COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

ELECTRONIC 2024 INTEGRATED RESOURCE PLAN OF DUKE ENERGY KENTUCKY, INC.	))	CASE NO. 2024-00197

O R D E R

The Commission initiated this proceeding for Commission Staff to conduct a review of the 2024 Integrated Resource Plan (IRP) filed by Duke Energy Kentucky, Inc. (Duke Kentucky), pursuant to 807 KAR 5:058. Attached as an Appendix to this Order is the Commission Staff's Report summarizing Commission Staff's review of the IRP. This Commission Staff's Report is being entered into the record of this case pursuant to 807 KAR 5:058, Section 11(3).

Based on the evidence of record, the Commission finds that the Commission Staff's Report represents the final substantive action in this matter. The final administrative action will be an Order closing the case and removing it from the Commission's docket. That Order will be issued after the period for comments on the Commission Staff's Report has expired.

IT IS THEREFORE ORDERED that:

1. The Commission Staff's Report on Duke Kentucky's 2024 IRP represents the final substantive action in this matter.

2. Any party desiring to file comments regarding the Commission Staff's Report on Duke Kentucky's 2024 IRP shall do so on or before April 21, 2025.

3. Duke Kentucky shall file comments with respect to the Commission Staff's Report and in response to Intervenor comments on or before May 5, 2025.

4. An Order closing this case and removing it from the Commission docket shall be issued after the period for comments on the Commission Staff's Report has expired.

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PUBLIC SERVICE COMMISSION

Chairman

Vice Chairman

Commissioner

ATTEST:

Executive Director

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APPENDIX

AN APPENDIX TO AN ORDER OF THE KENTUCKY PUBLIC SERVICE COMMISSION IN CASE NO. 2024-00197 DATED APR 07 2025

FORTY-ONE PAGES TO FOLLOW

Kentucky Public Service Commission

Commission Staff's Report on the

2024 Integrated Resource Plan of

Duke Energy Kentucky, Inc.

Case No. 2024-00197

April 7, 2025

SECTION 1

INTRODUCTION

In 1990, the Kentucky Public Service Commission (Commission) promulgated 807 KAR 5:058 to create an integrated resource planning process to provide for review of the long-range resource plans of Kentucky's jurisdictional electric generating utilities by Commission Staff. The Commission's goal was to ensure that all reasonable options to meet projected load were being examined in order to provide ratepayers a reliable supply of electricity that is cost-effective.[1]

Each electric generating utility is required by 807 KAR 5:058, Section 2, to file an Integrated Resource Plan (IRP) every three years. This plan requires the utility to 1) forecast its load, or expected demand, for the following 15 years;[2] 2) identify existing and potential supply- and demand-side resources;[3] and 3) determine how to meet its demand in a way that minimizes cost while maintaining reliable service. The load forecast is compared to existing resource generation capacity, and the utility must establish a plan for meeting any capacity shortfall for each year. Modern generation planning involves complex software modeling systems in which the utility includes available resources as variables and the model is intended to output the most cost-effective[4] generation portfolio for each of several scenarios combining variables such as variance from forecasted load, fuel costs, changes to reserve margin requirements, changes in environmental regulation, and capital expenditures.

Duke Energy Kentucky, Inc. (Duke Kentucky) is an investor-owned utility and wholly owned subsidiary of Duke Energy Ohio, Inc. providing retail electric service to approximately 153,000 customers in Northern Kentucky.[5] Duke Kentucky owns and operates its own electric transmission and distribution system.[6] Duke Kentucky is a member of Regional Transmission Organization (RTO) PJM Interconnection LLC (PJM). Duke Kentucky is currently a member of PJM's Fixed Resource Requirement (FRR) construct but has filed to transition to the Reliability Pricing Model (RPM), Base Residual

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[1] *See* Admin. Case No. 308, *An Inquiry into Kentucky's Present and Future Electric Needs and the Alternatives for Meeting Those Needs* (Ky. PSC Aug. 8, 1990), Order at 1–3. *See also* 807 KAR 5:058.

[2] 807 KAR 5:058, Section 7.

[3] 807 KAR 5:058, Section 8.

[4] Subject to the requirements that the utility provide adequate, efficient and reasonable service under KRS 278.030 and the rebuttable presumption against retirement of fossil fuel-fired electric generating units found in KRS 278.264.

[5] 2024 IRP at 2. Duke Kentucky also provides natural gas service to approximately 104,500 customers.

[6] 2024 IRP at 66.

Auction (BRA), and Incremental Auction (IA) construct beginning June 1, 2027.[7] This Report will address the significance of that proposed change.

Duke Kentucky's stated present total power capacity is 1,197 megawatts (MW) and its existing resources include:[8]

- 600 MW of coal-fired steam capacity at East Bend Unit 2 Station,
- 564 MW of natural gas-fired peaking capacity at Woodsdale Station,
- 24 MW of Demand Response (DR),
- 9 MW of solar capacity.

Duke Kentucky stated that its objectives as set forth in its 2024 IRP include:[9]

- Provide adequate, efficient, reasonable service that is economic in an uncertain environment,
- Maintain the flexibility and ability to alter the plan in the future as circumstances change,
- Choose a near-term plan that is robust over a wide variety of possible futures,
- Minimize risks such as wholesale market risks, reliability risks.

Duke Kentucky submitted its 2024 IRP to the Commission on June 21, 2024. On July 16, 2024, an Order was issued establishing a procedural schedule for this proceeding. The procedural schedule established a deadline for requesting intervention, two rounds of data requests to Duke Kentucky, an opportunity for intervenors to file written comments, and an opportunity for Duke Kentucky to file a response to any intervenor comments. A hearing was set in this matter on December 10, 2024.

The following parties filed for, and were granted, intervention in this matter: The Attorney General of the Commonwealth of Kentucky, by and through the Office of Rate Intervention (Attorney General), Sierra Club, and Joint Intervenors Kentucky Solar Energy Society (KSES), Kentuckians for the Commonwealth, and Kentucky Resources Council (Joint Intervenors). Duke Kentucky and Intervenors may submit comments to this Staff Report on or before April 7, 2025. Intervenors' pre-hearing comments and Duke Kentucky's reply comments are summarized within this report's applicable sections.

The purpose of this report is to review and evaluate Duke Kentucky's 2024 IRP in accordance with 807 KAR 5:058, Section 11(3), which requires Staff to issue a report

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[7] Case No. 2024-00285, *Electronic Application of Duke Energy Kentucky, Inc. to Become a Full Participant in the PJM Interconnection LLC, Base Residual and Incremental Auction Construct for the 2027/2028 Delivery Year and for Necessary Accounting and Tariff Changes* (filed Sept. 6, 2024), Application.

[8] 2024 IRP at 35.

[9] 2024 IRP at 7.

summarizing its review of each IRP filing made with the Commission and make suggestions and recommendations to be considered by each utility in its next IRP filing. Staff recognizes that resource planning is a dynamic, ongoing process. Specifically, Staff's goals are to ensure, among other things, the following:

- All resource options are adequately and fairly evaluated;
- Critical data, assumptions, and methodologies for all aspects of the plan are adequately documented and are reasonable; and
- The report includes an incremental component, noting any significant changes from Duke Kentucky's most recent IRP filed in 2021.

The remainder of this report is organized as follows:

- Section 2: Load Forecasting—reviews Duke Kentucky's projected load growth and load forecasting methodology.
- Section 3: Demand-Side Management and Energy Efficiency (DSM/EE)—summarizes Duke Kentucky's evaluation of DSM opportunities.
- Section 4: Supply-Side Resource Assessment—focuses on supply-side resources available to meet Duke Kentucky's load requirements and environmental compliance planning.
- Section 5: Integration—discusses Duke Kentucky's overall assessment of supply-side and demand-side options and their integration into an overall resource plan.
- Section 6: Reasonableness and Recommendations—discusses Commission Staff's position regarding the reasonableness of the IRP and its assumptions and includes Commission Staff's recommendations.

SECTION 2

LOAD FORECASTING

INTRODUCTION

This Section reviews and comments on the projected load growth for Duke Kentucky's systems and Duke Kentucky's load forecasting methodology. This section also reviews the parties' comments regarding Duke Kentucky's load and demand forecast. Commission Staff's discussion of and recommendations regarding Duke Kentucky's load and demand forecasting are discussed in Section 6 of this Report.

Calculating the energy consumption and peak demand forecast for each customer class and for the entire system is an important first step in the IRP process. It forms the basis for projecting how the generation fleet may evolve over time to meet projected customer demand, which in turn can affect long-term capital budgeting and investment decisions.

Duke Kentucky's energy and peak load forecasting process begins with a national economic forecast, leading to a service area economic forecast and an electric load forecast provided by Itron, Inc. (Itron).[10] Moody's Analytics (Moody's) provided forecasts of economic and demographic data including population, employment, industrial production, inflation, wages, and income. The economy of northern Kentucky is contained within the Cincinnati Primary Metropolitan Statistical Area.[11] Using historical and forecasted economic and demographic data, Duke Kentucky employed Statistical End Use (SAE) Models and other economic regression models to forecast customer class demand. In addition to obtaining a base case forecast, Duke Kentucky ran various scenario analyses reflecting more optimistic and pessimistic outlooks to set upper and lower bounds on the base forecast.

FORECASTING METHODOLOGY AND ASSUMPTIONS

Statistically Adjusted End-Use (SAE) Models

Itron's SAE modeling techniques were used in forecasting residential and commercial energy use. SAE models are structured to capture unique trends and variations within customer classes over time by separating electricity consumption into specific end-uses. Peak demand models are made at a granular level to capture incremental impacts of factors including electric vehicles and rooftop solar, energy

[10] 2024 IRP, Appendix B, at 66.

[11] 2024 IRP, Appendix B, at 66-67.

efficiency measures, and demand response (DR) programs.[12] SAE techniques allow for the breakdown of electricity consumption into specific end-uses. Also, SAE allows for efficiency trends through the incorporation of behavioral and technical changes in usage patterns through end-use intensities.[13]

Data Documentation

The economic forecast data supporting the various customer class forecasts was developed by Moody's. This data included national, state, and local (the Cincinnati Primary Metropolitan Statistical Area) population by age cohort, inflation indices such as the Personal Consumption Expenditures and Consumer Price Index, employment, and local income by subcategory. Employment was comprised of quarterly national and local employment series by industrial code. Income was comprised of wages, rents, proprietors' income, transfer payments, other labor income, personal contributions for social insurance, and non-farm proprietors' income.[14] Electricity and natural gas price data were obtained from Duke Kentucky financial reports. Marginal electricity prices by customer class were collected from customer records and rate schedules while projections were obtained from the Duke Energy Fundamentals Forecast team. For Peak Load and Energy forecasts, Moody's supplied the economic data, and all local weather data was obtained from the National Oceanic and Atmospheric Administration.[15] Using daily weather data, heating degree days (HDD) and cooling degree days (CDD) were created, and an average of extreme weather conditions was used to create a normal weather day on a 30-year basis.[16] An appliance stock variable included appliance saturations, efficiencies, and energy consumption.[17] Appliance saturation and efficiency data was obtained from Duke Kentucky's Appliance Saturation Surveys. Itron supplied historical appliance efficiency and saturation forecasts.[18]

Duke Kentucky reported several enhancements to its forecast methodology. The appliance stock variable development is now derived completely from Itron's latest historical estimates of appliance efficiencies, as well as recent economic data and forecasts from Moody's. For the Residential and Commercial customer classes, the SAE modeling specification is now the principle modeling technique to estimate the economic

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[12] 2024 IRP, Appendix B, at 67 and Appendix F, at 141-142. *See also* Duke Kentucky's Response to Staff's First Request for Information (Staff's First Request) (filed Sept. 4, 2024), Item 27; Duke Kentucky's Response to Staff's Second Request (Staff's Second Request) (filed Oct. 16, 2024), Item 8a, for a detailed explanation of the SAE methodology and how specific variables are constructed.

[13] 2024 IRP, Appendix F at 141.

[14] 2024 IRP, Appendix B at 71-72.

[15] 2024 IRP, Appendix B at 69, 71-72.

[16] 2024 IRP, Appendix B at 72; Duke Kentucky's Response to Staff's First Request, Item 27.

[17] 2024 IRP, Appendix B at 72.

[18] 2024 IRP, Appendix B at 72.

and behavioral relationships between the relevant variables. Duke Kentucky used an average of the last 30 years to derive its weather projections. The 30-year window was selected to reduce the year-to-year variability and to better capture the range of calendar weather values for peaks and daily observations.[19]

Electric Vehicle (EV) Forecast

The Guidehouse Vehicle Analytics and Simulation Tool was used to develop Duke Kentucky's electric vehicle forecast. An EV vehicle adoption variable is developed based on the total cost of ownership, which is a function of historical and projected vehicle registrations, vehicle manufacturers' suggested retail price values, vehicle efficiency characteristics, projections of fuel costs, future availability, consumer acceptance, and vehicle miles traveled.[20] The energy and load forecast associated with EV adoption is then projected. Vehicle miles traveled and vehicle efficiency are used to forecast vehicle energy requirements. Then associated load charging profiles are developed, broken down by light, medium, and heavy duty. Based upon the adoption forecast, the projected amount of energy needed to charge the three types of EV, and the hourly EV demand profiles, the jurisdictional EV load forecast is developed.[21]

Residential Forecast

The Residential class sales forecast was defined as the product of forecasted residential customers (households) in the service territory and energy use per customer. Residential usage per customer is a function of real household income, real electricity prices, and the combined impact of the saturation and efficiency of air conditioners, electric space heating, and other appliances.[22] The number of residential customers was expected to show moderate growth over the 2025-2045 forecast period at an average annual rate of 0.34 percent (from 140,321 to 150,166 by 2045).[23] Over the forecast period, residential energy use was expected to grow at an average annual rate of 0.91 percent, from 1,531,911 to 1,834,988 MWh per year, after accounting for current and

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[19] 2024 IRP, Appendix B at 74-75. Duke Kentucky noted that the 30-year window reduced the year-to-year variability by 70 percent.as compared to using a 10-year window. Even though recent years exhibit a statistically robust slight upward trend, that trend is less than the year-to-year variability.

[20] 2024 IRP Appendix B at 69. Data is obtained from IHS Markit, Guidehouse Insights, Argonne National Lab, U.S. Energy Information Administration (EIA), Federal Highway Administration, and the Automotive Association of America.

[21] 2024 IRP, Appendix B at 69.

[22] 2024 IRP, Appendix B at 67. *See also* 2024 IRP, Table B.2 at 77-78 for specific demand equations for all customer classes. In addition to weather related and economic variables, all equations contain qualitative (binary) variables to account for outliers in the data and an autoregressive variable.

[23] 2024 IRP, Appendix B, Table B .9 at 85.

expected EE programs.[24] Appliances included in calculations included electric ranges, frost free and manual defrost refrigerators, food freezers, dishwashers, clothes washers and dryers, water heaters, microwaves, televisions, room air conditioners, central air conditioners, electric resistance heaters, electric heat pumps, and miscellaneous uses such as lighting.[25]

Commercial Forecast

The Commercial class sales forecast was defined as the product of the forecast number of customers and energy use per commercial customer.[26] The number of commercial customers was forecast to decline slowly at an average annual rate of 0.91 percent from 12,270 to 10,224 over the 2025-2045 forecast period.[27] Commercial energy use per customer is modeled as a function of median household income, total employment, real electricity prices, weather, and the combined impact of the commercial saturation of air conditioners, commercial heating, other appliances, appliance efficiency, and commercial building square footage. In addition, the anticipated energy sales from a large new facility associated with the Northern Kentucky/Greater Cincinnati Airport was added to the Commercial class forecast.[28] Although the number of commercial customers was forecast to decline and accounting for EE effects, commercial energy use is forecast to grow at an average annual rate of 0.81 percent from 1,429,597 MWh to 1,681,453 MWh over the forecast period.[29]

Industrial Forecast

The Industrial class sales forecast was defined as a function of real manufacturing gross domestic product (GDP), manufacturing employment, and the impacts of real electricity prices and weather.[30] The number of industrial customers was expected to increase from 329 in 2025 to 347 in 2045.[31] Despite the increase in the number of

[24] 2024 IRP, Appendix B, Table B.10 at 86 and Table B.11 at 87. Comparing Tables B.10 (After EE) and B.11 (Before EE), EE programs have a very small effect on reducing forecast residential use per customer accounting for a reduction of 8,194 MWh in 2025 and 50,164 MWh by 2045.

[25] 2024 IRP, Appendix B at 72.

[26] 2024 IRP, Appendix B at 68.

[27] 2024 IRP, Appendix B, Table B.9 at 85.

[28] 2024 IRP, Appendix B at 68.

[29] 2024 IRP, Appendix B, Table B.10 at 86 and Table B.11 at 87. Comparing Tables B.10 (After EE) and B.11 (Before EE), EE programs have a very small effect on reducing forecast commercial use per customer accounting for a reduction of 3,797 MWh in 2025 and 37,825 MWh by 2045.

[30] 2024 IRP, Appendix B at 68.

[31] 2024 IRP, Appendix B, Table B .9 at 85.

customers, industrial use was expected to decline slowly at an average annual rate of 0.08 percent from 742,085 MWh in 2025 to 729,634 MWh by 2045.[32]

Street Lighting Forecast

The Street Lighting class sales forecast was defined as a function of the number of residential customers (service area population) and the lighting intensity end-use as reported by the Energy Information Administration (EIA) long-term forecast.[33] Over the forecast period, street lighting use was expected to decline slightly from 12,606 MWh to 111,303 MWh by 2034 and then hold steady through 2045.[34]

Other - Public Authority (OPA), Company, and Inter-Departmental Use Forecast

The Public Authority customer class includes those customers involved or affiliated with federal, state, or local government, including schools, government facilities, airports, and water-pumping stations.[35] The energy sales forecast for these customers was defined as a function of real government output and HDD. Including Company and Inter-departmental use, energy use over the forecast period was expected to decline slowly from 253,086 MWh to 241,352 MWh.[36]

Total Electric Sales Consumption Company Net Energy Forecast

Total Electric Sales forecast was the sum of Residential, Commercial, Industrial, Street Lighting, OPA, Company, and Interdepartmental use.[37] Total System Send-Out (net energy for load) equals Total Electric Sales forecast plus forecasts of total Company use and system losses.[38] Net energy for load was expected to grow over the forecast period at an average annual rate of 1.1 percent from 4,283,996 MWh to 4,855,285 MWh.[39] The table below provides Duke Kentucky's net system energy forecast, including the effects of EE programs.[40]

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[32] 2024 IRP, Appendix B, Table B .10 at 86.

[33] 2024 IRP, Appendix B, at 68.

[34] 2024 IRP, Appendix B, Table B .10 at 86.

[35] 2024 IRP, Appendix B, at 68.

[36] 2024 IRP, Appendix B, Table B .10 at 86.

[37] 2024 IRP, Appendix B, at 68.

[38] 2024 IRP, Appendix B, at 68.

[39] 2024 IRP, Appendix B, Table B .10 at 86.

[40] 2024 IRP, Appendix B, Table B .10 at 86.

The Table below provides Duke Kentucky's energy forecasts over the review period.[41]

Year	Rural and Residential	Commercial	Industrial	Street-Hwy Lighting	Other	Total Consumption	Losses and Unaccounted For	Net Energy for Load
2024	1,521,775	1,460,036	727,962	12,474	251,216	3,973,462	315,042	4,288,504
2025	1,531,911	1,429,597	742,085	12,606	253,086	3,969,285	314,710	4,283,996
2026	1,533,956	1,436,236	741,214	12,424	251,595	3,975,426	315,197	4,290,623
2027	1,538,474	1,430,971	738,074	12,248	250,199	3,969,966	314,764	4,284,730
2028	1,547,199	1,431,949	735,053	12,079	249,078	3,975,359	315,192	4,290,551
2029	1,547,804	1,426,981	732,952	11,916	248,235	3,967,887	314,599	4,282,486
2030	1,552,517	1,497,937	732,201	11,758	247,696	4,042,108	320,485	4,362,594
2031	1,559,522	1,497,984	732,520	11,605	247,383	4,049,014	321,033	4,370,047
2032	1,572,058	1,503,791	732,937	11,456	247,091	4,067,333	322,486	4,389,818
2033	1,582,593	1,503,765	732,844	11,313	246,697	4,077,212	323,269	4,400,481
2034	1,598,235	1,508,308	731,698	11,173	246,122	4,095,536	324,722	4,420,258
2035	1,617,342	1,588,063	730,311	11,173	245,486	4,192,375	332,401	4,524,776
2036	1,642,840	1,599,382	727,719	11,173	244,600	4,225,715	335,045	4,560,760
2037	1,661,427	1,601,837	723,190	11,173	243,334	4,240,961	336,254	4,577,215
2038	1,683,929	1,609,048	718,580	11,173	242,056	4,264,786	338,144	4,602,929
2039	1,707,174	1,616,024	714,382	11,173	240,839	4,289,592	340,111	4,629,703
2040	1,733,954	1,630,395	716,711	11,173	240,859	4,333,093	343,560	4,676,653
2041	1,747,994	1,634,757	718,955	11,173	240,888	4,353,766	345,200	4,698,965
2042	1,766,815	1,644,617	721,375	11,173	240,967	4,384,948	347,672	4,732,620
2043	1,787,850	1,655,959	723,965	11,173	241,080	4,420,026	350,454	4,770,481
2044	1,815,023	1,672,505	726,783	11,173	241,218	4,466,702	354,155	4,820,857
2045	1,834,988	1,681,453	729,634	11,173	241,352	4,498,600	356,685	4,855,285

Peak Demand

Duke Kentucky used the SAE methodology to forecast its summer and winter peak demand. Monthly peak demand models utilize heating and cooling variables, other end-uses, and energy usage to obtain monthly peak day forecasts loads. These models are designed to closely represent the relationship of weather extremes to peak loads occurring during each month. The summer peak usually occurs in July in the afternoon and the winter peak in January in the morning.[42]

[41] 2024 IRP, Appendix B, Table B.10 at 86. Note that the Sales For Resale column had Zero entries and was omitted from the table.

[42] 2024 IRP, Appendix B, at 68 and Appendix F, at 141-142. *See also* Duke Kentucky's Response to Staff's First Request, Item 27, and Duke Kentucky's Response to Staff's Second Request, Item 8a, for a detailed explanation of the SAE methodology and how specific variables are constructed.

The table below provides Duke Kentucky's base case seasonal peak load (MW) forecast.[43]

Year	Summer	Winter
2024	808	748
2025	810	737
2026	812	738
2027	812	740
2028	812	740
2029	812	739
2030	822	747
2031	827	749
2032	831	746
2033	838	755
2034	844	759
2035	862	774
2036	872	777
2037	882	779
2038	892	778
2039	902	798
2040	910	808
2041	916	808
2042	930	813
2043	942	816
2044	954	818
2045	965	842

Once the Base Case (most likely) energy and peak demand forecasts were calculated, Duke Kentucky ran two additional scenarios. Moody's provided the base economic scenario. The Low and High forecasts used divergent economic scenarios from Moody's, varied weather assumptions, and different electric vehicle adoption rates.[44] The Table below provides the primary assumptions.[45]

	Economic	Weather	Electric Vehicle
Low	Pessimistic	Average 15 most mild years	Base
Base	Base	30-year Average	Base
High	Optimistic	Average 15 most extreme years	High

Overall, Duke Kentucky expects continued growth in the near term based upon the area's economic resilience and labor market and population growth. The table below

[43] Corrected Table B.18. *See* Duke Kentucky's Response to Staff's First Request, Item 32.

[44] 2024 IRP, Appendix B at 76.

[45] 2024 IRP, Appendix B, Table B.1 at 76.

provides the most likely, pessimistic and optimistic energy, and peak load forecasts after accounting for EE.[46]

	Net Energy Forecast (GWh/YR) After EE			Peak Load Forecast (MW) After EE		
Year	Low	Most Likely	High	Low	Most Likely	High
2024	4,078	4,289	4,480	748	808	887
2025	4,032	4,284	4,513	724	810	892
2026	4,046	4,291	4,526	728	812	896
2027	4,044	4,285	4,524	728	812	898
2028	4,049	4,291	4,533	728	812	899
2029	4,044	4,282	4,535	728	812	902
2030	4,126	4,363	4,623	738	822	913
2031	4,134	4,370	4,639	743	827	922
2032	4,152	4,390	4,665	747	831	928
2033	4,165	4,400	4,686	754	838	938
2034	4,186	4,420	4,713	759	844	945
2035	4,291	4,525	4,824	777	862	965
2036	4,326	4,561	4,864	787	872	977
2037	4,345	4,577	4,888	796	882	989
2038	4,370	4,603	4,919	805	892	1,000
2039	4,397	4,630	4,950	815	902	1,012
2040	4,442	4,677	4,999	822	910	1,020
2041	4,466	4,699	5,030	829	916	1,028
2042	4,499	4,733	5,071	841	930	1,046
2043	4,537	4,770	5,117	852	942	1,060
2044	4,584	4,821	5,173	864	954	1,075
2045	4,620	4,855	5,218	874	965	1,088

For the Pessimistic scenario, energy use is anticipated to grow at a 0.63 percent rate and annual peak demand at a 0.78 percent rate. For the Optimistic scenario, energy use is anticipated to grow at a 0.77 percent rate and annual peak at a 1.03 percent rate. Duke Kentucky's most likely scenario, which also forms the basis of its optimal resource portfolio development process, energy use is expected to grow at an annual 0.62 percent rate and annual peak demand at a 0.89 percent rate.

RESPONSES TO PREVIOUS COMMISSION STAFF'S RECOMMENDATIONS

[46] 2024 IRP, Appendix B, Table B.19 at 94.

Commission Staff issued a report on Duke Kentucky's 2021 IRP which included recommendations for future load forecasts.[47] The following are Duke Kentucky's 2024 IRP responses to load forecast recommendations:

1) Duke Energy Kentucky should be consistent in its presentations and calculation of forecasted results. For example, the forecasted effects of both EE and DR programs presented in IRP Figure 5.2 on page 41 do not match the effects of these programs inherent in the energy and demand forecasts in IRP Figures B-2a and B-2b on pages 97 and 98 and Figures B-3b and B-4b on pages 100 and 102, respectively. Inconsistent reporting of forecast results call into question the veracity of the results overall. Nonetheless, the program effects inherent in the Figures in Appendix B appear to be used as a starting point to design an appropriate resource portfolio.

Response: The IRP Figure 5.2 values differ from those in Appendix B for several reasons described below:

- EE Program Impacts (MWh): This EE impacts are higher by 2,027 MWh due to the inclusion of behavioral program impacts. However, for forecasting purposes, these impacts are excluded as they are already accounted for in the baseline actual. As such the savings reported in Appendix B is lower by 2,027 MWh.
- EE Program Impacts (MW): This column represents peak August reductions, which is not coincidental with the system peak reported in Appendix B.
- DR Program Impacts (MW): The DR impacts shown in Figure 5.2 are at the meter level. In the Appendix B, the DR impacts are grossed up for losses because the values are represented at the system-level.

2) Though not discussed in any meaningful way, SAE modeling was used to forecast Residential, Commercial, and Industrial energy use. While becoming more common in modeling Residential and Commercial use, it is not as common to see SAE methods used for industrial classes. In the next IRP, Duke Energy Kentucky should provide detailed discussions of why SAE modeling is considered better than prior forms of modeling and how the various independent variables are derived. In addition, if SAE modeling continues to be used for the industrial class, there needs to be a discussion of the industrial appliance, equipment and process efficiencies being modeled, whether Itron tracks and forecasts these industrial factors, and the extent to which Duke Energy Kentucky has any influence over the growth or appliance saturation levels.

Response: The current forecast was prepared used SAE methodology, which is generally a better approach compared to other methodologies. The SAE methodology offers several key features, including but not limited to the following:

1. End-Use Breakdown: SAE allow for the decomposition of electricity consumption into specific end-uses (heating, cooling, other), enabling more precise forecasting.

[47] Case No. 2021-00245, *Electronic 2021 Integrated Resource Plan of Duke Energy Kentucky, Inc.* (Ky. PSC May 10, 2022), Order, Appendix (Staff Report) at 13–15.

2. Efficiency trends: SAW incorporate behavior and technology usage patterns, through end-use intensities, leading to improved demand forecast accuracy.

3. Scenario analysis: SAE enables scenario analysis by adjusting individual drives, providing greater flexibility and agility in the forecasting process.

These advantages make the SAE methodology a more robust and accurate approach to forecasting, resulting in enhanced forecast. The current forecast did not utilize SAE methodology for industrial forecast.

3) The SAE methodology was used in the peak-demand modeling. As with the energy modeling, there was little discussion of how the methodology was applied to each of the independent model variables. For the next IRP, Duke Energy Kentucky should include greater discussion of how independent variables are constructed for both the energy and demand model.

Response: The regression models for residential and commercial sales uses the following specification:

$$\mathrm{USE}_t = b_1\mathrm{XHeat}_t + b_2\mathrm{XCool}_t + b_3\mathrm{XOther}_t + \varepsilon_t$$

where each of the variable is contructured as follows:

$$\mathrm{XHeat}_t = \mathrm{HeatIndex}_t + \mathrm{HeatUse}_t$$

where HeatIndex is the intensities from EIA and HeatUse is constructed as such:

$$\mathrm{HeatUse}_t = \left(\frac{\mathrm{HDD}_t}{\mathrm{NormHDD}}\right) \mathrm{x} \left(\frac{\mathrm{HHSize}_t}{\mathrm{HHSize}_b}\right)^h \mathrm{x} \left(\frac{\mathrm{Econ}_t}{\mathrm{Econ}_b}\right)^e \mathrm{x} \left(\frac{\mathrm{Price}_t}{\mathrm{Price}_b}\right)^p$$

where HDD is heating degree days, HHSize is the household size, Econ is the economic variable, and Price is the average price for the specified class, XCool and XOther follows a similar design. However, the OtherUse includes billing days instead of weather.

$$\mathrm{OtherUse}_t = \left(\frac{\mathrm{BillingDays}_t}{365}\right) \mathrm{x} \left(\frac{\mathrm{HHSize}_t}{\mathrm{HHSize}_b}\right)^h \mathrm{x} \left(\frac{\mathrm{Econ}_t}{\mathrm{Econ}_b}\right)^e \mathrm{x} \left(\frac{\mathrm{Price}_t}{\mathrm{Price}_b}\right)^p$$

For Industrial and OPA, the regression specifications are not based on SAE methodology. The following specification is used:

$$\mathrm{IndUSE}_t = b_1\mathrm{XEcon}_t + b_2\mathrm{XWeather}_t + \varepsilon_t$$

$$\mathrm{OPAUSE}_t = b_1\mathrm{XEcon}_t + b_2\mathrm{XWeather}_t + \varepsilon_t$$

The peak model uses the following model:

$$\mathrm{Peak}_t = b_1\mathrm{HeatVar}_t + b_2\mathrm{CoolVar}_t + b_3\mathrm{Other}_t + b_3\mathrm{Energy}_t + \varepsilon_t$$

where HeatVar, CoolVar, and OtherVar are from sales model and Energy is monthly energy.

Regarding the selection of variables (e.g., economic, weather, indicators, etc.), the Company utilizes a combination of judgement and model performance to determine which variables are included in the model.

4) The sensitivity analyses were based on variations in economic activity only. While reasonable, modeling variations in weather, separately and in conjunction with economic activity, would also be reasonable. Modeling the extremes (however defined) of both economic activity and weather together to set plausible upper and lower limits to energy and demand forecasts is prudent. For the next IRP, Duke Energy Kentucky should model more diverse sensitivity analyses, including projected variations in weather.

Response: The forecasts include a sensitivity analysis using varying levels of electric forecasts, different weather assumptions, and different economic projections from Moody's. The table below details the assumptions used for each forecast to create base, low, and high cases.

	Economic	Weather	Electric Vehicle
Low	Pessimistic	15 most mild years Average	Base
Base	Base	30-year Average	Base
High	Optimistic	15 most extreme years average	High

5) For models in which two variations of the same variable are used, there needs to be additional explanation of why it is appropriate to include such closely related variables as there often does not appear to be any statistically significant collinearity between the variables. Simply improving the regression R-squared value is not a sufficient reason to include both variables. The discussion should also identify and describe the separate effects these variables have on the dependent variable.

Response: The Company updated its model to only include one variable each for cooling, heating, and other in the regression analysis.

SECTION 3

DEMAND-SIDE MANAGEMENT AND ENERGY EFFICIENCY

INTRODUCTION

Depending on the circumstances, the IRP regulation permits demand-side resources to be assessed as options that could be selected to meet projected load or based on their projected effects on load.[48] This section briefly describes Duke Kentucky's existing DSM and EE programs, summarizes how existing programs were reflected in the IRP, and discusses DSM/EE programs that Duke Kentucky reviewed to meet projected load. This section also reviews Duke Kentucky's response to Commission Staff's recommendations regarding DSM/EE in its 2021 IRP and the parties' comments specifically regarding Duke Kentucky's DSM/EE programs. Commission Staff's discussion of and recommendations regarding Duke Kentucky's DSM/EE forecasting are located in Section 6 of this Report.

SUMMARY DISCUSSION OF DSM-EE

Duke Kentucky has a robust suite of DSM programs. Duke Kentucky's IRP listed existing DSM programs but did not evaluate potential DSM programs as required by 807 KAR 5:058 Section 8(2)(b). Duke Kentucky described its existing DSM programs in its IRP and in its recent DSM case, in which the Commission approved Duke Kentucky's application:[49]

- Residential Smart $aver® Energy Efficient Residences Program: Offers customers incentives for energy conservation measures designed to target the largest energy consumption equipment and increase energy efficiency in their homes.

- Residential Smart $aver® Energy Efficient Products Program: Provides high efficiency product options though a Savings Store.

- Residential Energy Assessments Program (Residential Home Energy House Call): An energy specialist completes a walkthrough assessment of the home and discusses behavioral and equipment modifications that can save energy and money.

- Income Qualified Services Program: Income qualified households are provided weatherization, heating tune-up and repairs or replacement, venting repairs, water

[48] *See* 807 KAR 5:058, Section 7(3).

[49] 2024 IRP at 101-121 (Appendix C); Case No. 2024-00352, *Electronic Annual Cost Recovery Filing for Demand Side Management by Duke Energy Kentucky, Inc.* (filed Nov. 1, 2024), Application; (Ky. PSC Feb. 7, 2025), final Order.

heater wrap and pipe wrap, cleaning of refrigerator coils, cleaning of dryer vents, energy efficient light bulbs, and low-flow shower heads and aerators.

- Power Manager® Program: Reduces demand by controlling residential air conditioning usage during periods of peak demand, high wholesale price conditions and/or generation emergency conditions during the summer months.

- Non-Residential Smart $aver® Program: Provides incentives to commercial and industrial consumers for installation of high efficiency equipment in applications involving new construction, retrofit, and replacement of failed equipment.

- PowerShare® Program: Customers have the opportunity to reduce their electric costs by managing their electric usage during the Company's peak load periods.

- Income Qualified Neighborhood Program: Provides community-based events to promote the services provided in the Income Qualified Services Program.

- Home Energy Report Program: Compares household electric usage to similar, neighboring homes, and provides recommendations and actionable tips to lower energy consumption.

- Business Energy Saver Program: Reduces energy usage through the direct installation of energy efficiency measures within qualifying non-residential customer facilities.

- Non-Residential Pay for Performance: Encourages the installation of high efficiency equipment in new and existing non-residential establishments.

- Peak Time Rebate (PTR) Pilot Program: Offers participating customers the opportunity to lower their electric bill by reducing their electric usage during Company-designated peak load periods known as Critical Peak Events.

Duke Kentucky provided cost-efficiency scores for these programs:[50]

[50] 2024 IRP at 101.

Program Name	UCT	TRC	RIM	PCT
Residential Programs				
Low Income Neighborhood	0.37	0.37	0.26	2.02
Low Income Services	0.49	0.49	0.33	1.97
My Home Energy Report	4.73	4.73	0.98	NA
Residential Energy Assessments	1.53	1.44	0.53	32.61
Residential Smart $aver®	1.25	1.05	0.52	3.86
Power Manager	2.30	3.11	2.30	NA
Peak Time Rebate Pilot Program	0.17	0.17	0.17	NA
Total	**1.31**	**1.35**	**0.79**	**3.63**
Non-Residential Programs				
Small Business Energy Saver	1.83	1.25	0.63	3.02
Smart $aver® Non-Residential	3.22	2.12	0.64	5.77
PowerShare®	1.96	4.72	1.96	NA
Total	**2.27**	**2.34**	**0.88**	**5.02**
Overall Portfolio Total	**1.70**	**1.74**	**0.84**	**4.35**

The Utility Cost Test (UCT) compares utility benefits such as avoided energy and capacity related costs to utility costs incurred to implement the program such as marketing, customer incentives, and measuring offset costs, but does not consider other benefits such as participant savings or societal impacts. Total Resource Cost (TRC) score compares the total benefits to the utility and participants relative to the costs of utility program implementation and costs to the participant. The benefits to the utility are the same as those computed under the UTC. The benefits to the participant are the same as those computed under the Participant Test Rate Impact Measure (RIM) Test. A TRC score over 1.00 is considered cost-effective. The Participant Cost Test (PCT) compares the benefits to the participant through bill savings and incentives from the utility relative to the costs to the participant for implementing the DSM measure.[51]

Using the TRC score, all of Duke Kentucky's DSM programs are cost-effective except for the Low Income (Income Qualified) Neighborhood Program, Low Income (Income Qualified) Services Program, and PTR Pilot Program.

[51] 2024 IRP at 100.

RESPONSES TO PREVIOUS COMMISSION STAFF'S RECOMMENDATIONS

Commission Staff's report on Duke Kentucky's 2021 IRP included recommendations for DSM evaluation.[52] The following are Duke Kentucky's 2024 IRP responses to DSM recommendations:

1) Duke Energy Kentucky's next IRP should include a detailed explanation of whether peak-time rebates decrease Duke Energy Kentucky's demand and avoid costs as suggested in Case No. 2019-00277, and if so, it should explain how the peak-time rebates decrease Duke Energy Kentucky's demand and avoid costs.

Response: Duke Energy Kentucky requested to terminate the Peak Time Rebate program in Case No. 2022-00251 due to the low cost effectiveness scores. The Commission scheduled a hearing for March 23, 2023, and an Order was submitted on April 1, 2024 stating the Company should provide the implementation plan based on the order no later than August 15, 2024.

2) The next IRP should also discuss other DSM rate options that Duke Energy Kentucky has explored.

Response: Duke Energy Kentucky offers several time of use (TOU) based rates to non-residential customers to assist them with managing their bills including Rate RTP, Rate DT, Rate TT, and Rider LM. In addition, the Company currently has a pending TOU residential rate option in Case No. 2022-00372; Rate RS-TOU-CPP. However, these TOU rates are not offered through the Company's DSM portfolio of programs. They are either mandatory or optional rates customers can consider to help manage their bill.

3) Duke Energy Kentucky should continue to examine all reasonable DSM programs for cost-effectiveness and possible implementation regardless of whether they are available year around.

Response: The Company continues to do this and provides an update on cost effectiveness for every program in the Annual Cost Recovery Filing for Demand Side Management.

4) Duke Energy Kentucky should continue to scrutinize the results of each existing DSM program's individual measure's cost-effectiveness test and continue to provide those results in future DSM cases, along with detailed support for future DSM program expansions and additions. Duke Energy Kentucky should also be mindful of the increasing saturation of EE products and be watchful for the opportunity to scale back on programs offering incentives for behavior that may be dictated by factors other than the incentives.

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[52] 2021 Staff Report at 18-19.

Response: The Company continues to do this and provides an update on cost effectiveness for every program in the Annual Cost Recovery Filing for Demand Side Management and only requests future individual measures that meet the cost-effectiveness tests standards.

5) Commission Staff encourages Duke Energy Kentucky to continue with the DSM Collaborative process and strive to include recommendations and inputs from the stakeholders.

Response: The Company continues to meet with the DSM Collaborative on an annual basis and as needed.

6) Duke Energy Kentucky should evaluate low-income DSM programs in other jurisdictions and analyze whether such programs would be effective in Duke Energy Kentucky's service territory.

Response: The Company monitors programs in other jurisdictions and requests changes to the Kentucky programs as deemed necessary.

7) For the next IRP, Duke Energy Kentucky should present its portfolio analyses results with a demand forecast that considers the effects of both EE and DR programs.

Response: All portfolios were developed with the inclusion of EE and DR forecasts.

INTERVENOR AND RESPONSE COMMENTS

Joint Intervenors commented that Duke Kentucky failed to comply with the 807 KAR 5:058 Section 8(2)(b) requirement that the utility evaluate potential DSM programs.[53] Joint Intervenors praised the inclusion of the Income Qualified Neighborhood Energy Saver Program and Income Qualified Services Program; however, they recommend expanding the programs, because under the current plans, which are capable of serving 559 homes per year, Duke Kentucky would take over 66 years to provide program benefits to all customers qualifying under the 200% of the federal poverty level program criteria.[54] Lastly, Joint Intervenors recommended that Duke Kentucky evaluate the cost-effectiveness of distributed energy resources (DERs).[55]

Duke Kentucky filed reply comments indicating that all DSM programs determined to be cost-effective in Kentucky have been implemented.[56]

[53] Joint Intervenors' Initial Comments at 6-7; Joint Intervenors Post-Hearing Comments at 5-6.

[54] Joint Intervenors' Initial Comments at 11.

[55] Joint Intervenors' Initial Comments at 12.

[56] Duke Kentucky's Reply Comments (filed Nov. 27, 2024) at 6-7.

SECTION 4

SUPPLY-SIDE RESOURCE ASSESSMENT

INTRODUCTION

In this Section, Commission Staff reviews, summarizes, and comments on Duke Kentucky's evaluation of existing and future supply-side resources. Commission Staff's discussion of and recommendations regarding Duke Kentucky's supply-side resource assessment forecasting are in Section 6 of this Report.

SUMMARY OF EXISTING AND PLANNED CAPACITY AND RESOURCES

Duke Kentucky's stated present total power capacity is 1,197 megawatts (MW) and its existing resources include:[57]

- 600 MW of coal-fired steam capacity at East Bend Unit 2 Station,
- 564 MW of natural gas-fired peaking capacity at Woodsdale Station,
- 24 MW of Demand Response (DR),
- 9 MW of solar capacity.

As a PJM FRR member, Duke Kentucky is required to satisfy PJM's mandated planning reserve margin requirement (PRMR), which can be accomplished through its own generation resources, or by purchasing capacity through PJM or through bilateral contracts. However, if Duke Kentucky's application to switch to the RPM construct is approved, Duke Kentucky will not have a PJM mandated PRMR, but it will also have to pay RPM Locational Reliability Charges to participate in capacity purchases through PJM.

TRANSMISSION AND DISTRIBUTION SYSTEM PLANNING

Duke Kentucky's only newly completed transmission project since its 2021 IRP was a 138 kV line from Duke Energy Ohio-owned Woodspoint Substation to Aero Substation.[58] Duke Kentucky plans in 2025 to erect an approximately one-mile, 69 kV line from Hebron Substation to a point on the Feeder 15268C line, re-feed the 15268C tap directly from Hebron Substation and rebuild a 1.4-mile section of 69 kV Feeder 6763 from Limaburg Substation to Oakbrook Substation to increase capacity.[59] No other transmission facilities are planned.

Since its 2021 IRP, Duke Kentucky has increased the capacity of its distribution system by constructing 10.5 MVA of transformer banks at the Dry Ridge substation, 22.4

[57] 2024 IRP at 35.

[58] 2024 IRP at 65.

[59] *See* Case No. 2024-00158, *Electronic Application of Duke Energy Kentucky, Inc. for a Certificate of Public Convenience and Necessity to Construct a 138-kV Transmission Line and Associated Facilities in Boone County* (filed June 27, 2024), Application.

MVA of transformer banks at the Longbranch substation, and 22.4 MVA of transformer banks at the Richwood Substation.[60] Substations are planned to be upgraded at Litton, White Tower, Oakbrook, Buffington, and York Substations and new substations built in Taylor Mill and Turfway through 2026.[61]

SUMMARY OF NEW GENERATION CONSIDERED

PJM will require a PRMR of 17.8 percent for 2025/2026.[62] Duke Kentucky's IRP uses predictions for future-year PRMR that will be required by PJM. To meet the capacity required to meet the needs indicated by the load forecast plus the PRMR minus any reduction of capacity caused by retirements or conversions due to environmental regulations, the EnCompass modeling system must consider new generation options.

The resources made available to the EnCompass model included:[63]

- Pulverized coal units
- Natural gas combustion turbines (CTs)
- Natural gas combined cycle units (CCs)
- Dual fuel/full natural gas conversion of East Bend Station
- Carbon capture and sequestration (CCS)
- Nuclear stations
- Onshore wind
- Solar photovoltaic
- Battery energy storage options

Duke Kentucky did not include certain resources that it believed were not technically or commercially available, including solar steam augmentation, fuel cells, supercritical CO_2 Brayton cycle, and liquid air energy storage.[64] Duke Kentucky excluded additional resources as not feasible or available in the Duke Energy Kentucky service territory, including geothermal, offshore wind, pumped storage hydropower, and compressed air energy storage.

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[60] 2024 IRP at 65.

[61] 2024 IRP at 65.

[62] 2024 IRP at 38.

[63] 2024 IRP at 12.

[64] 2024 IRP at 12.

Duke Kentucky did not consider retirement of East Bend station prior to 2030 because replacement generation and retirement could not be secured in time to comply with KRS 278.264 and KRS 164.2807.[65]

RELIABILITY

PJM seeks to ensure reliability within its service territory, in part, by imposing reserve margin capacity requirements upon its members. Duke Kentucky, like other utilities in an RTO, generally plans for reliability by planning to meet the reserve margin requirements of PJM based on the capacity credits assigned to various resources by PJM. Duke Kentucky's IRP did not include an evaluation of potential portfolios' effect on Duke Kentucky's loss of load expectation (LOLE).

Duke Kentucky responded to a data request issued by Commission Staff regarding the reliability of dispatchable resources.[66] Duke Kentucky only evaluated coal and natural gas in its response. Duke Kentucky differentiated between reliability of supply and reliability of operations, providing information only about operational reliability. Duke Kentucky noted that Effective Load Carrying Capability (ELCC) class ratings from the PJM 2025/2026 Base Residual Auction were relied upon to determine reserve margin requirements, and that coal can provide an ELCC of 87 percent of its installed capacity towards meeting reserve requirements while natural gas combined cycle provides an ELCC of 79 percent. However, Duke Kentucky also noted that Equivalent Forced Outage Rate (EFOR) for the coal-powered East Bend station is 18.7 percent, while the assumed EFOR for a new combined cycle natural gas-powered plant is 1.7 percent. Duke Kentucky did not address differences in generation unit startup time or cost.

Although Duke Kentucky did not discuss additional dispatchable generation other than coal- and gas-fired generation in response to this data request, the IRP provides ELCC values for several types of generation:[67]

[65] Duke Kentucky's Response to Sierra Club's First Request for Information, Item 8. KRS 278.264 created a rebuttable presumption against retirement of fossil fuel generation that may only be overcome by, among other requirements, construction of replacement dispatchable generation of equal or greater capacity. KRS 164.2807 requires all requests for generation CPCNs to be reviewed by the Kentucky Energy Planning and Inventory Commission, which may add up to 315 days to the generation construction and retirement timelines.

[66] Duke Kentucky's Response to Staff's Second Request, Item 10(a).

[67] 2024 IRP at 37.

Table 4.2: Effective Load Carrying Capability Class Ratings

	2025/2026 BRA ELCC Class Ratings
Onshore Wind	35%
Offshore Wind	60%
Fixed-Tilt Solar	9%
Tracking Solar	14%
Landfill Intermittent	54%
Hydro Intermittent	37%
4-hr Storage	59%
6-hr Storage	67%
8-hr Storage	68%
10-hr Storage	78%
Demand Resource	76%
Nuclear	95%
Coal	84%
Gas Combined Cycle	79%
Gas Combustion Turbine	62%
Gas Combustion Turbine Dual Fuel	79%
Diesel Utility	92%
Steam	75%

Using ELCC as a metric for operational reliability, nuclear power is the most reliable generation resource.

Renewable resources (primarily solar in Kentucky) tend to generate energy at the time of PJM system peaks, hence PJM's minimal accredited capacity values attributed to renewable resources.[68] However, although Duke Kentucky vis-à-vis PJM attributes some capacity credit to renewable resources in the summer season, little to no capacity credit is attributed to these resources in the winter season.

RESPONSES TO PREVIOUS COMMISSION STAFF'S RECOMMENDATIONS

1) Presenting resource capacity values on an ICAP basis is informative; however, since PJM required reserve margins are calculated on a UCAP basis, presenting resource capacity values and reserve margins on a UCAP basis provides a different perspective.

[68] Note that Duke Kentucky's system peak generally may not correspond to PJM's summer system peaks, which form the basis for PJM's capacity requirements attributed or allocated to its individual member systems.

This view is important as increasing amounts of renewable generation resources are added to the generation mix. For the next IRP, Duke Energy Kentucky should present results on both an ICAP and UCAP basis.

Response: Duke Energy Kentucky utilized the PJM Delivery Year 2025/2026 Forecasted Pool Requirement and ELCC ratings to generate UCAP values for reserve margin and existing/future resources. Please review Section 6 of this document for the ICAP and UCAP resource values.

2) The optimal portfolio shows the addition of wind resources starting with 40 MW's and then adding 10 MW blocks annually beginning in 2024 and 10 MW blocks of solar annually beginning in 2021. Kentucky is not typically selected for utility scale wind resources. Even though wind appears to be a cost-effective resource addition to the portfolio, a greater explanation of the practicality and underlying assumptions would lend credence to the selection. Also, even though there are many merchant-utility scale projects being proposed and possibly built in Kentucky, none are being proposed in Duke Energy Kentucky's service territory. For the next IRP, Duke Energy Kentucky should discuss for planning purposes whether these renewable resources will be realistically located in its service territory, in Kentucky or out of state. Also, for resources that are located outside its service territory, the estimated cost of wheeling the energy should be included in the analyses and whether Duke Energy Kentucky is acquiring the capacity and energy through direct ownership, a partnership, or through a PPA.

Response: Duke Energy Kentucky provided a detail explanation regarding the potential selection and risks associated with wind resources, both in-and-out of Duke Energy Kentucky's service territory. Please review Section 3 of this documents for the detailed explanation.

3) The efficiency of solar PV units varies with temperature swings, which impacts its effectiveness in meeting PJM capacity requirements and in meeting Duke Energy Kentucky's needs. For the next IRP, Duke Energy Kentucky should discuss how the evolving performance of solar panels varies and how those variations affect Duke Energy Kentucky's ability to meet its energy and capacity obligations.

Response: There have been significant increases in the efficiency of solar technologies in recent years and this has provided greater power density for solar cells. Along with increases in the physical dimensions of modules has allowed for greater power output per individual module. This, in turn, has led to better land utilization for solar array area compared to those built years ago. This trend is expected to continue but at a slower rate in the near future. The PV module output is affected by the operating temperature of the cells within the solar module. Conversion efficiency decreases because higher cell temperatures result in a decrease in module output voltage. This effect is well known and is accounted for in the DC system design. Typically, this is addressed by installing significantly more DC nameplate capacity than interconnected AC capacity, so the system will perform as required under typical operating conditions. Solar irradiance is the primary driver of the output of a PV cell and dictates the current output. The basic relationship of current and voltage is constantly changing in a PV system and is controlled by the weather. The system DC and AC functionality is also modeled dynamically across a wide range of typical weather conditions to better understand the operational power and energy characteristic of the system to determine the energy and capacity expectations. Through design and incorporation into forecasts, variations in solar panel efficiency do not impact Duke Energy Kentucky's ability in meeting energy and capacity obligations.

4) As renewable resources are added to Duke Energy Kentucky's and within PJM's service territories, operational and reliability challenges from intermittent resources could arise. For the next IRP, Duke Energy Kentucky should discuss any issues that it or PJM is facing currently or in the near future, and if there were any issues, how they would be addressed.

Response: As more intermittent resources come online in PJM, and as dispatchable resources retire, PJM will face operational challenges as uncertainty around performance of intermittent resources at all times of day could create potential issues. In PJM's recent capacity filings in which all resources are moving toward an ELCC framework, dispatchable generation will be more valuable relative to intermittent resources as far as capacity accreditation. This may encourage dispatchable generation to remain online, and possibly to enter the market with likely higher capacity payments.

5) For the next IRP, Duke Energy Kentucky should provide an update to the latest environmental laws and any actions it has taken recently or is planning to take for compliance.

Response: Appendix D contains updated information on environmental laws and regulations that have changed since the 2021 IRP. Specifically, the sections on the Regulation of Greenhouse Gases and the Mercury and Air Toxics Standard (MATS) rule contain the most impactful developments. Modeling scenarios as described in Sections 2 & 3 were developed that reflect the most recent (April 2024) greenhouse gas rule.

6) Carbon regulation can take several forms, from gradually increasing prices, set prices and market clearing prices as well as physical emission limitations and how the carbon regulations are applied to which fossil resources. Each will have different impacts on the degree to which resource portfolios/generation fleets evolve over time and the subsequent impact on customers' bills. For the next IRP, Duke Energy Kentucky should test the sensitivity of its portfolios to various forms of carbon regulation. The analyses should include detailed explanations of the underlying assumptions.

Response: Appendix D contains updated information on greenhouse gas requirements that EPA finalized in April 2024. Modeling scenarios as described in Sections 2 & 3 were developed that reflect that rule.

7) In addition, Duke Energy Kentucky should include a discussion of the state of carbon capture and sequestration and its potential viability.

Response: Section 4 addresses carbon capture and sequestration and its potential viability.

INTERVENOR AND RESPONSE COMMENTS

Joint Intervenors commented that Duke Kentucky's supply-side modeling included unreasonable assumptions. First, Joint Intervenors argued that the modeling did not allow an economically optimal retirement timeline for East Bend station, including limiting the years the model could select retirement.[69] Second, they asserted that the modeling failed to reasonably account for carbon emission risks, particularly potential new costs on emissions other than Section 111(d) Update rules.[70] Third, Joint Intervenors stated that the model did not consider the potential for cost savings under the Energy Infrastructure Reinvestment (EIR) program.[71]

Sierra Club also commented that economic retirement of East Bend Unit 1 should have been considered for the selected portfolio and cited poor economic performance of the unit due to reliance on must-run commitment as opposed to economic commitment of the unit.[72]

Duke Kentucky responded in reply comments that allowing the model to retire East Bend prior to 2032 would ignore the practical considerations of developing, constructing, and interconnection of equally reliable replacement generation in time to retire the unit ahead of the end of 2031.[73] Duke Kentucky also argued that Section 111(d) Update rules are a reasonable stand-in for carbon emission regulations in general, and to model other carbon regulations would have been redundant.[74]

The Attorney General provided post-hearing comments that noted PJM's changes to ELCC accreditation for different generation resources and suggested that Duke Kentucky explain how these changes would affect its load obligation.[75] The Attorney General reiterated the importance of reliability and the concern that dispatchable thermal resources not be prematurely retired.[76]

[69] Joint Intervenors' Initial Comments at 19-20; Joint Intervenor's Post-Hearing Comments at 9-10.

[70] Joint Intervenors' Initial Comments at 21-22.

[71] Joint Intervenors' Initial Comments at 24.

[72] Sierra Club's Post-Hearing Comments at 7-8.

[73] Duke Kentucky's Reply Comments at 10.

[74] Duke Kentucky's Reply Comments at 8.

[75] Attorney General's Post-Hearing Comments at 1.

[76] Attorney General's Post-Hearing Comments at 4.

SECTION 5

INTEGRATION

INTRODUCTION

A goal of the IRP process is to integrate supply-side and demand-side options to achieve an optimal resource plan. This section will discuss the integration process and the resulting Duke Kentucky's plan. Commission Staff's discussion of and recommendations regarding Duke Kentucky's integration are in Section 6 of this Report.

Resources

Duke Kentucky evaluated multiple resources for this IRP. Potential resources were evaluated on technical feasibility, commercial availability, fuel availability, operations and maintenance (O&M) cost, reliability, and environmental impacts.[77] Along with existing resources, the resources initially considered included combustion turbines (CTs), natural gas combined cycles (NGCCs), small nuclear modular reactors (SMRs), onshore wind, solar voltaic, and battery storage options.[78] Potential resources were eliminated if not technically or commercially available, including within Duke Kentucky's service territory. The maximum amount of individual resource capacities ultimately made available to the capacity expansion model include SMRs (300 MW, 95 percent with capacity factor), 2x1 NGCC (1,282 MW, with 70 percent capacity factor), 1x1 NGCC (636 MW, with 70 percent capacity factor), 1x1 NGCC with CCS (535 MW, with 70 percent capacity factor), CT (791 MW, with ten percent capacity factor), wind (150 MW, 43 percent capacity factor), solar photovoltaic (PV) with single axis tracking (100 MW, 25 percent capacity factor), and battery storage, 4-hour Lithium-ion (16 MW, with 16 percent capacity factor).[79] Beginning in PJM Delivery Year 2025/2026, PJM will begin using the effective load carrying capability (ELCC) methodology to accredit all capacity resources. Though related, ELCC capacity ratings differ from unforced capacity (UCAP) ratings.[80] For the 2025/2026 Delivery Year, PJM established the Install Reserve Margin and the Forecasted Pool Requirement to be 17.8 percent and 0.9387 respectively. The Encompass model used a combination of these measures to develop the various scenario portfolios discussed below.

As a result of the updated EPA CAA, Section 111(d), Duke Kentucky's IRP focused on how the various options for coal-fired electric generation plants affected the East Bend

[77] 2024 IRP at 32.

[78] 2024 IRP at 32.

[79] 2024 IRP at 33 and Duke Kentucky's Response to Staff's First Request, Item 9k. Note capacity is nameplate summer capacity rating. Wind, solar and battery storage capacity contributions to peak is 43 percent, 25 percent, and 16 percent respectively. *See also* Duke Kentucky's Response to Staff's First Request, Item 5a, for specific unit capacity values and cost information.

[80] 2024 IRP, Table 4.2 at 37.

plant specifically and how its generation portfolio more generally. The four options available for coal fired plants under the EPA update are:

1. Retire by January 1, 2032, without restriction on operation until retirement;
2. Convert to full natural gas operation by January 1, 2030;
3. Convert to at least 40 percent gas co-firing by January 1, 2030; or
4. Add CCS by January 1, 2032.[81]

Duke Kentucky initially ran two sets of three different optimization portfolios: three optimization scenarios assuming the CAA Section 111(d) Update ultimately went into effect and three scenarios assuming it did not go into effect.[82] Each set of optimizations assumed the same three scenarios, the only difference being whether the CAA Section 111(d) Update went into effect. The primary criteria for evaluating each portfolio was affordability (present value revenue requirement, (PVRR)), CO_2 reduction, and the level of market purchases.[83] Scenarios with the CAA Section 111(d) Update, include East Bend Dual Fuel Operation (DFO) by 2030, East Bend natural gas conversion by 2030, and East Bend retirement by 2032. Scenarios without the CAA Section 111(d) Update included East Bend Dual Fuel Operation (DFO) by 2030, East Bend natural gas conversion by 2030, and East Bend retirement by 2036.[84] Duke Kentucky reported that the results of these initial scenario analyses indicated that DFO conversion was the optimal compliance method.[85]

Duke Kentucky developed 11 additional alternate portfolios to test the value of accelerating solar power, to test the value of differing East Bend retirement dates and resource replacement options based on East Bend DFO conversion and accelerating solar implementation from dates selected in the six initial optimization scenarios. Five alternate optimization scenarios were tested with the CAA Section 111(d) Update: East

[81] 2024 IRP at 4.

[82] EPA CAA, Section 111 has been challenged by several states and is under review by the Court of Appeals for the D.C. Circuit. *West Virginia v. EPA*, Case No. 24-1120 (D.C. Cir. 2024). As of the issuance of this report, the U.S. Supreme Court denied the states' application for a stay of enforcement of Section 111. *West Virginia v. EPA*, 604 U.S. (2024). Subsequently, the EPA has announced plans to review many environmental regulations, including the CAA Section 111(d) regulation. *See* https://www.epa.gov.newsrelease/epa-launches-biggest-deregulatory-action-us-history (Mar. 12. 2025).

[83] 2024 IRP at 9.

[84] 2024 IRP at 9 and 43-44.

[85] 2024 IRP at 45. *See also* Duke Kentucky's Response to Staff's First Request, Items 18-20, for the numerical results of the evaluations of the initial six optimization scenarios. However, Staff notes that from examining Items 18-20, it is not clear what support Duke Kentucky is relying upon to choose the East Bend DFO conversion as the optimal path warranting further study. On a PVRR basis, the East Bend DFO conversion portfolio is virtually never the least expensive portfolio in any year of the forecast period with or without the CAA Section 111(d) Update. The Retire East Bend in 2032 portfolio (with CAA Section 111(d) Update) or Retire East Bend by 2036 (without CAA Section 111(d) Update) appear to be the least expensive portfolio paths warranting further study.

Bend NGCC replacement by 2039, East Bend DFO conversion with SMR replacement by 2039, East Bend DFO Conversion with NGCC with CCS replacement by 2036, East Bend DFO conversion with NGCC replacement by 2039 and accelerated renewables, and East Bend retirement by 2032 with NGCC replacement.[86] Six alternate optimization scenarios were tested without CAA Section 111(d) Update: East Bend DFO conversion with NGCC replacement by 2039, East Bend DFO conversion with SMR replacement by 2039, East Bend DFO conversion with NGCC replacement by 2036, East Bend DFO conversion with NGCC replacement by 2039 and accelerated renewables, East Bend retirement by 2036 and accelerated renewables, and East Bend retirement by 2042.[87]

The table below represents Duke Kentucky's Preferred Resource Portfolio over the forecast period.[88] The portfolio is based upon the scenario of converting East Bend generation to dual fuel (coal and natural gas co-firing) by 2030 and then replacing with a NGCC in 2039 and accelerating solar generation throughout the forecast period beginning in 2029.

Duke Kentucky Preferred Resource Portfolio (ICAP MW)

Resources (MW)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
East Bend (Coal)	600	600	600	600	600											
East Bend DFO						600	600	600	600	600	600	600	600	600		
East Bend NGCC (1x1)															664	664
Woodsdale CTs	564	564	564	564	564	564	564	564	564	564	564	564	564	564	564	564
Demand Response	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Solar	9	9	9	9	59	59	109	109	159	159	209	209	259	259	309	309

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[86] 2024 IRP at 45 and Tables 6.7–6.11 at 46-47.

[87] 2024 IRP at 45 and Tables 6.12–6.17 at 48-49.

[88] 2024 IRP, Figure 7.1 at 61. This portfolio is equal to the portfolios in Tables 6.10 at 47 and Table 6.15 at 48. These portfolios represent the East Bend DFO Conversion with NGCC replacement by 2039 and Accelerated Renewables. In this instance, the modeled portfolio selection is the same regardless of CAA Section 111(d) enactment. However, Staff notes that given the East Bend DFO conversion path, the selection of the Preferred Portfolio does not appear to be fully supported by examining the evaluation criteria. *See* Duke Kentucky's Response to Staff's First Request, Items 18-20. With the CAA Section 111(d) Update, the Preferred Portfolio is almost never the least cost PVRR alternative. Retiring East Bend by 2032 with NGCC replacement portfolio is the least cost alternative in the early years and the East Bend DFO Conversion with NGCC and CCS by 2036 is the least cost option in later years. Without the CAA Section 111(d) Update, the Preferred Portfolio is never the least cost PVRR alternative. Retiring East Bend by 2036 with Accelerated Renewables is the least cost PVRR beginning in 2030. Additionally, Duke Kentucky's model is unclear as to whether the PVRR costs include the cost of purchased energy and legacy costs created by generation technology changes.

The table below summarizes Duke Kentucky's seasonal forecast peak load and preferred resource portfolio.[89]

Duke Kentucky Forecast Peak Load and Resources (UCAP MW)

Summer	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Peak Load	808	810	812	812	812	812	822	827	831	838	844	862	872	882	892	902	910
Firm Generation	888	888	888	887	887	887	887	887	887	887	887	887	887	887	887	388	388
Demand Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additions	0	0	0	0	0	2	2	5	4	6	6	9	9	11	11	516	516
Purchases / Sales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	499	0
Total	888	888	888	888	888	890	889	892	891	893	893	896	896	898	898	904	904
FPR = 94%	758	760	762	762	762	762	772	777	780	787	792	809	819	828	837	847	854
Capacity Excess / (Deficit)	80	78	76	76	75	77	67	65	60	55	50	34	24	16	7	2	-5
Reserve Margin %*	10	10	9	9	9	10	8	8	7	7	6	4	3	2	1	0	-1

Winter	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Peak Load	748	737	738	740	740	739	747	749	746	755	759	774	777	779	778	798	808
Firm Generation	959	959	959	959	959	959	959	959	959	959	959	959	959	959	959	460	460
Demand Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additions	0	0	0	0	0	2	2	5	4	6	6	9	9	11	11	538	538
Purchases / Sales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	499	0
Total	959	959	959	959	959	961	960	963	962	965	965	967	967	970	970	998	998
FPR = 94%	702	691	692	694	695	694	701	704	701	709	713	727	730	731	730	749	759
Capacity Excess / (Deficit)	211	223	222	220	219	222	214	214	216	210	205	193	190	191	192	200	190
Reserve Margin %*	28	30	30	30	30	30	29	29	29	28	27	25	24	25	25	25	23

The Forecast Pool Requirement is the measure determined for the specified Delivery Year to establish the level of UCAP that will provide an acceptable level of reliability

[89] 2024 IRP, Appendix H, Table H.3 at 153. Note that the Required Reserve Margin equals (FPR -1 = -6.13 percent). Peak Load represents Duke Kentucky's Most Likely scenario accounting for EE and before DR. *See also* Table H.1 at 150 for a breakdown of the firm summer and winter capacity ratings of generating resources included in the Preferred Portfolio. Commission Staff notes that this data does not match rating information found in Table 4.1. Like the existing Woodsdale CTs, the NGCC unit installed in 2039 is modeled as being able to function with fuel oil.

consistent with PJM Reliability Principles and Standards. . .the Forecast Pool Requirement (FPR) multiplied by peak load forecasts provides unforced capacity values, required to meet the reliability criterion."[90]

INTERVENOR AND RESPONSE COMMENTS

The Attorney General's initial comments focused on reliability and the need for adequate dispatchable generation, and cautioning against replacement of dispatchable resources with renewable resources.[91] The Attorney General supports Duke Kentucky's preferred portfolio of DFO conversion of the East Bend plant, and construction of a combined cycle gas-fired plant upon East Bend's retirement.[92]

Joint Intervenors commented that Duke Kentucky failed to include specific steps to be taken during the next three years to implement the plan as required by 807 KAR 5:058, Section 5(5), including timelines and scope of transmission projects, regulatory review, dealing with East Bend reagent supply issues, Certificates for Public Convenience and Necessity (CPCNs), DSM filings, and rate case filings.[93] Joint Intervenors reiterated this requirement in their post-hearing comments and noted that at hearing, Duke Kentucky addressed its three-year timeline, including filing CPCN application, obtaining permits, and conducting engineering planning for conversion of its East Bend 2 wet flue-gas desulfurization (FGD) scrubber and East Bend 2 co-firing conversion.[94] Joint Intervenors also included additional rationale for greater analysis of transmission and distribution planning, recommending evaluation of efficiencies such as Grid Enhancing Technologies.[95]

Sierra Club's comments asserted that Duke Kentucky's IRP did not comply with regulatory requirements because its preferred portfolio is not the least-cost option.[96] Sierra Club stated that full conversion of East Bend station without an intermediate DFO conversion is the least-cost option. Sierra Club argued that the full conversion option was

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[90] *See* PJM Manual 18, Revision: 59, Effective Date: 06/27/2024 at 20-21. https://www.pjm.com/documents/manuals/~/media/documents/manuals/m18.ashx (Last accessed Nov. 11, 2024). For Delivery Years through the 2024/2025 Delivery Year, the Forecast Pool Requirement (FPR) for the Delivery Year is equal to (1 + Installed Reserve Margin) times (1-Pool-wide Average EFORd). Starting with the 2025/2026 Delivery Year and for all subsequent Delivery Years, the Forecast Pool Requirement (FPR) for the Delivery Year is equal to (1 + Installed Reserve Margin) times (Pool-wide average Accredited UCAP Factor).

[91] Attorney General's Initial Comments at 8-13.

[92] Attorney General's Initial Comments at 14.

[93] Joint Intervenors' Initial Comments at 15-16.

[94] Joint Intervenors' Post-Hearing Comments at 7-8.

[95] Joint Intervenors' Post-Hearing Comments at 12.

[96] Sierra Club's Initial Comments (filed Nov. 6, 2024) at 1; Sierra Club's Post-Hearing Comments at 2-3.

the least costly under two of the six sensitivities modeled, that the cost of the East Bend Unit 2 Limestone Conversion Project should not have been included in every scenario because it would be unnecessary under full conversion, and that full conversion would not trigger the need for compliance with KRS 278.264 or EPA CAA Section 111(d) retirement obligations in 2039.[97] Sierra Club noted that the modeling for the natural gas conversion option should have been even cheaper, because Duke Kentucky unnecessarily included the cost of the FGD scrubber[98] upgrade project in its modeling for this option.[99] Sierra Club also stated that selecting natural gas conversion would result in additional benefits not captured by the model, such as not relying on decreasing coal supply which could threaten reliability and cost, lower cycling cost for gas over coal, and increasing the ability to commit the unit economically.[100] Gas conversion also mitigates the most environmental compliance costs without reducing dispatchable generation capacity.[101]

Sierra Club also commented that the modeling did not allow the model to select all possible options—that Duke Kentucky instead started with the outcomes of each generation selection in selected years paired with EPA regulation or no EPA regulation and worked backwards to fill in the gaps.[102]

Duke Kentucky filed reply comments, agreeing with the Attorney General that the transition to renewables should not be too aggressive and reiterating the selection of East Bend DFO conversion.[103] Duke Kentucky responded to Sierra Club's comments by stating that the "East Bend Retirement by 2036 and Accelerated Renewables" portfolio was cheaper by PVRR than the optimized Natural Gas Conversion portfolio in scenarios with and without EPA CAA Section 111(d) and has a lower PVRR than the optimized Retirement portfolio in the scenario with EPA CAA Section 111(d).[104] The preferred portfolio was selected over a CC with CCS as the replacement for East Bend 2 in the optimized DFO and Retirement portfolios, but Duke Kentucky concluded that CCS technology has not achieved a level of maturity sufficient to form the basis of the preferred portfolio—that DFO provides fuel flexibility, allowing time for technologies such as CCS to evolve and potentially be considered as replacement options for East Bend in the late

[97] Sierra Club's Initial Comments at 2.

[98] Including the related Limestone Conversion Project.

[99] Sierra Club's Post-Hearing Comments at 3-4.

[100] Sierra Club's Post-Hearing Comments at 9-10.

[101] Sierra Club's Post-Hearing Comments at 9-11.

[102] Sierra Club's Post-Hearing Comments at 5-6.

[103] Duke Kentucky's Reply Comments at 5.

[104] Duke Kentucky's Reply Comments at 13.

2030s.[105] Duke Kentucky also indicated that regarding the Limestone Conversion Project, it would be in the best interest of customers to undertake the conversion project regardless of whether East Bend would be converted to gas fuel by 2030, because the economics of the conversion project were favorable in comparison to the cost of reagents that would be required without the conversion even if the unit were to stop burning coal by 2030.[106]

Regarding the transmission and distribution planning discussed by Joint Intervenors, Duke Kentucky stated that planning and cost analysis occurred downstream of the IRP process and therefore have no influence on resource selection.[107]

[105] Duke Kentucky's Reply Comments at 13.

[106] Duke Kentucky's Reply Comments at 11.

[107] Duke Kentucky's Reply Comments at 9; Duke Kentucky's Post-Hearing Reply Comments at unnumbered 2.

SECTION 6

REASONABLENESS AND RECOMMENDATIONS

INTRODUCTION

Some aspects of Duke Kentucky's 2024 IRP, including some of the methodologies and assumptions used to produce the IRP, are reasonable and consistent with 807 KAR 5:058. However, there are areas in which Duke Kentucky could improve its IRPs going forward, including issues with certain methodologies and assumptions that affected the reasonableness of the 2024 IRP. This section discusses the reasonableness of Duke Kentucky's 2024 IRP and the issues and areas for improvement and makes recommendations for Duke Kentucky's next IRP.

LOAD FORECAST

Duke Kentucky's IRP noted the national expansion of load intensive data center facilities and indicated that it is monitoring the potential effects of this proliferation.[108] Duke Kentucky did not provide alternate scenarios or load forecasts to account for potential data centers locating in its service territory. However, Duke Kentucky did model and provide two additional load forecasts and corresponding optimized portfolios upon Staff's request.[109]

RECOMMENDATION: In its next IRP, Duke Kentucky should include load forecasts that to account for known, potential significant increases in load.

DEMAND AND SUPPLY SIDE RESOURCE ASSESSMENTS

Duke Kentucky's IRP evaluated existing DSM programs but did not evaluate potential DSM programs as required by 807 KAR 5:058 Section 8(2)(b). Duke Kentucky stated that it has implemented all programs in Kentucky that are cost-effective.[110]

RECOMMENDATION: Duke Kentucky has a robust suite of DSM programs. However, Duke Kentucky should provide an evaluation of potential DSM programs in its next IRP with estimated TRC scores, budget, and descriptions for all evaluated programs, regardless of whether they are cost-effective. Commission Staff must assume that additional DSM programs were not evaluated if no studies or data were provided.

With incentives, significantly large loads from data centers and other industrial entities are giving Kentucky serious consideration as a viable place to locate future facilities.

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[108] 2024 IRP at 63.

[109] Duke Kentucky's Response to Staff's Post-Hearing Request for Information, Item 9.

[110] Duke Kentucky's Reply Comments at 6-7.

RECOMMENDATION: With the advent of potentially significant data center or other industrial loads locating in Kentucky, Duke Kentucky's next IRP should evaluate and discuss the potential reliability impact on its system of such loads. The evaluation should consider the potential impact on reliability including but not limited to such electrically sensitive loads suddenly leaving the system and or coming online with little notice and any other changes that could affect the integrity and reliability of Duke Kentucky's system. The response should include how such large potential load swings would be avoided and delt with in the event of an actual event by PJM and by Duke Kentucky to insulate the rest of Duke Kentucky's system. In addition, such loads could potentially have a significant impact on the selection and timing of resource additions and retirements. Duke Kentucky should continue to model a full suite of potential resources that may be selected to satisfy is normal historic growth as well as the special requirements of data center and other significant load additions.

Duke Kentucky stated that EV charging management is not yet a viable DSM/EE technology in other jurisdictions.[111]

RECOMMENDATION: Duke Kentucky should continue to evaluate EV charging management as a possible DSM/EE program. In the next IRP, Duke Kentucky should provide an update on the viability and a full analysis of an EV charging management program for Duke Kentucky's service territory.

Duke Kentucky's IRP does not significantly address reliability as contemplated by 807 KAR 5:058, Section 8(1).

RECOMMENDATION: In the Attorney General's comments to Commission Staff's Report in Big Rivers Electric Corporation's (BREC's) 2023 IRP case,[112] the Attorney General recommended that "the Commission should consider either adding a new discrete assessment to its IRP reports addressing electric utility system reliability, or augmenting its supply-side assessment to fully address system reliability" due to "the nation's impending electrical reliability crisis."[113] Commission Staff agrees that this is an issue of import requiring independent evaluation. Indeed, 807 KAR 5:058, Section 8(1) differentiates between "providing an adequate and reliable supply of electricity." The bulk of Duke Kentucky's IRP deals with adequacy of supply—determining future load and taking steps necessary to provide adequate capacity. While adequacy of supply can be narrowly interpreted as having the capacity resources necessary to meet current and forecasted peak load under reasonable assumptions, reliability of supply can be

[111] Hearing Testimony of Tim Duff, Hearing Video Transcript (HVT) December 10, 2024 Hearing at 07:51:51-07:52:05.

[112] Case No. 2023-00310, *Electronic 2023 Integrated Resource Plan of Big Rivers Electric Corporation*, (Ky. PSC Aug. 20, 2024), Commission Staff's Report at 34.

[113] Case No. 2023-00310, Attorney General's Comments on Staff Report (filed Sept. 6, 2024) at 3.

interpreted as having generation resources be available and able to generate energy (be dispatched) on an as-needed basis.

PJM seeks to ensure reliability within its service territory, in part, by imposing reserve margin capacity requirements upon its members, and Duke Kentucky, like other utilities in an RTO, generally plans for reliability by planning to meet the reliability, or capacity requirements of the PJM. Although PJM plans for reliability at the regional level, Commission Staff believes that Duke Kentucky should also independently examine the reliability of its preferred portfolio options by considering the impact on the LOLE of the various portfolio options to the extent possible, and if not possible, the effect, if any, of portfolio options on the LOLE of the PJM zone in which Duke Kentucky is located.[114]

Commission Staff notes that the Attorney General has generally cast reliability as a coal versus renewable generation issue, stating in multiple rounds of comments to BREC's IRP that dispatchable thermal resources, historically coal, should be favored over intermittent renewable resources.[115] The Attorney General reiterated this stance in its comments to Duke Kentucky's IRP, cautioning against moves to replace thermal resources with renewables.[116]

Commission Staff agrees with the Attorney General regarding the importance of thermal generation in ensuring reliability for Kentucky customers. However, while the manner in which a resource generates electricity is important, there are other factors that will affect whether a resource will actually add reliability for Kentucky customers, including the expected location of the resource. Commission Staff believes that examining the effect of various portfolios on the LOLE for Duke Kentucky will best reflect the reliability effects of the portfolios for Duke Kentucky customers.

However, Commission Staff notes that Kentucky utilities do not generally include renewable resources in a portfolio for their capacity contribution or their contribution to reliability, and therefore, they are generally not replacing thermal resources. Rather, renewable resources are sometimes a more cost-effective source of energy, as opposed to capacity, due to various subsidies and the absence of fuel costs, which is a primary driver to being added to generation portfolios in production cost modeling. Thus, both intermittent renewable and firm thermal generation resources should be considered in resource planning in order to plan for and ultimately build a generation portfolio that provides for sufficient capacity to provide reliable service at the lowest reasonable PVRR.

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[114] *See* Case No. 2022-00402, *Electronic Joint Application of Kentucky Utilities Company and Louisville Gas and Electric Company for Certificates and Approval of a Demand Side Management Plan and Approval of Fossil Fuel-Fired Generating Unit Retirements* (Ky. PSC Nov. 6, 2024), Order at 100-102 (explaining the Commission's position that LOLE, along with Loss of Load Hour (LOLH) and Expected Unserved Energy (EUE), are the appropriate metrics for measuring the reliability of a transmission system).

[115] Case No. 2023-00310, Attorney General's Comments (filed Mar. 8, 2024) at 15–16; Attorney General's Supplemental Post-Hearing Comments (filed July 2, 2024) at 2–3; Attorney General's Initial Comments (filed Nov. 6, 2024) at 8.

[116] Attorney General's Initial Comments at 12-13.

Commission Staff believes that is generally achieved through a resource-neutral planning process, to the extent allowed by law, because there are cost and reliability trade-offs for all resources.

While thermal units generally deliver firm, reliable power, they do experience forced outages and derates price risks associated with certain aging units or fuel supply limitations. For instance, Duke Kentucky responded to data requests submitted by the Attorney General regarding coal supply. Duke Kentucky provided causes for limitations on its coal supply and indicated that U.S. coal production is expected to decline 14 percent from 2023 production levels and an additional five percent by 2025, due in part to relatively low natural gas prices.[117] However, natural gas transportation is not immune to availability issues as well--gas pipelines may become unavailable due to maintenance, repairs, or other problems.[118] Further, federal environmental regulations and the uncertainty surrounding their implementation may affect both coal and gas generation planning. Under EPA Clean Air Act (CAA) Section 111(d), coal plants must either be retired or implement CSS by 2039.[119] Section 111(d) also would also make natural gas generation subject to CCS requirements by 2032 for operation above a 40 percent capacity factor.[120]

Commission Staff acknowledges that each generation resource technology embodies specific attributes that affect its reliability and appropriateness in a utility's preferred generation portfolio. Commission Staff also notes that utilities and the Commission must weigh the cost of generation resources against their benefit to reliability. Commission Staff encourages utilities and intervenors to provide data, studies, and any other relevant information supporting assertions about the reliability of different resources, including the effect of portfolios on Duke Kentucky's LOLE as discussed above.

For future IRPs and Staff Reports, Commission Staff has the following goals:

- Identifying all factors that affect system reliability with the input of utilities and intervenors.
- Gathering data, studies, and any other relevant information that allows Staff to compare and contrast generation resource reliability alongside cost and any other factors evaluated in selection of a preferred portfolio.

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[117] Duke Kentucky's Response to KSES's First Request for Information, Item 14.

[118] Louisville Gas & Electric (LG&E)/Kentucky Utilities Company (KU) stated that its December 23, 2022 load shedding event during Winter Storm Elliott was a result of an unprecedented gas pipeline pressure problem. Case No 2023-00422, *Electronic Investigation of Louisville Gas and Electric Company and Kentucky Utilities Company Service Related to Winter Storm Elliott*, LGE&E/KU's Post-Hearing Reply Brief (filed Sept. 20, 2024) at 7. However, LGE&E/KU also noted that a coal tripper froze, causing a derate. Case No 2023-00422, LGE&E/KU's Post-Hearing Brief (filed Aug. 9, 2024) at 11.

[119] If Environmental Protection Agency (EPA) Clean Air Act (CAA), Section 111(d) Update goes into effect, carbon capture and sequestration (CCS) will be required. 2024 IRP at 10 and 30.

[120] 2024 IRP at 30.

- Using this information to evaluate the effect of each modeled scenario output on the reliability of the electric system.

INTEGRATION

Duke Kentucky stated that the proposed switch from PJM FRR membership to RPM membership would not change Duke Kentucky's "IRP modeling outcome."[121]

RECOMMENDATION: Switching to RPM from FRR may or may not change the Preferred Portfolio outcome. However, Duke Kentucky should have provided calculations supporting the assertion that the change would have no material effect on the modeling outcomes. This is especially true where the timing of significant large loads coming online prior to additional capacity being built. In addition to lowering reserve margin requirements, being a PJM RPM participant provides greater flexibility to purchase as well as sell capacity into PJM.

For the six optimized portfolios and 11 alternative portfolios, the IRP is unclear as to how assumptions were modeled and why East Bend's outcome appears to have been hardwired into each scenario. For example, Table 6.10 stated that East Bend DFO Conversion with CC replacement by 2039 was hardwired into the Encompass model run. Commission Staff is unsure of the utility of the portfolios if East Bend's outcome is predetermined in each scenario.

RECOMMENDATION: The IRP appropriately runs separate models for planning with and without the effects of EPA CAA Section 111(d) Update. Alternate scenarios are also appropriate for evaluating portfolios with different goals. However, the alternate portfolio analyses focused on the East Bend DFO conversion instead of also running alternate portfolio scenarios without the East Bend DFO conversion. This would have been consistent with the primary set of analyses, since the ultimate fate of the Section 111(d) regulation was uncertain. When testing the selection of preferred portfolios under different sets of assumptions, Duke Kentucky should model alternate portfolios to test the appropriateness of portfolios selected in the primary analyses. In this case, running alternate portfolio analyses for East Bend DFO conversion and without DFO conversion should have been undertaken.

Multiple portfolios have East Bend eventually being replaced by an NGCC, but without CCS. Since this seemed to function as a base load unit in the modeling, it appeared to have a capacity factor greater than 40 percent, thus requiring CCS under the updated CAA Section 111(d) requirements. Also, the IRP is unclear why the New Source Performance Standard would not mandate CCS.

RECOMMENDATION: The next IRP should provide a more detailed explanation of required EPA regulations and how these constraints are modeled into the resource selection and production cost models.

[121] Duke Kentucky's Response to Staff's Second Request, Item 2.

Duke Kentucky stated that cost, PVRR, CO_2 reduction, and purchases were three main drivers in choosing optimization path after running the six initial optimization runs.[122] Duke Kentucky chose the DFO path,[123] but did not fully explore or explain why it did not continue evaluating East Bend options without the DFO conversion, which appeared to have much lower PVRR.

RECOMMENDATION: The next IRP should make clear why a different resource portfolio was selected if different from the least-cost option overall.

The IRP is unclear as to why DFO conversion was chosen in alternate portfolios applying the EPA CAA Section 111(d) Update, as natural gas conversion or the retirement by 2032 scenarios had far greater reductions in CO_2 emissions than the DFO conversion portfolio,[124] especially after 2030, when Duke Kentucky has to declare what its plans are for East Bend.

RECOMMENDATION: The IRP should explain any portfolio results that are not the least-cost option, or are inconsistent with other goals, such as carbon reduction.

The Encompass model appears to add solar generation in 8 MW to 12 MW blocks,[125] which seems contrary to information in Table 4.1.[126] Table 6.3 includes 210 MW Solar + Storage: Solar and 75 MW Solar + Storage: Battery.[127] This represents three separate projects of 70 MW solar and 25 MW battery.[128] The solar and battery additions do not match information in Table 4.1.[129]

RECOMMENDATION: The next IRP should ensure that the discussion and presentation of data and modeling results be consistent throughout the IRP.

The IRP does not indicate whether CCS implementation assumes on-site CO_2 storage or disposal.[130]

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[122] Duke Kentucky's Response to Staff's First Request, Item 18.

[123] 2024 IRP at 45.

[124] Duke Kentucky's Response to Staff's First Request, Item 19.

[125] 2024 IRP at 153, Table H.3.

[126] 2024 IRP at 33, Table 4.1.

[127] 2024 IRP at 33, Table 6.3

[128] Duke Kentucky's Response to Staff's First Request, Item 15.

[129] 2024 IRP at 44, Table 4.1.

[130] *See* Duke Kentucky's Response to Staff's First Request, Item 5(a) (confidentially filed).

RECOMMENDATION: To the extent it can be reasonably estimated, the next IRP should include specific cost data for storage and or disposal of CCS CO_2.

REASONABLENESS

Commission Staff finds Duke Kentucky's load forecast methodology and results reasonable. Commission Staff determined that Duke Kentucky did not comply with the 807 KAR 5:058 Section 8(2)(b) requirement that the utility evaluate potential DSM programs. Duke Kentucky only provided evaluation of existing DSM programs.

Duke Kentucky's preferred plan was not necessarily unreasonable, but the IRP does not include enough modeling details to explain why it selected a plan that does not appear to be the least-cost alternative to meet capacity requirements. The IRP is unclear as to what the model was permitted to select for each scenario. Duke Kentucky also should have modeled with the RPM membership change and provided this modeling data.

The IRP process is a precursor to CPCN applications for generation resources. The modeling outputs created by Duke Kentucky's modeling do not clearly establish that the selected portfolio is the least-cost reasonable option for meeting forecasted load. Duke Kentucky would either need to select a different portfolio or fully explain why the selected portfolio is less costly or justify selecting a portfolio other than the least-cost option.

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