centers in its base case. In the load forecast, data centers are treated like other large customer additions. Only additions with a high probably of occurrence are included in the forecast. No data center inquiries met this requirement. The data center scenario represents a hypothetical new large data center customer with a 30 MW peak and 90% load factor. The customer is added in 2030. Figure 6-78 compares the Data Center scenario's annual energy forecast with the base case. Table 6-62 shows the Data Center scenarios' annual energy, summer peak, and winter peaks compared with the base case for selected years.

Figure 6-78 – Data Center Scenario – Annual Energy

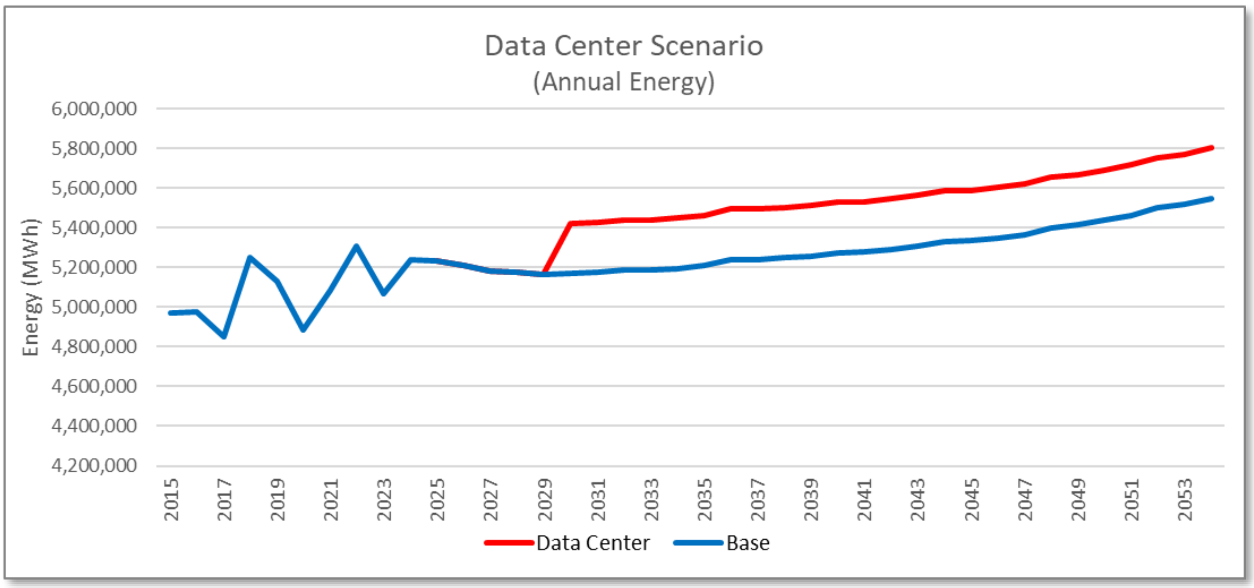


Table 6-62 – Data Center Scenario

Year	Base Energy (MWh)	Scenario Energy (MWh)	Base Summer Peak (MW)	Scenario Summer Peak (MW)	Base Winter Peak (MW)	Scenario Winter Peak (MW)
2012^	4,896,614		1,078		906	
2015^	4,971,141		1,036		1,096	
2020^	4,886,351		994		982	
2023^	5,070,124		1,120		941	
2025	5,233,509	5,233,509	1,123	1,123	1,176	1,176
2030	5,170,878	5,423,706	1,111	1,141	1,178	1,208
2035	5,208,619	5,461,446	1,128	1,157	1,200	1,230
2040	5,273,710	5,527,230	1,153	1,182	1,222	1,252
2045	5,336,034	5,588,861	1,180	1,209	1,245	1,275
2050	5,437,934	5,690,761	1,216	1,245	1,272	1,302

^Historical data excludes municipals (Monett, Mount Vernon, and Chetopa)

Portfolio modeling of a 300 MW data center load scenario is outlined further on in this SCI response.

Residential Building Electrification

Empire's base case includes native growth of electric end-use technologies based on the 2023 EIA AEO forecast. The forecast does not include specific electrification policy goals. In this scenario, Empire assumes electrification begins in 2025 and requires all new customers using electric space heating, water heating, cooking, and clothes drying. Additionally, the scenario assumes at non-electric heating replacements are replaced with electric heating technologies in the same proportion as currently used. Because Missouri does not have a residential electrification policy requirement, this scenario is hypothetical and imagines a future policy decision that moves residential end-uses toward electric technologies. The future policy mirrors the actions of some cities that are banning natural gas and phasing out fossil fuels. For example, in 2021, New York City signed legislation to phase out fossil fuel combustion in new construction. Figure 6-79 compares the Electrification scenario's annual energy forecast with the base case. Table 2 shows the Electrification scenarios' annual energy, summer peak, and winter peaks compared with the base case for selected years.

Figure 6-79 – Residential Building Electrification Scenario – Annual Energy

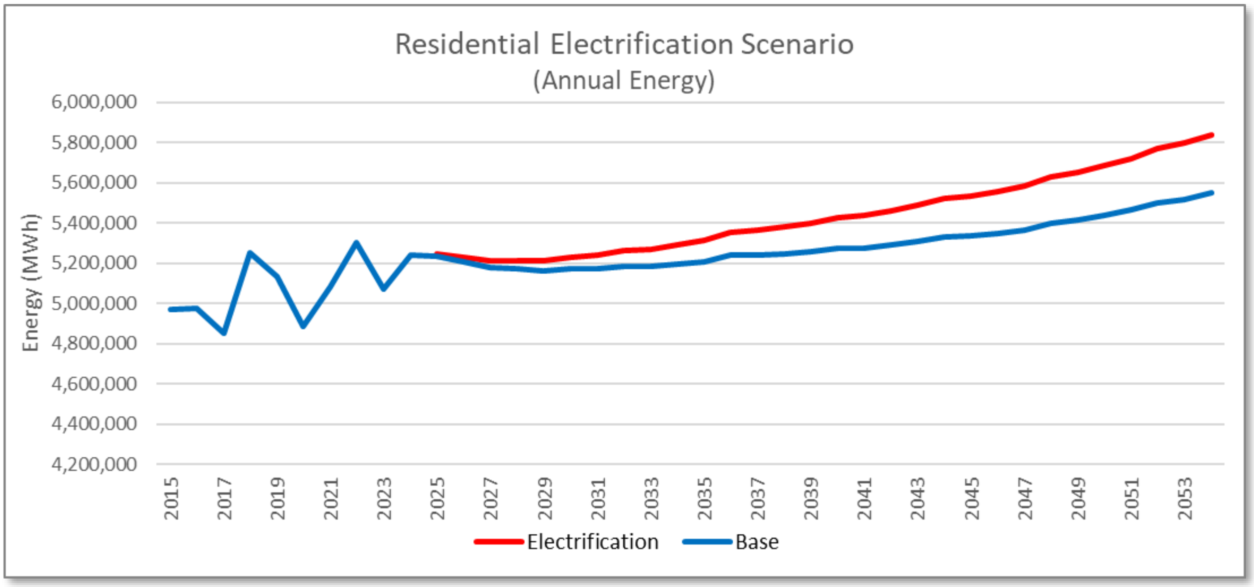


Table 6-63 – Residential Building Electrification Scenario

Year	Base Energy (MWh)	Scenario Energy (MWh)	Base Summer Peak (MW)	Scenario Summer Peak (MW)	Base Winter Peak (MW)	Scenario Winter Peak (MW)
2012^	4,896,614		1,078		906	
2015^	4,971,141		1,036		1,096	
2020^	4,886,351		994		982	
2023^	5,070,124		1,120		941	
2025	5,233,509	5,244,215	1,123	1,120	1,176	1,180
2030	5,170,878	5,228,532	1,111	1,109	1,178	1,205
2035	5,208,619	5,312,887	1,128	1,127	1,200	1,249
2040	5,273,710	5,425,305	1,153	1,152	1,222	1,293
2045	5,336,034	5,533,836	1,180	1,179	1,245	1,340
2050	5,437,934	5,684,413	1,216	1,216	1,272	1,389

^Historical data excludes municipals (Monett, Mount Vernon, and Chetopa)

Electric Vehicle Policy

Empire's base case includes a forecast of electric vehicle adoption based on the EIA's 2023 AEO forecast. Additionally, Empire created the high-high scenario to present a plausible scenario that includes 100% of vehicle purchases are electric by 2045.

In this scenario, Empire assumes that 100% of vehicle purchases are electric by 2035. This hypothetical scenario implements the current electric vehicle mandate created by the California Air Resources Board, Advanced Clean Cars II regulations and has been adopted by 17 states. While Missouri has not adopted the standard, this scenario imagines extending the 2035 mandate to Missouri. Figure 6-80 compares the EV Policy scenario's annual energy forecast with the base case. Table 6-64 shows the EV Policy scenarios' annual energy, summer peak, and winter peaks compared with the base case for selected years.

Figure 6-80 – Electric Vehicle Policy Scenario – Annual Energy

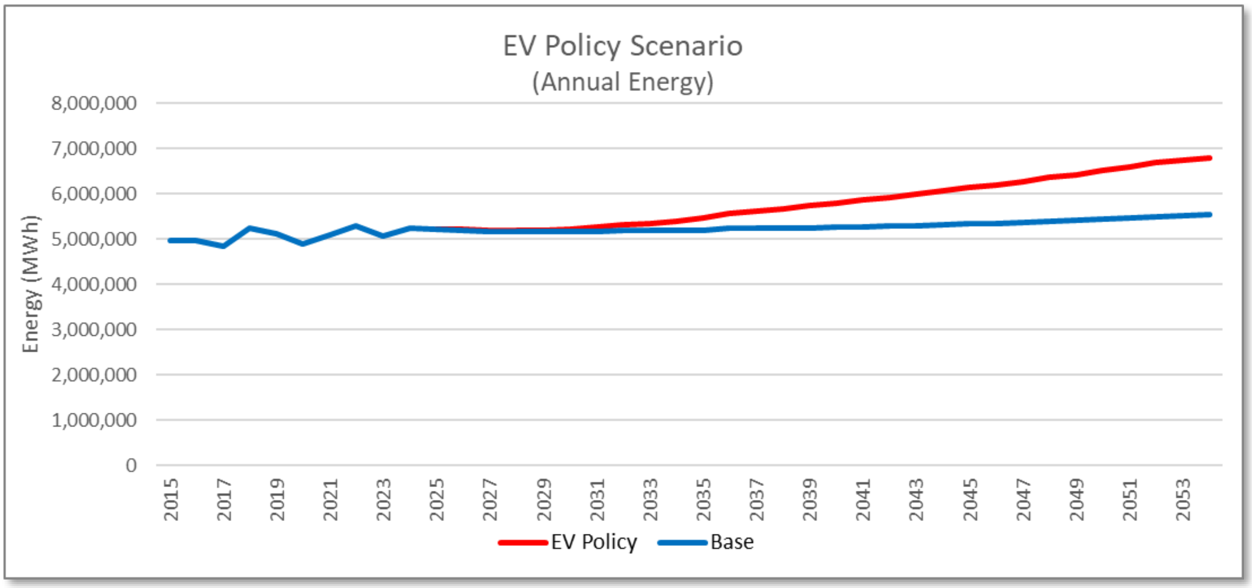


Table 6-64 – Electric Vehicle Policy Scenario

Year	Base Energy (MWh)	Scenario Energy (MWh)	Base Summer Peak (MW)	Scenario Summer Peak (MW)	Base Winter Peak (MW)	Scenario Winter Peak (MW)
2012^	4,896,614		1,078		906	
2015^	4,971,141		1,036		1,096	
2020^	4,886,351		994		982	
2023^	5,070,124		1,120		941	
2025	5,233,509	5,233,509	1,123	1,123	1,176	1,176
2030	5,170,878	5,232,418	1,111	1,114	1,178	1,192
2035	5,208,619	5,473,673	1,128	1,139	1,200	1,269
2040	5,273,710	5,808,541	1,153	1,181	1,222	1,358
2045	5,336,034	6,140,641	1,180	1,237	1,245	1,426
2050	5,437,934	6,512,318	1,216	1,302	1,272	1,497

^Historical data excludes municipals (Monett, Mount Vernon, and Chetopa)

See section 8.3 of Volume 3 for further detail about the high-high load scenario. This scenario was also tested as a part of the critical uncertain factor analysis.

<u>Portfolio Modeling for 300 MW of Data Center Load</u>

Liberty-Empire modeled four additional portfolios which account for the possibility of data center load growth incremental to the standard load outlook cases. For these four portfolios, Liberty-Empire assumed 300 MW of data center load by 2031 additional to the base case load outlook, with a trajectory of an additional 50 MW in 2028, 50 MW in 2029, 100 MW in 2030, and 100 MW in 2031.

A summary of the four data center alternative resource plans is illustrated in Figure 6-81. The plans were modeled under the Gas/Renewable Mix replacement theme, like plans 3-6.

Figure 6-81 – Themes for the Development of Data Center Alternative Resource Plans

Global Theme	Data Center Load (4 Plans)			
Retirement (Remaining Key Fossil Units)	Energy Center 1/2 – 2035 Riverton 10/11 – 2026 Riverton CC – n/a		Stateline CC – n/a Iatan 1 – 2039 Iatan 2 – n/a	
Replacement Options	Gas/Renewable Mix			
	Data Center Load <u>Cent. + Dist.</u> Gas, Solar, Stor., Wind *DSM (MAP)*	**Data Center Load** <u>Cent. + Dist.</u> Gas, Solar, Stor., Wind **+ Frame CT (2029)** *DSM (MAP)*	**Data Center Load** <u>Cent. + Dist.</u> Gas, Solar, Stor., Wind **+ 2x Frame (2029, 2031)** *DSM (MAP)*	**Data Center Load** <u>Cent. + Dist.</u> Gas, Solar, Stor., Wind **+ 5x Aero (2029)** *DSM (MAP)*

The resulting portfolios share commonalities with the preferred plan (Plan 4), including gas resources added in 2029 and solar added in the mid-2030's. This provides optionality for Liberty-Empire to pursue a similar build program if the need should arise to serve additional data center load. The build profiles are shown below in Table 6-65 Table 6-66.

Table 6-65 – ICAP Capacity Additions for Data Center Plans 1-3

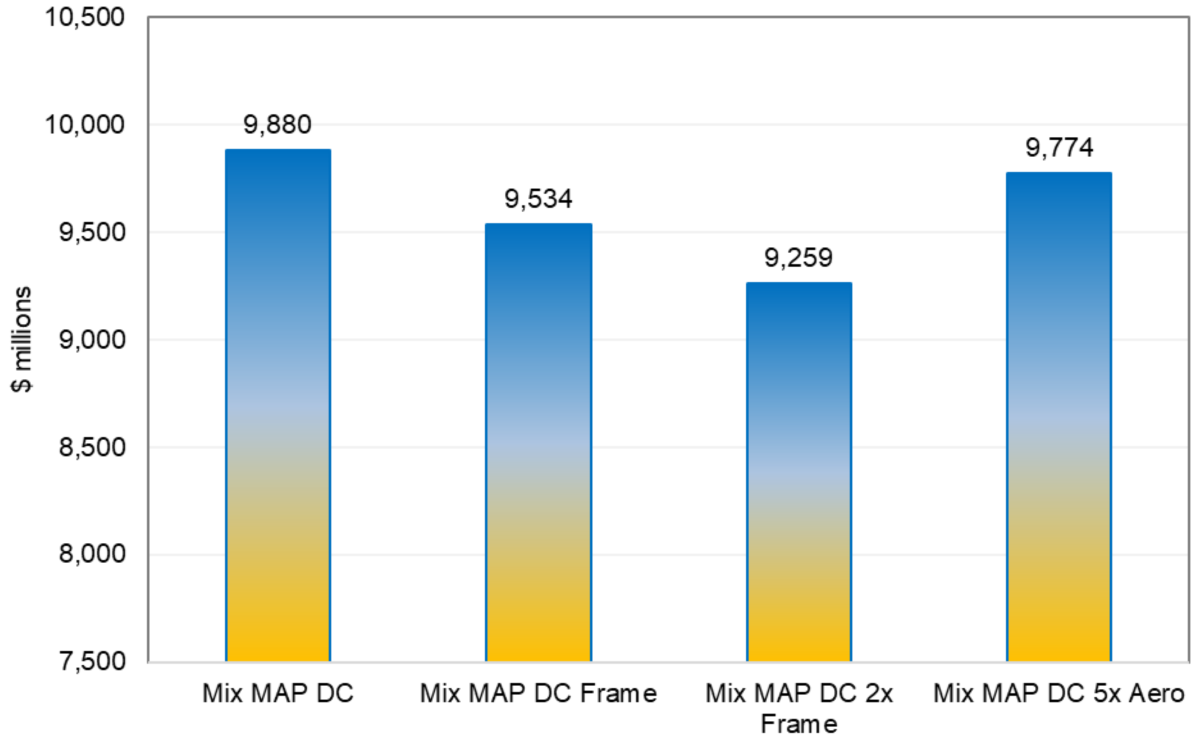
	Mix MAP DC	Mix MAP DC Frame	Mix MAP DC 2x Frame
2025			
2026			
2027	MAP DSM (Low-, Mid-, and High-Cost Bundles); Utility-Scale Solar (300 MW); Dist. Solar (10 MW)	MAP DSM (All Bundles); Dist. Solar (5 MW)	MAP DSM (All Bundles); Dist. Solar (5 MW)
2028	Utility-Scale Solar (300 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Utility-Scale Solar (50 MW); Dist. Solar (5 MW); Dist. Storage (2 MW)	Utility-Scale Solar (50 MW); Dist. Solar (5 MW); Dist. Storage (2 MW)
2029	Gas Aero (100 MW utilizing existing IC); Gas Aero (50 MW co-located at solar site); Utility-Scale Solar (250 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Gas Frame CT (240 MW); Gas RICE (50 MW co-located at solar site); Utility-Scale Solar (300 MW); Dist. Storage (2 MW)	Gas Frame CT (240 MW); Gas RICE (50 MW co-located at solar site); Utility-Scale Solar (300 MW); Dist. Storage (2 MW)
2030	Gas Aero (150 MW co-located at solar site); Utility-Scale Solar (100 MW); Li-Ion 4-hr (50 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Utility-Scale Solar (300 MW); Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)	Utility-Scale Solar (300 MW); Dist. Storage (2 MW)
2031	Li-Ion 4-hr (100 MW); Dist. RICE (8 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Utility-Scale Solar (300 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Gas Frame CT (240 MW); Utility-Scale Solar (300 MW); Dist. Storage (2 MW)
2032	Li-Ion 4-hr (100 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Dist. Storage (2 MW)
2033	Li-Ion 4-hr (50 MW); Dist. Solar (5 MW); Dist. Storage (1 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Dist. Storage (2 MW)
2034	Li-Ion 4-hr (100 MW); Dist. Storage (1 MW)	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)	Dist. Storage (2 MW)
2035	Utility-Scale Solar (100 MW); Li-Ion 4-hr (100 MW); Dist. Solar (5 MW); Dist. Storage (2 MW)	Utility-Scale Solar (150 MW); Li-Ion 4-hr (100 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)	Utility-Scale Solar (150 MW); Dist. Solar (10 MW); Dist. Storage (2 MW)
2036	Utility-Scale Solar (50 MW); Li-Ion 4-hr (100 MW)	Utility-Scale Solar (50 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Utility-Scale Solar (50 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2037	Li-Ion 4-hr (100 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2038	Li-Ion 4-hr (100 MW)	Li-Ion 4-hr (100 MW)	Li-Ion 4-hr (100 MW)
2039	Li-Ion 4-hr (100 MW)	Li-Ion 4-hr (100 MW)	Li-Ion 4-hr (100 MW)
2040	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2041	Utility-Scale Solar (200 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Utility-Scale Solar (100 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)	Utility-Scale Solar (100 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2042	Li-Ion 4-hr (50 MW)	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)
2043	Li-Ion 4-hr (50 MW)	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)
2044	Dist. Storage (1 MW)	Utility-Scale Solar (100 MW); Dist. Storage (2 MW)	Utility-Scale Solar (100 MW); Dist. Storage (2 MW)

Table 6-66 – ICAP Capacity Additions for Data Center Plan 4

	Mix MAP DC 5x Aero
2025	
2026	
2027	MAP DSM (Low-, Mid-, and High-Cost Bundles); Dist. Solar (5 MW)
2028	Utility-Scale Solar (100 MW); Dist. Storage (2 MW)
2029	Gas Aero (250 MW); Utility-Scale Solar (200 MW); Dist. Storage (2 MW)
2030	Utility-Scale Solar (300 MW); Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)
2031	Gas Aero (50 MW co-located at solar site); Utility-Scale Solar (300 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2032	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2033	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2034	Li-Ion 4-hr (50 MW); Dist. Storage (2 MW)
2035	Utility-Scale Solar (200 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2036	Utility-Scale Solar (50 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2037	Li-Ion 4-hr (100 MW)
2038	Li-Ion 4-hr (100 MW)
2039	Li-Ion 4-hr (100 MW)
2040	Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2041	Utility-Scale Solar (200 MW); Li-Ion 4-hr (100 MW); Dist. Storage (2 MW)
2042	Li-Ion 4-hr (50 MW)
2043	Li-Ion 4-hr (50 MW)
2044	

The costs of the four data center alternative resource plans were analyzed under the Base Case, and the 20-year PVRR of these plans are shown in Figure 6-82. The additional data center load requires more resources for adequacy, resulting in these plans being roughly 10-15% higher cost on a present value basis over 20 years when compared to their standard load equivalents in the Gas/Renewable Mix theme (Plans 3-6).

Figure 6-82 – Deterministic 20-Year PVRR of All Data Center Plans ($ millions)



8.1.4 EPA Greenhouse Gas Rule

(d) Provide a review of the technology and methods currently available, as well as the dollar impact for relevant and projected resources, to be compliant with the Environmental Protection Agency's rules targeting reduction of fossil fuel fired power plant pollution.

The EPA targets various types of pollution from fossil fuel fired power plant pollution, although Liberty-Empire assumes that this Special Contemporary Issue referred to the proposed greenhouse gas standards.

Compliance with the EPA's greenhouse gas standards can be accomplished through the following methods:

- <u>Existing coal resource options:</u>
    - Cease operations by 2032;
    - Co-fire 40% of fuel input with natural gas for operations from 2032 to 2039;

  - Employ 90% rate of carbon capture and storage either from 2032 without natural gas co-fire, or to continue operations from 2039 onward.

- <u>Existing gas resource options:</u>
  - Routine methods of operation and maintenance, no additional compliance required.

- <u>New gas resource options:</u>
  - Combined cycle – operate below 40% capacity factor; or employ 90% rate of carbon capture and storage from 2032 onward.
  - Peaker – operate below 20% capacity factor.

As a part of the regular IRP process, CRA modeled a portfolio which complies with the EPA greenhouse gas regulations (Plan 12, as discussed in Section 3 of Volume 6). The portfolio assumed retirement of Plum Point and Iatan coal plants by 2032, the most stringent approach for compliance. The 20-year present value cost of Plan 12 was $241 million or roughly 3% higher than the lowest cost Plan, as shown in Figure 6-4.

8.1.5 Supercritical Carbon Dioxide Power Cycle Plant

(e) Investigate the option of a supercritical carbon dioxide power cycle plant as a resource candidate in future supply-side generation planning and modeling scenarios.

As part of its analysis of potential supply-side resource options, Liberty-Empire assessed supercritical carbon dioxide power cycle plants as a potential generation resource option. This resource type was screened out during the feasibility screening stage of the analysis based on technical feasibility, commercial viability, and cost efficiency. The technology is nascent, with only a single pilot project currently operational. It remains costly and is unlikely to be available for utility deployment in the near to medium term. Refer to Volume 4 Section 2.3 for details.

8.1.6 Interconnection Costs

(f) Model for low, medium, and high interconnection cost estimates that are supported by historic total interconnection costs by fuel type for SPP in its resource planning scenarios.

Liberty-Empire assessed current and future costs for new transmission interconnections during the normal course of the IRP study. Refer to Volume 4 Section 5.7 for details. Liberty Empire also assessed and modeled low and high interconnection costs as a part of the critical uncertain factor analysis.

8.1.7 New Generation Resource Project Length

(g) Articulate the estimated project length for all generation resources given the current SPP backflow, and the overall demand for generation resources across the United States.

Liberty-Empire considered the SPP interconnection queue when determining the first available year for each resource. The first available year of operation was 2031 for gas and 2027 for renewables and storage. This was based on Berkeley lab data and how long projects have historically taken to move through the queue in SPP.

SPP recently proposed the Expedited Resource Addition Study (ERAS) provision which creates a one-time study process to expedite the interconnection of new generation projects to meet resource adequacy needs. Liberty-Empire estimates that ERAS would reduce queue time to facilitate commissioning of a new gas resource by 2029. The advanced timing was made available for new greenfield gas resources in Plans 4 and 5.

8.1.8 Long-Duration and Non-Chemical Energy Storage

(h) Describe any research, investigation, consideration, and/or inclusion of long-duration energy storage (10 or more hours) as well as non-chemical energy storage technologies the Company performed in the development of its IRP update/ triennial analysis. Nonchemical energy storage technologies mainly refer to thermal or mechanical methods of storing energy which could include storing heat in solid materials such as sand, rocks, or concrete blocks or liquids such as molten salts or water and processes utilizing compression, displacement against gravity, rotation, or accumulation of kinetic energy. Include any details or analysis of costs estimates if relied upon.

1. Explore the design and feasibility of piloting energy storage projects with the *specific objective of enhancing system reliability and increasing capacity accreditation of renewable energy resources. Discuss the opportunities and benefits facilitated by inclusion of the explored technology and detail any identified limitations.*

2. Detail any other emerging technologies intended to improve reliability or resource adequacy discovered by the Company or suggested by stakeholders that was considered and describe any pertinent analysis or findings.

As part of its 2025 IRP process, Liberty-Empire performed an extensive review of supply-side resource options for inclusion in its future portfolio resource mix, including long-duration and non-chemical energy storage 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, and distributed resources, among others. Liberty-Empire then used a screening process to narrow the broader list of resource options to only those that were likely feasible to develop and operate in the Company's service territory. A more detailed discussion of this process and the results of the feasibility screening can be found in Volume 4, Sections 2.1 through 2.3.

Liberty-Empire reviewed the key advantages and challenges of several storage types, including mechanical, thermal, electrochemical, and molecular storage. Further, Liberty-Empire evaluated use cases for long-duration energy storage resources, including their ability to smooth intermittency of wind and solar resources, augment high-emission peaker capacity, defer transmission and distribution infrastructure upgrades, and hedge against extreme events. Potential storage technologies considered in this analysis include lithium-ion (4-hour, 8-hour, 10-hour+), vanadium redox flow (8-hour), molten salt (10 hour+), Energy Vault concrete block gravity storage (8-hour), compressed air (10 hour+), iron air (10 hour+), and CO_2 storage (10 hour+).

Of the storage options, the following were screened out during the feasibility screening process: compressed air, molten salt, iron air, and CO_2 storage. These resources were not included in the final list of resource options due largely to engineering complexity, scarcity of operating examples, and low commercial deployment. The 10-hour+ duration options provide for higher accreditation levels per unit of installed capacity due to their enhanced ability to reliability deploy duration highest demand hours of day; however, on balance, this characteristic was not enough to overcome the other drawbacks noted above, especially relative to the 8-hour duration storage options. Piloting these technologies would likely introduce risks for cost overruns, operational performance, and technology provider support, all of which Liberty-Empire would like to avoid in the interest of customers. Liberty-Empire did not include specific renewable-storage pairings as a part of its resource options. Pairing was considered, although it was decided to instead assess quantities of renewables and storage independently, while still capturing accreditation and resource adequacy attributes, in order to allow for flexibility in siting locations and quantity ratios. Liberty-Empire will continue evaluating emerging storage technologies as markets evolve and potential use cases are further identified.

The remaining four storage technologies (4-hr lithium-ion, 8-hr lithium-ion, Vanadium redox flow, and 8-hr gravity storage) were compared across operating parameters and levelized costs. Based on this screening analysis, Liberty-Empire found that lithium-ion batteries are cost-competitive with standard generation resources on a capacity basis. However, the value of the capacity is likely to erode over time as more storage is added to the system. Relative to other storage resources, lithium-ion batteries' high flexibility and efficiency also provide significant value opportunities across multiple SPP market products, with additional long-term energy arbitrage opportunities and ancillary service value potential associated with the expected growth of intermittent resource capacity in the market. The screening analysis also demonstrated that flow batteries and gravity storage are expected to be competitive with lithium-ion in the longer term due largely to the longer duration configuration of these technologies, which allows them to provide more capacity value for deployment during peak demand. Liberty-Empire will continue evaluating emerging storage technologies as markets evolve and potential use cases are further identified.

In addition to peak load-shifting value, energy arbitrage value, and capacity value, storage resources also have the potential to provide a host of ancillary services, such as frequency regulation and spinning reserves. Thus, Liberty-Empire also assessed and incorporated the ancillary service value of storage resources (as well as thermal resources) in the integrated resource analysis based on potential SPP market revenues in the spinning reserve, regulation up, and regulation down markets.

8.1.9 Coal to Gas Conversion

(i) Evaluate the potential for coal to natural gas conversions.

Liberty-Empire is a minority joint owner in the three coal resources. The Company is a joint owner in Iatan units 1 and 2 (12% owner of each) and Plum Point (7.52% owner). Therefore, the Company would not be in a position to initiate a coal to gas conversion.

**[redacted]

[redacted]

[redacted]**

Figure 6-83 – **[redacted]**

Confidential in Its Entirety

[redacted]

SECTION 9 APPENDIX

Appendix 6A

Table 6A-1 – Avoided Costs for All Plans
****Confidential in its Entirety****

[redacted]

Table 6A-2 – PVRR (20 Years) For All Plans

Plan	Portfolio Name	20-Year NPVRR (2025-2044) ($M) - Base Case
1	Gas RAP	8,666
2	Gas MAP	8,649
3	Mix RAP	8,696
4	Mix RAP Frame CT	8,541
5	Mix RAP 5x Aero	8,812
6	Mix MAP	8,693
7	Renewable RAP	9,373
8	Renewable MAP	9,572
9	NZ Renewable	9,890
10	NZ SMR	10,203
11	NZ H2	9,590
12	EPA	8,859

Table 6A-3 – Annual Rate Increases for All Plans

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

[redacted]

Table 6A-4 – Average Rate Revenue of All Plans

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

[redacted]

Appendix 6B

DSM Composition Tables

Table 6B-1 – DSM Composition of RAP DSM (MW)

Plan Name	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Residential Prescriptive	0.31	0.32	0.33	0.34	0.34	0.34	0.34	0.30	0.31	0.22	0.24	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24	0.23	0.23
Income Eligible Lighting	0.37	0.39	0.42	0.37	0.34	0.29	0.28	0.28	0.10	0.10	0.10	0.01	0.01	0.01	0.01	0.06	0.02	0.03	0.04	0.07	0.07
SBDI	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Commercial Prescriptive	1.80	1.80	1.80	1.80	1.80	1.80	1.79	1.78	1.77	1.77	1.76	1.76	1.76	1.75	1.74	1.74	1.73	1.72	1.71	1.70	1.74
Commercial Custom	0.17	0.21	0.25	0.29	0.33	0.37	0.42	0.46	0.51	0.55	0.59	0.64	0.68	0.73	0.77	0.66	0.67	0.68	0.69	0.70	0.71
Battery Storage DLC	0.11	0.28	0.52	0.77	1.09	1.43	1.87	2.32	2.77	3.31	3.36	3.41	3.45	3.49	3.52	3.56	3.61	3.67	3.74	3.81	3.81
CPP	1.22	3.62	8.34	10.51	11.44	11.17	10.88	10.80	10.72	10.64	10.57	10.50	10.43	10.36	10.29	10.23	10.17	10.11	10.04	9.97	9.97
Grid-Interactive WH	0.04	0.13	0.36	0.53	0.64	0.69	0.73	0.77	0.81	0.74	0.68	0.62	0.56	0.51	0.47	0.43	0.39	0.36	0.33	0.30	0.30
Smart Appliances DLC	0.36	1.05	2.34	2.92	3.17	3.13	3.08	3.09	3.10	3.11	3.12	3.13	3.14	3.14	3.15	3.16	3.17	3.18	3.19	3.19	3.19
Smart Thermostats DLC - Hea	2.80	6.30	10.49	16.02	21.49	27.60	34.35	34.23	34.11	33.99	33.89	33.80	33.74	33.68	33.64	33.39	33.19	33.02	32.83	32.72	32.72
TOU Opt-Out	1.91	5.50	11.85	14.40	15.34	14.94	14.50	14.39	14.28	14.17	14.07	13.97	13.88	13.78	13.68	13.59	13.51	13.43	13.32	13.22	13.22

Table 6B-2 – DSM Composition of MAP DSM (MW)

Plan Name	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Residential Prescriptive	0.41	0.42	0.43	0.43	0.43	0.43	0.43	0.39	0.39	0.30	0.32	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.28	0.29
Income Eligible Lighting	0.37	0.39	0.42	0.37	0.34	0.29	0.28	0.28	0.10	0.10	0.10	0.01	0.01	0.01	0.01	0.06	0.02	0.03	0.04	0.07	0.07
SBDI	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08
Commercial Prescriptive	2.60	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20	2.17	2.14	2.10	2.07	2.03	2.00	1.96	1.93	1.90	1.94
Commercial Custom	0.24	0.29	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.74	0.78	0.83	0.87	0.91	0.73	0.72	0.71	0.71	0.70	0.71
Battery Storage DLC	0.33	0.85	1.57	2.31	3.27	4.28	5.60	6.96	8.32	9.92	10.07	10.22	10.35	10.47	10.58	10.69	10.84	11.00	11.21	11.42	11.42
CPP	2.10	6.20	14.20	17.75	19.16	18.53	17.85	17.70	17.55	17.39	17.27	17.15	17.03	16.91	16.79	16.69	16.59	16.50	16.37	16.25	16.25
Grid-Interactive WH	0.08	0.30	0.80	1.16	1.41	1.52	1.61	1.70	1.78	1.63	1.49	1.36	1.23	1.12	1.02	0.94	0.86	0.78	0.72	0.66	0.66
Smart Appliances DLC	0.36	1.04	2.31	2.85	3.07	3.00	2.92	2.92	2.93	2.94	2.95	2.96	2.97	2.97	2.98	2.99	3.00	3.01	3.02	3.02	3.02
Smart Thermostats DLC - Hea	4.21	9.45	15.74	24.03	32.24	41.40	51.53	51.35	51.16	50.99	50.83	50.70	50.60	50.53	50.46	50.08	49.79	49.53	49.25	49.08	49.08
TOU Opt-Out	3.16	8.85	18.01	20.98	21.70	20.78	19.79	19.60	19.41	19.22	19.06	18.92	18.78	18.62	18.46	18.34	18.22	18.09	17.93	17.78	17.78

Appendix 6C

Composition of DSM Energy Provided Tables

Table 6C-1 – Composition of DSM Energy Provided in RAP DSM (MWh)

Plan Name	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Residential Prescriptive	723	1,456	2,198	3,013	3,838	4,667	5,504	6,081	6,669	7,165	7,675	7,884	8,024	8,163	8,249	8,318	8,332	8,349	8,359	8,352	8,415
Income Eligible Lighting	1	3	3	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SBDI	335	669	1,042	1,414	1,801	2,180	2,568	2,913	3,250	3,584	3,888	4,182	4,474	4,725	4,975	4,938	4,901	4,864	4,827	4,790	4,768
Commercial Prescriptive	2,982	5,961	8,935	11,896	14,814	17,722	20,598	23,391	26,156	28,903	31,469	34,049	36,623	39,190	41,746	41,578	41,391	41,183	40,962	40,730	40,545
Commercial Custom	337	733	1,200	1,735	2,345	3,023	3,773	4,594	5,501	6,476	7,483	8,558	9,715	10,941	12,227	13,005	13,759	14,461	15,114	15,719	16,285
Battery Storage DLC	2	5	8	12	17	23	30	37	44	53	54	55	56	56	57	58	59	60	61	62	62
CPP	89	264	613	780	859	849	840	835	830	826	822	817	813	808	802	796	790	784	778	771	771
Grid-Interactive WH	1	5	14	20	24	26	28	29	30	28	25	23	21	19	17	16	14	13	12	11	11
Smart Appliances DLC	242	711	1,582	1,972	2,144	2,116	2,083	2,091	2,098	2,104	2,110	2,115	2,120	2,125	2,130	2,136	2,142	2,148	2,154	2,160	2,160
Smart Thermostats DLC - Hea	115	258	430	656	880	1,131	1,407	1,402	1,397	1,393	1,388	1,385	1,382	1,380	1,378	1,368	1,360	1,353	1,345	1,341	1,341
TOU Opt-Out	3,628	10,489	22,797	28,045	30,293	29,926	29,537	29,369	29,189	29,021	28,854	28,692	28,536	28,308	28,078	27,849	27,612	27,368	27,098	26,814	26,814

Table 6C-2 – Composition of DSM Energy Provided in MAP DSM (MWh)

Plan Name	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Residential Prescriptive	1,167	2,328	3,484	4,731	5,971	7,202	8,423	9,211	10,004	10,656	11,318	11,478	11,535	11,593	11,577	11,538	11,409	11,285	11,153	11,002	10,958
Income Eligible Lighting	2	3	4	4	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SBDI	477	946	1,444	1,931	2,435	2,925	3,414	3,841	4,263	4,677	5,052	5,400	5,746	6,031	6,314	6,189	6,062	5,936	5,820	5,711	5,607
Commercial Prescriptive	4,305	8,550	12,706	16,789	20,736	24,610	28,375	32,005	35,570	39,062	42,243	45,387	48,478	51,520	54,518	53,527	52,539	51,553	50,583	49,630	48,775
Commercial Custom	481	1,048	1,701	2,438	3,248	4,158	5,150	6,204	7,325	8,541	9,791	11,122	12,512	13,960	15,472	16,226	16,873	17,439	17,917	18,328	18,663
Battery Storage DLC	5	13	25	37	52	68	89	111	133	159	162	165	167	169	171	173	176	179	182	186	186
CPP	161	480	1,111	1,412	1,550	1,528	1,506	1,497	1,488	1,480	1,472	1,464	1,457	1,446	1,436	1,426	1,415	1,404	1,392	1,379	1,379
Grid-Interactive WH	3	11	31	44	54	57	61	64	66	61	55	50	46	42	38	34	32	29	26	24	24
Smart Appliances DLC	241	705	1,558	1,924	2,073	2,026	1,971	1,977	1,983	1,989	1,995	2,000	2,005	2,009	2,014	2,020	2,027	2,033	2,039	2,044	2,044
Smart Thermostats DLC - Hea	172	387	645	984	1,321	1,696	2,111	2,103	2,096	2,089	2,082	2,077	2,073	2,070	2,067	2,052	2,040	2,029	2,018	2,011	2,011
TOU Opt-Out	5,944	16,791	34,641	41,238	43,642	42,869	42,038	41,762	41,467	41,184	40,923	40,668	40,420	40,052	39,681	39,312	38,928	38,532	38,097	37,634	37,634

Appendix 6D

Plan Tornado Diagrams Tables

Table 6D-1 – Plan 1 Tornado Diagram ($ in Millions)

Gas RAP PVRR ($M)	Low (below Base)	High (above Base)	Base
Load	(89)	168	8,698
Gas	(181)	93	
Emissions	(240)	(300)	
LCOE	(173)	457	
All Critical Uncertain Factors	(674)	484	

Table 6D-2 – Plan 2 Tornado Diagram ($ in Millions)

Gas MAP PVRR ($M)	Low (below Base)	High (above Base)	Base
Load	(89)	171	8,676
Gas	(176)	89	
Emissions	(236)	(297)	
LCOE	(176)	464	
All Critical Uncertain Factors	(669)	493	

Table 6D-3 – Plan 3 Tornado Diagram ($ in Millions)

Mix RAP PVRR ($M)	Low (below Base)	High (above Base)	Base
Load	(89)	168	8,694
Gas	(161)	77	
Emissions	(224)	(289)	
LCOE	(193)	560	
All Critical Uncertain Factors	(670)	589	

Table 6D-4 – Plan 4 Tornado Diagram ($ in Millions)

Mix RAP Frame PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(89)	154	8,574
Gas	(141)	(36)	
Emissions	(227)	(267)	
LCOE	(193)	547	
All Critical Uncertain Factors	(646)	530	

Table 6D-5 – Plan 5 Tornado Diagram ($ in Millions)

Mix RAP 5x Aero PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(89)	154	8,820
Gas	(169)	81	
Emissions	(231)	(295)	
LCOE	(207)	566	
All Critical Uncertain Factors	(695)	571	

Table 6D-6 – Plan 6 Tornado Diagram ($ in Millions)

Mix MAP PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(89)	173	8,689
Gas	(161)	75	
Emissions	(225)	(289)	
LCOE	(199)	566	
All Critical Uncertain Factors	(676)	598	

Table 6D-7 – Plan 7 Tornado Diagram ($ in Millions)

Renew RAP PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(88)	124	9,179
Gas	(123)	97	
Emissions	(155)	(255)	
LCOE	(439)	1,258	
All Critical Uncertain Factors	(794)	1,299	

Table 6D-8 – Plan 8 Tornado Diagram ($ in Millions)

Renew MAP PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(88)	129	9,373
Gas	(138)	109	
Emissions	(177)	(256)	
LCOE	(457)	1,305	
All Critical Uncertain Factors	(850)	1,350	

Table 6D-9 – Plan 9 Tornado Diagram ($ in Millions)

NZ Renew PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(88)	118	9,623
Gas	(123)	93	
Emissions	(157)	(259)	
LCOE	(328)	1,444	
All Critical Uncertain Factors	(686)	1,463	

Table 6D-10 – Plan 10 Tornado Diagram ($ in Millions)

NZ SMR PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(93)	109	9,712
Gas	(40)	20	
Emissions	(90)	(211)	
LCOE	(550)	2,255	
All Critical Uncertain Factors	(803)	2,214	

Table 6D-11 – Plan 11 Tornado Diagram ($ in Millions)

NZ H2 PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(88)	124	9,388
Gas	(138)	108	
Emissions	(176)	(255)	
LCOE	(469)	1,328	
All Critical Uncertain Factors	(860)	1,369	

Table 6D-12 – Plan 12 Tornado Diagram ($ in Millions)

EPA PVRR ($M)	**Low (below Base)**	**High (above Base)**	**Base**
Load	(89)	162	8,815
Gas	(110)	(50)	
Emissions	(194)	(249)	
LCOE	(260)	786	
All Critical Uncertain Factors	(671)	789	

Appendix 6E

Cumulative Probability Tables

Table 6E-1 – Cumulative Probability Plans 1-6 ($ in Millions)

Gas RAP 20-Yr NPVRR ($M)	*Gas RAP* Cumulative Prob %	*Gas MAP* 20-Yr NPVRR ($M)	*Gas MAP* Cumulative Prob %	*Mix RAP* 20-Yr NPVRR ($M)	*Mix RAP* Cumulative Prob %	*Mix RAP Frame* 20-Yr NPVRR ($M)	*Mix RAP Frame* Cumulative Prob %	*Mix RAP 5x Aero* 20-Yr NPVRR ($M)	*Mix RAP 5x Aero* Cumulative Prob %	*Mix MAP* 20-Yr NPVRR ($M)	*Mix MAP* Cumulative Prob %
7,997	0.16%	7,982	0.16%	8,006	0.16%	7,907	0.16%	8,102	0.16%	7,995	0.16%
8,024	0.48%	8,008	0.48%	8,024	0.48%	7,928	0.48%	8,126	0.48%	8,014	0.48%
8,065	0.84%	8,050	0.84%	8,074	0.84%	7,966	0.96%	8,170	0.84%	8,063	0.84%
8,092	1.56%	8,076	1.56%	8,092	1.56%	7,975	1.32%	8,194	1.56%	8,082	1.56%
8,142	1.96%	8,121	1.96%	8,130	1.96%	7,996	2.04%	8,235	1.96%	8,120	1.96%
8,170	2.36%	8,158	2.36%	8,198	2.36%	8,031	2.44%	8,289	2.24%	8,188	2.76%
8,197	3.16%	8,184	3.16%	8,200	3.16%	8,055	3.52%	8,305	3.04%	8,194	3.16%
8,202	3.44%	8,187	3.96%	8,213	3.44%	8,077	4.32%	8,309	3.44%	8,202	4.06%
8,208	4.24%	8,191	4.24%	8,213	4.34%	8,095	4.60%	8,317	4.34%	8,206	4.34%
8,225	5.14%	8,204	5.14%	8,217	5.14%	8,100	5.00%	8,333	5.14%	8,212	5.14%
8,238	6.04%	8,226	6.04%	8,229	5.62%	8,106	5.24%	8,338	5.70%	8,217	5.62%
8,254	6.60%	8,230	6.52%	8,249	6.18%	8,114	6.14%	8,339	6.18%	8,238	5.86%
8,255	7.08%	8,241	7.08%	8,250	6.42%	8,121	6.94%	8,361	6.42%	8,243	6.42%
8,265	8.88%	8,248	7.40%	8,263	6.74%	8,141	7.50%	8,367	6.74%	8,253	6.74%
8,268	9.20%	8,252	9.20%	8,267	7.64%	8,154	9.30%	8,377	7.64%	8,262	7.64%
8,278	9.44%	8,252	9.44%	8,277	9.44%	8,158	10.50%	8,382	9.44%	8,265	9.44%
8,285	11.24%	8,264	11.24%	8,285	11.24%	8,164	10.82%	8,401	11.24%	8,280	11.24%
8,315	12.24%	8,297	12.24%	8,319	12.32%	8,168	11.72%	8,429	12.32%	8,306	12.32%
8,344	12.96%	8,319	13.32%	8,323	13.32%	8,189	13.52%	8,442	13.32%	8,318	13.32%
8,344	14.04%	8,325	14.04%	8,340	14.04%	8,198	14.06%	8,444	14.04%	8,330	14.04%
8,370	14.58%	8,344	14.58%	8,343	14.58%	8,206	14.90%	8,453	14.58%	8,330	14.58%
8,375	15.28%	8,363	16.58%	8,372	15.28%	8,224	15.90%	8,457	15.28%	8,365	15.28%
8,381	17.28%	8,364	17.28%	8,393	17.28%	8,240	16.62%	8,497	15.98%	8,387	17.28%
8,381	17.98%	8,367	17.98%	8,405	17.98%	8,246	17.10%	8,512	17.98%	8,401	19.53%
8,398	20.23%	8,380	20.23%	8,405	20.23%	8,248	19.80%	8,515	19.38%	8,402	20.33%
8,427	21.63%	8,406	21.43%	8,413	21.03%	8,254	20.50%	8,524	20.18%	8,404	21.03%
8,428	22.83%	8,412	22.23%	8,422	22.23%	8,270	22.50%	8,525	22.43%	8,415	22.23%
8,432	24.23%	8,415	23.63%	8,424	23.63%	8,288	23.20%	8,546	23.83%	8,416	23.63%
8,436	25.03%	8,417	25.03%	8,441	25.03%	8,288	24.60%	8,547	25.03%	8,437	24.23%
8,441	25.83%	8,424	25.83%	8,443	25.63%	8,293	25.40%	8,568	25.63%	8,442	25.63%
8,451	26.43%	8,428	26.43%	8,456	26.43%	8,298	26.24%	8,575	26.43%	8,452	26.43%
8,458	30.93%	8,440	30.93%	8,470	30.93%	8,299	26.84%	8,579	27.27%	8,464	30.93%
8,501	31.49%	8,485	31.49%	8,479	31.41%	8,307	29.09%	8,586	27.83%	8,466	31.41%
8,508	32.33%	8,486	32.33%	8,484	32.25%	8,333	30.49%	8,589	32.33%	8,475	32.25%
8,517	34.13%	8,490	32.81%	8,496	32.81%	8,346	31.57%	8,594	32.81%	8,491	34.05%
8,517	36.83%	8,495	35.51%	8,501	34.61%	8,347	36.07%	8,613	34.61%	8,491	34.61%
8,519	37.31%	8,500	37.31%	8,512	37.31%	8,356	36.87%	8,618	35.03%	8,505	37.31%
8,525	39.11%	8,501	39.11%	8,530	37.73%	8,364	37.29%	8,636	37.73%	8,523	37.73%
8,543	40.46%	8,520	40.46%	8,533	39.53%	8,381	39.09%	8,646	38.57%	8,528	39.53%
8,552	40.88%	8,530	40.88%	8,535	40.88%	8,383	39.65%	8,651	40.37%	8,529	40.88%
8,554	42.63%	8,540	42.63%	8,547	41.72%	8,391	41.00%	8,660	41.72%	8,539	41.72%
8,583	43.47%	8,558	43.47%	8,564	43.47%	8,399	43.10%	8,665	43.47%	8,564	43.47%
8,605	46.97%	8,588	45.47%	8,579	44.55%	8,433	44.90%	8,694	44.55%	8,566	44.55%
8,609	48.97%	8,589	46.55%	8,605	46.55%	8,439	46.10%	8,723	48.05%	8,601	46.55%
8,618	50.05%	8,591	50.05%	8,617	50.05%	8,447	47.85%	8,732	50.05%	8,615	50.05%
8,627	50.29%	8,621	50.29%	8,669	51.45%	8,481	51.35%	8,767	51.45%	8,663	51.45%
8,654	50.77%	8,647	50.77%	8,672	52.65%	8,486	53.35%	8,787	53.55%	8,665	52.65%
8,674	52.17%	8,661	52.17%	8,676	54.75%	8,491	55.45%	8,793	54.95%	8,673	54.75%
8,681	54.27%	8,662	54.27%	8,689	56.15%	8,536	56.85%	8,802	56.15%	8,689	59.25%
8,692	55.47%	8,666	55.47%	8,694	60.65%	8,539	59.55%	8,820	60.65%	8,690	60.65%
8,693	56.87%	8,671	56.87%	8,723	61.70%	8,557	60.60%	8,825	61.70%	8,721	61.70%
8,695	57.41%	8,676	61.37%	8,740	63.80%	8,574	65.10%	8,853	63.80%	8,737	63.80%
8,698	61.91%	8,690	61.91%	8,758	64.04%	8,575	66.50%	8,875	64.04%	8,760	64.04%
8,722	62.99%	8,706	62.96%	8,771	66.74%	8,647	66.74%	8,899	64.52%	8,765	66.74%
8,725	64.04%	8,715	64.04%	8,777	67.22%	8,668	67.22%	8,902	67.22%	8,778	67.22%
8,756	66.14%	8,734	66.14%	8,826	67.76%	8,706	67.94%	8,943	67.76%	8,828	67.76%
8,772	66.74%	8,761	66.74%	8,845	68.84%	8,715	68.48%	8,967	68.84%	8,846	68.84%
8,791	69.44%	8,765	69.44%	8,862	72.34%	8,729	71.98%	8,974	72.34%	8,862	72.34%
8,832	69.86%	8,827	70.64%	8,883	72.94%	8,736	73.06%	9,008	72.94%	8,885	72.94%
8,838	71.06%	8,830	71.06%	8,952	74.14%	8,772	73.66%	9,063	73.36%	8,953	74.14%
8,855	72.41%	8,843	72.41%	8,965	74.56%	8,795	75.28%	9,078	74.56%	8,967	75.49%
8,866	75.91%	8,847	75.91%	8,965	75.91%	8,817	76.48%	9,091	75.91%	8,971	75.91%
8,884	76.75%	8,869	76.63%	8,982	76.63%	8,835	76.90%	9,112	76.75%	8,982	76.63%
8,885	77.47%	8,880	77.47%	9,001	77.47%	8,846	77.26%	9,113	77.47%	9,003	76.99%
8,898	77.95%	8,888	77.95%	9,003	77.83%	8,854	78.61%	9,134	77.83%	9,008	77.83%
8,908	78.31%	8,891	78.31%	9,016	78.31%	8,881	79.45%	9,141	78.31%	9,018	78.31%
8,915	81.01%	8,904	81.01%	9,030	81.01%	8,894	82.15%	9,155	81.01%	9,030	81.01%
8,974	82.09%	8,959	82.63%	9,072	82.63%	8,904	82.63%	9,202	82.63%	9,071	82.63%
8,974	83.71%	8,964	83.71%	9,092	83.71%	8,939	83.44%	9,217	83.71%	9,095	83.71%
9,000	84.52%	8,983	84.52%	9,095	84.52%	8,946	84.70%	9,226	84.52%	9,095	84.52%
9,011	85.57%	9,003	85.57%	9,124	85.57%	8,980	85.78%	9,230	85.57%	9,130	85.57%
9,062	87.67%	9,051	86.77%	9,165	86.77%	8,986	86.50%	9,289	87.67%	9,167	86.77%
9,066	88.87%	9,054	88.87%	9,177	88.87%	8,994	87.55%	9,297	88.87%	9,181	88.87%
9,131	89.71%	9,124	89.71%	9,232	89.59%	9,028	89.65%	9,353	90.13%	9,231	89.59%
9,138	90.97%	9,125	90.97%	9,236	90.85%	9,033	90.85%	9,359	90.97%	9,240	90.85%
9,149	91.69%	9,129	91.69%	9,249	91.69%	9,038	92.11%	9,368	91.69%	9,256	93.55%
9,155	94.39%	9,140	94.39%	9,254	94.39%	9,086	93.73%	9,386	94.39%	9,256	94.39%
9,182	95.02%	9,170	95.02%	9,283	95.02%	9,105	94.36%	9,391	95.02%	9,287	95.02%
9,213	96.28%	9,197	96.28%	9,300	96.28%	9,121	97.06%	9,419	96.28%	9,303	96.28%
9,248	97.90%	9,229	97.90%	9,331	97.90%	9,123	97.90%	9,467	97.90%	9,331	97.90%
9,323	100.00%	9,310	100.00%	9,422	100.00%	9,276	100.00%	9,540	100.00%	9,428	100.00%

Table 6E-2 – Cumulative Probability Plans 7-12 ($ in Millions)

Renew RAP	*Renew RAP*	*Renew MAP*	*Renew MAP*	*NZ Renew*	*NZ Renew*	*NZ SMR*	*NZ SMR*	*NZ H2*	*NZ H2*	*EPA*	*EPA*
20-Yr NPVRR ($M)	Cumulative Prob %	20-Yr NPVRR ($M)	Cumulative Prob %	20-Yr NPVRR ($M)	Cumulative Prob %	20-Yr NPVRR ($M)	Cumulative Prob %	20-Yr NPVRR ($M)	Cumulative Prob %	20-Yr NPVRR ($M)	Cumulative Prob %
8,343	0.16%	8,500	0.16%	8,891	0.16%	8,863	0.40%	8,505	0.16%	8,135	0.16%
8,385	0.48%	8,523	0.48%	8,937	0.48%	8,897	0.64%	8,527	0.48%	8,144	0.48%
8,404	0.88%	8,567	0.84%	8,954	0.88%	8,899	0.80%	8,572	0.84%	8,155	0.96%
8,411	1.24%	8,578	1.24%	8,958	1.24%	8,909	1.12%	8,582	1.24%	8,203	1.32%
8,453	1.96%	8,590	1.96%	9,005	1.96%	8,951	2.02%	8,595	1.96%	8,212	2.04%
8,486	2.86%	8,660	2.86%	9,036	2.86%	8,955	2.50%	8,664	2.86%	8,224	2.44%
8,508	3.66%	8,662	3.66%	9,051	3.14%	8,972	2.86%	8,666	3.66%	8,245	3.52%
8,510	3.94%	8,670	3.94%	9,061	3.94%	8,979	3.58%	8,672	3.94%	8,282	3.76%
8,516	4.18%	8,691	4.18%	9,064	4.18%	8,992	4.38%	8,693	4.50%	8,284	4.56%
8,537	4.66%	8,695	4.74%	9,088	4.66%	9,001	4.92%	8,694	4.74%	8,306	5.46%
8,541	4.98%	8,701	5.06%	9,095	5.22%	9,043	5.24%	8,705	5.06%	8,334	5.74%
8,551	5.54%	8,717	5.54%	9,096	5.54%	9,048	6.32%	8,720	5.54%	8,352	6.30%
8,585	7.34%	8,738	7.34%	9,138	7.34%	9,056	7.02%	8,743	7.34%	8,361	8.10%
8,610	8.04%	8,777	8.06%	9,152	8.04%	9,059	7.30%	8,781	8.06%	8,368	8.42%
8,613	8.58%	8,788	8.76%	9,158	8.58%	9,061	7.86%	8,788	8.76%	8,374	8.96%
8,617	9.30%	8,789	9.30%	9,172	9.30%	9,070	8.66%	8,791	9.30%	8,395	9.36%
8,626	10.38%	8,806	10.38%	9,177	10.38%	9,072	10.46%	8,809	10.38%	8,403	10.20%
8,652	11.18%	8,827	11.18%	9,207	11.18%	9,076	10.94%	8,831	11.18%	8,403	11.00%
8,677	12.58%	8,834	12.58%	9,219	11.58%	9,098	11.78%	8,835	12.58%	8,405	11.48%
8,732	13.14%	8,897	13.14%	9,227	12.98%	9,122	12.20%	8,896	13.14%	8,415	12.68%
8,738	13.62%	8,915	14.94%	9,266	13.78%	9,122	12.92%	8,919	14.94%	8,445	13.40%
8,740	15.42%	8,924	15.42%	9,279	14.34%	9,158	13.76%	8,926	15.42%	8,458	14.10%
8,756	16.26%	8,941	16.26%	9,282	15.34%	9,162	15.56%	8,940	16.26%	8,463	15.00%
8,782	16.68%	8,957	16.66%	9,287	16.24%	9,167	16.96%	8,959	16.68%	8,467	15.80%
8,782	17.08%	8,960	17.08%	9,288	16.72%	9,183	18.04%	8,973	17.52%	8,469	16.64%
8,784	17.92%	8,975	17.92%	9,295	18.52%	9,216	18.60%	8,974	17.92%	8,472	18.44%
8,824	18.72%	8,980	18.72%	9,300	19.36%	9,271	20.00%	8,996	18.72%	8,483	19.44%
8,838	19.80%	9,024	19.80%	9,314	19.78%	9,413	21.00%	9,026	19.80%	8,501	20.84%
8,843	20.80%	9,025	20.70%	9,325	20.62%	9,446	21.60%	9,041	20.70%	8,505	23.54%
8,850	21.70%	9,036	21.70%	9,333	22.42%	9,450	22.00%	9,043	22.10%	8,505	24.62%
8,864	23.10%	9,044	23.10%	9,364	24.67%	9,459	22.80%	9,051	23.10%	8,542	25.22%
8,892	24.90%	9,048	24.90%	9,380	25.37%	9,501	25.05%	9,064	24.90%	8,544	27.22%
8,925	27.15%	9,117	27.15%	9,388	26.45%	9,504	26.25%	9,133	27.15%	8,555	29.02%
8,947	29.15%	9,119	29.15%	9,389	28.45%	9,523	27.15%	9,135	29.15%	8,558	29.44%
8,949	29.85%	9,128	29.85%	9,392	29.05%	9,528	28.95%	9,140	29.85%	8,566	31.69%
8,955	30.45%	9,148	30.45%	9,413	30.45%	9,541	30.95%	9,161	31.25%	8,593	32.25%
8,976	31.65%	9,153	31.85%	9,416	31.65%	9,551	32.30%	9,163	31.85%	8,593	32.95%
8,980	32.45%	9,159	32.65%	9,424	33.05%	9,594	33.10%	9,174	32.65%	8,612	34.35%
8,989	33.85%	9,175	33.85%	9,424	33.85%	9,597	35.80%	9,189	33.85%	8,621	38.85%
9,024	38.35%	9,196	38.35%	9,466	38.35%	9,606	37.55%	9,212	38.35%	8,628	39.65%
9,049	40.10%	9,235	40.15%	9,480	40.10%	9,610	38.25%	9,250	40.15%	8,634	41.00%
9,052	41.45%	9,245	41.90%	9,486	41.45%	9,610	39.65%	9,257	41.90%	8,662	43.10%
9,056	43.25%	9,247	43.25%	9,500	43.25%	9,619	41.65%	9,260	43.25%	8,665	44.30%
9,065	45.95%	9,264	45.95%	9,505	45.95%	9,622	46.15%	9,278	45.95%	8,705	46.10%
9,091	47.95%	9,285	47.95%	9,535	47.95%	9,625	47.35%	9,300	47.95%	8,717	47.50%
9,116	51.45%	9,292	51.45%	9,555	51.45%	9,647	49.45%	9,303	51.45%	8,718	49.25%
9,171	52.85%	9,355	52.85%	9,607	52.85%	9,671	50.50%	9,365	52.85%	8,726	51.25%
9,177	54.05%	9,373	57.35%	9,617	54.05%	9,672	52.30%	9,388	57.35%	8,729	53.35%
9,179	58.55%	9,381	58.55%	9,623	58.55%	9,707	54.40%	9,395	58.55%	8,760	56.85%
9,195	60.65%	9,398	60.65%	9,628	60.65%	9,712	58.90%	9,409	60.65%	8,765	59.55%
9,220	61.70%	9,418	61.70%	9,643	61.70%	9,716	62.40%	9,428	61.70%	8,815	64.05%
9,223	63.80%	9,432	63.80%	9,653	63.80%	9,732	65.10%	9,442	63.80%	8,818	65.10%
9,277	66.50%	9,482	66.50%	9,717	66.50%	9,766	66.50%	9,495	66.50%	8,852	66.50%
9,303	70.00%	9,502	70.00%	9,741	70.00%	9,821	70.00%	9,511	70.00%	8,977	70.00%
10,040	70.24%	10,262	70.24%	10,663	70.24%	11,667	70.60%	10,301	70.24%	9,181	70.24%
10,082	70.72%	10,285	70.72%	10,709	70.72%	11,701	70.96%	10,324	70.72%	9,190	70.72%
10,100	71.32%	10,330	71.26%	10,726	71.32%	11,703	71.20%	10,369	71.26%	9,201	71.44%
10,107	71.86%	10,340	71.86%	10,730	71.86%	11,714	71.68%	10,379	71.86%	9,249	71.98%
10,149	72.94%	10,353	72.94%	10,777	72.94%	11,755	73.03%	10,392	72.94%	9,258	73.06%
10,182	74.29%	10,422	74.29%	10,808	74.29%	11,760	73.75%	10,461	74.29%	9,269	73.66%
10,205	75.49%	10,424	75.49%	10,823	74.71%	11,776	74.29%	10,463	75.49%	9,291	75.28%
10,207	75.91%	10,433	75.91%	10,833	75.91%	11,783	75.37%	10,468	75.91%	9,328	75.64%
10,213	76.27%	10,453	76.27%	10,836	76.27%	11,796	76.57%	10,489	76.75%	9,330	76.84%
10,233	76.99%	10,457	77.11%	10,860	76.99%	11,806	77.38%	10,491	77.11%	9,352	78.19%
10,238	77.47%	10,464	77.59%	10,867	77.83%	11,847	77.86%	10,502	77.59%	9,379	78.61%
10,247	78.31%	10,480	78.31%	10,868	78.31%	11,853	79.48%	10,517	78.31%	9,398	79.45%
10,281	81.01%	10,501	81.01%	10,910	81.01%	11,860	80.53%	10,540	81.01%	9,407	82.15%
10,306	82.06%	10,540	82.09%	10,924	82.06%	11,863	80.95%	10,578	82.09%	9,414	82.63%
10,309	82.87%	10,550	83.14%	10,930	82.87%	11,865	81.79%	10,585	83.14%	9,420	83.44%
10,314	83.95%	10,552	83.95%	10,944	83.95%	11,874	82.99%	10,588	83.95%	9,449	84.70%
10,322	85.57%	10,568	85.57%	10,949	85.57%	11,877	85.69%	10,606	85.57%	9,451	85.42%
10,349	86.77%	10,590	86.77%	10,979	86.77%	11,880	86.41%	10,628	86.77%	9,491	86.50%
10,373	88.87%	10,597	88.87%	10,999	88.87%	11,902	87.67%	10,631	88.87%	9,504	87.55%
10,429	89.71%	10,660	89.71%	11,051	89.71%	11,926	88.30%	10,693	89.71%	9,512	88.75%
10,434	90.43%	10,678	92.41%	11,060	90.43%	11,926	89.38%	10,716	92.41%	9,515	90.01%
10,437	93.13%	10,686	93.13%	11,067	93.13%	11,963	90.64%	10,723	93.13%	9,546	92.11%
10,452	94.39%	10,703	94.39%	11,072	94.39%	11,967	93.34%	10,736	94.39%	9,551	93.73%
10,478	95.02%	10,722	95.02%	11,086	95.02%	11,971	95.44%	10,756	95.02%	9,601	96.43%
10,481	96.28%	10,737	96.28%	11,097	96.28%	11,987	97.06%	10,770	96.28%	9,604	97.06%
10,534	97.90%	10,787	97.90%	11,160	97.90%	12,020	97.90%	10,823	97.90%	9,638	97.90%
10,561	100.00%	10,807	100.00%	11,185	100.00%	12,076	100.00%	10,839	100.00%	9,763	100.00%

Appendix 6F: Reliability Validation Report