Kentucky Public Service Commission

Staff Report on the

2018 Integrated Resource Plan

of Duke Energy Kentucky, Inc.

Case No. 2018-00195

August 2019

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 (Staff). The Commission's goal was to ensure that all reasonable options for the future supply of electricity were being examined in order to provide ratepayers a reliable supply of electricity that is cost-effective.

Duke Energy Kentucky, Inc. (Duke Kentucky), filed its 2018 Integrated Resource Plan (IRP) on June 21, 2018. The IRP includes Duke Kentucky's plan for meeting its customers' electricity requirements for the period 2018-2038.[2]

A procedural schedule was established for this proceeding, which allowed two rounds of data requests to Duke Kentucky, written comments by intervenors, and reply comments by Duke Kentucky. The only intervenor is the Attorney General of the Commonwealth of Kentucky by and through his Office of Rate Intervention (Attorney General), who issued two data requests and filed written comments on Duke Kentucky's IRP.

Duke Kentucky, an investor-owned utility supplying electricity and natural gas in northern Kentucky, is a wholly owned subsidiary of Duke Energy Ohio, Inc. (Duke Ohio), which is a wholly owned subsidiary of Duke Energy Corporation. Duke Kentucky is a member of PJM Interconnection LLC (PJM), a regional transmission organization that is also Duke Kentucky's reliability coordinator. Duke Kentucky provides electricity to approximately 140,000 customers.[3] Its net summer generation capacity in 2017 was 1,083 megawatts (MW), consisting of 600 MW of coal-fired base load capacity and 476 MW of gas-fired combustion turbine (CT) peaking capacity and 6.8 MW (2.4 MW contribution to peak) of solar PV capacity.[4] Its highest all-time system peak demand of 895.1 MW occurred in the summer of 2012.[5] Its all-time energy requirement peak of 4,133,807 megawatt-hours (MWh) occurred in the calendar year 2018.[6]

The purpose of this report is to review and evaluate Duke Kentucky's 2018 IRP in accordance with 807 KAR 5:058, Section 11(3), which requires Staff to issue a report summarizing its review of each IRP filing and make suggestions and recommendations

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[2] The 15-year planning period for the IRP was from 2017 through 2031. However, Duke Kentucky provided much information through 2038, so Staff used that information when available.

[3] IRP at 14, Figure 2.1.

[4] *Id.* at 17.

[5] Duke Kentucky's response to Staff's First Request for Information, Item 5. The 2014 Staff Report, page 2, listed Duke Kentucky's all-time system peak demand at 930 MW in the summer of 2010.

[6] *Id.*

to be considered in future IRP filings. Staff recognizes resource planning is a dynamic, ongoing process. Specifically, the Staff's goals are to ensure that:

- 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 2014.

Duke Kentucky's objective in its IRP is to define a robust strategy to provide electric energy services in a reliable, efficient, and economic manner while considering the uncertainty of the current environment. Its long-term objective is to employ a flexible planning process and pursue a resource strategy that considers the costs and benefits to all stakeholders (customers, shareholders, employees, suppliers, and community). Duke Kentucky states that the plan in its IRP represents the most robust and economic outcome based on various assumptions and sensitivities, which reflect the current uncertainty in regulatory, economic, environmental, and operating conditions.

The major objectives of Duke Kentucky's 2018 IRP are to:

- 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; and
- Minimize risks, such as wholesale market risks and reliability risks.

Duke Kentucky's summer peak is expected to increase from 848 MW in 2018 to 990 MW in 2038, reflecting an annual growth rate of 0.8 percent. Its winter peak load is expected to increase from 730 MW to 842 MW over the same period, for a growth rate of 0.7 percent.[7] Energy requirements are projected to increase from 4,345,770 MWh in 2018 to 5,124,117 MWh in 2038, for an annual growth rate of 0.8 percent.[8]

The IRP was developed based on a minimum reserve margin of 13.7 percent.[9] With its planned Demand-Side Management (DSM) programs and demand response, Duke Kentucky expects to have a peak reduction of 1.2 MW reduction in demand by 2032.[10]

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[7] IRP Tables B.4a and B.6a at 67, 68, and 72.

[8] *Id.* Table B3a at 65–66.

[9] *Id.* at 20.

[10] *Id.* at 17.

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, summarizes Duke Kentucky's evaluation of DSM opportunities.
- Section 4: Supply-Side Resources and Environmental Compliance focuses on supply resources available to meet Duke Kentucky's load requirements and environmental compliance planning.
- Section 5: Integration and Plan Optimization, discusses Duke Kentucky's overall assessment of supply-side and demand-side options and their integration into an overall resource plan.

The Attorney General comments included a recommendation regarding the filing and processing of Duke Kentucky's next IRP. The Attorney General noted that Duke Kentucky's 2018 IRP was not filed three years after the filing of the 2014 IRP, as required by Commission regulations, but instead was filed three years after the conclusion of Duke Kentucky's 2014 IRP. The Attorney General further noted the delays in processing this case.[11] The Attorney General recommended that Duke Kentucky's next IRP be filed three years from the filing date of its 2018 IRP, or no later than June 21, 2021, and that it be timely processed.[12]

As was pointed out in the Order establishing a procedural schedule in this case and other recent IRP cases, due to staffing levels and workloads, the dates that would normally be set for processing were moved back to allow sufficient time to complete its review of the IRP and issue a Staff Report. Staff is in agreement with the Attorney General, and the next IRP should be filed three years from the filing date of the current IRP on June 21, 2021.

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[11] Attorney General's Comments on Duke Kentucky's 2018 IRP at 2.

[12] *Id.* at 2-3.

SECTION 2
LOAD FORECASTING

INTRODUCTION

Duke Kentucky prepares energy and load forecasts as a part of its annual planning process. The forecast framework is based on national and service area economic forecasts and electric sales forecast. Duke Kentucky's service territory is part of the Cincinnati Metropolitan Statistical Area and is greatly influenced by the regional economy. Increases in economic activity generally lead to increases in electric energy sales. Econometric and end-use models using a combination of historical and forecasted key economic variables produce electric sales forecasts, which are prepared for residential, commercial, industrial, and other segments. Final net sales forecasts are obtained after accounting for electric system losses. Duke Kentucky labels this initial forecast its Business-As–Usual or Most Likely forecast.[13]

FORECASTING METHODOLOGY AND ASSUMPTIONS

For the national economic forecast, Duke Kentucky obtains historical and projected data on key economic and demographic variables from Moody's Analytics. Key variables include population, employment, industrial production, inflation, wages, and income. A service area economy forecast is also obtained using data from Moody's Analytics. Key variables include service area population, number of households, employment, income, inflation, production, and output variables. Service area employment is broken out by segment, including non-agricultural, commercial, industrial, and government sectors. Service area income is broken out by wages, dividends, interest, rents, proprietors' income, personal contributions for social insurance, and transfer payments. Service area inflation is measured by changes in the Personal Consumption Expenditures Index for gasoline and other energy goods and the Consumer Price Index.[14]

An integral part of the forecasting process is forecasting fuel prices, power prices, and carbon emission prices. For the fuel and power prices, Duke Kentucky combines near term observable prices and long term fundamental projections. The near term observations were obtained from public sources, including the New York Mercantile Exchange (NYMEX). IHS Markit, Ltd. provided the fuel price forecasts. Natural gas prices are expected to remain low through the mid-2020s and then gradually increase as coal demand remains weak. Coal prices are expected to rise slightly above inflation over most of the forecast period.[15] Using the fuel price forecasts, Duke Kentucky used its PROMOD model to derive long-term fundamental power price projections using

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[13] IRP at 22.

[14] *Id.*, Appendix B - Load Forecast at 53.

[15] *Id.* at 29.

forecasted fuel and carbon price assumptions.[16] Duke Kentucky also utilized capital cost projections for the generation technologies in its overall optimization modeling. These projections are based upon the Energy Information Administration's Technology Forecast Factors.[17]

Statistically Adjusted End-Use Models

An integral part of Duke Kentucky's residential and commercial class energy use forecast is the use of statistically adjusted end-use (SAE) models obtained from Itron, Inc. These models take detailed energy end-use data pertaining to changes in building characteristics, appliance stocks, and saturation levels over time to construct energy intensity variables that are then integrated into Heating, Cooling, and Other end-use variables. These variables are then used in linear regression models to forecast residential and commercial energy consumption. The advantage of SAE models over standard econometric regression models is SAE models capture trends in underlying energy end use, and technology changes over time that affect energy consumption. Duke Kentucky's forecasts include projections of increasing saturation levels for many appliances as well as increasing trends of appliance efficiency.[18]

Residential Forecast

The service area residential sector energy forecast is obtained by multiplying the projected number of customers by the kWh energy usage per customer. The projected number of customers is a function of the forecast number of households. Duke Kentucky projects service area population growth to lag the national rate of 0.6 percent. The number of residential customers is projected to increase slowly from an annual average of 126,891 to 138,842 over the forecast period.[19] The projected kWh energy usage per customer is a function of real household income, real electricity prices, appliance saturations, and weather.[20] Weather data is obtained from the National Oceanographic and Atmospheric Administration (NOAA). Current and projected appliance saturation and

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[16] *Id.* at 22-23. Duke Kentucky included a carbon constraint scenario even though the Clean Power Plan had been repealed at the time it was making its forecasts.

[17] *Id.* at 23.

[18] *Id.* at 58 and Staff's Second Request Item 22. Item 22, Attachment 1 contains Itron's 2018 Residential SAE Update report. It contains detailed information regarding 20 residential end-use variables and a detailed explanation of the derivation of the residential Heating, Cooling, and Other variables. Item 22, Attachment 2 contains Itron's 2018 Commercial SAE Update report. It contains detailed information regarding nine commercial energy end uses and a detailed explanation of the derivation of the commercial Heating, Cooling, and Other variables.

[19] *Id.* at 57 and 59.

[20] *Id.* at 54.

efficiency data are obtained from Duke Kentucky appliance saturation surveys and Itron, Inc.[21]

In projecting energy usage and load, Duke Kentucky ran two DSM scenarios: one with its two remaining Energy Efficiency (EE) programs in place (Case #1) and another as if all its prior EE and Demand Response (DR) programs were in place (Case #2).[22] For Case #1, annual residential energy use is projected to increase from 1,455,709 MWh to 1,812,935 MWh or at an annual average of 1.1 percent over the twenty-year forecast period.[23] At the time Duke Kentucky made its forecasts, the projected impacts of the EE programs had virtually no effect on forecasted energy use. The impact of these programs amounted to 321 MWh in 2018, rising to 6,550 MWh in 2038.[24]

Commercial Forecast

The number of commercial customers closely tracks the number of service area households. Over the forecast period, the number of commercial customers is projected to grow from an average of 13,643 to 14,107.[25] The service area commercial energy use forecast is a function of median household income, total employment, real electricity prices, weather, and the combined effects of the saturation of air conditioners, heating, and other appliances, changes in appliance efficiencies, and building square footage.[26] Over the forecast period, annual commercial energy use is projected to increase at an annual average rate of 0.7 percent from 1,470,677 MWh to 1,679,222 MWh.[27]

Industrial Forecast

Duke Kentucky collects and maintains complete load profile information on its commercial and industrial customers with an average demand of 500 kW and above. Moody's Analytics projects a decline in employment in the manufacturing sector over the forecast period. This is reflected in the decline in the number of industrial customers from 361 to 313.[28] Service area industrial energy consumption is a function of real gross

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[21] *Id.* at 54, 60–61.

[22] IRP at 16-17. Even though two Case scenarios are run for EE and DR programs, Duke Kentucky focuses on Case #1 in reporting its energy and load forecasts. At the time, the forecasts were made, the outcome of Case No. 2017-00427 was not known. An Order was issued on September 13, 2018 authorizing Duke Kentucky to amend and reinstate several, but not all of its DSM programs. Case No. 2017-00427, *Electronic Annual Cost Recovery Filing for Demand Side Management by Duke Energy Kentucky, Inc.*, (Ky. PSC September 13, 2018).

[23] *Id.* at 65 and Tables B.3a and B.3b at 66–67.

[24] *Id.* Column 1 Table B.3a minus Column 1 Table B.3b at 66–67.

[25] *Id.* at Table B.1 at 59.

[26] *Id.* at 54-55.

[27] *Id.* at 65 and Table B.3b at 67.

[28] *Id.* at Table B.1 at 59.

manufacturing product (manufacturing GDP), real electricity prices, the electricity price relative to other alternative fuels and weather.[29] Over the 20-year forecast period, annual industrial energy consumption is projected to increase from 801,550 MWh to 905,940 MWh.[30]

Street and Highway Lighting Forecast

Street and highway lighting forecasts are a function of service area population and the intensity or efficiency of lighting end use. Lighting efficiency is dependent on the numbers of deployed lighting technologies, including Compact fluorescent, light-emitting diode, mercury, and sodium vapor lights.[31] Over the forecast period, the number of lighting customers is projected to increase from 452 to 612.[32] However, annual street and highway lighting energy consumption is expected to decline from 15,212 MWh to 13,472 MWh.[33]

Other Public Authority Sector Forecast

This customer class encompasses all customers involved and/or affiliated with federal, state, and local governments, including schools, government facilities, airports, and water pumping stations. Energy sales are a function of real electricity prices, heating degree days, and real government output.[34] The number of public sector customers is forecast to increase from 961 to 1,120 over the forecast period.[35] Over the forecast period, annual public sector energy consumption is projected to increase from 283,046 MWh to 329,553 MWh.[36]

Total Company Net Energy Forecast

As discussed above, Duke Kentucky made energy consumption forecasts using two different DSM scenarios. For Case #1, after accounting for system losses and unaccounted for energy, Duke Kentucky projects net energy usage to increase from 4,345 GWh to 5,117 GWh over the forecast period.[37] Though the energy use forecast for Case

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[29] *Id.* at 55.

[30] *Id.,* Table B.3b at 67.

[31] *Id.* at 55.

[32] *Id.* at Table B.1 at 59.

[33] *Id.* Table B.3b at 67.

[34] *Id.* at 55.

[35] *Id.* at Table B.1 at 59.

[36] *Id.* at Table B.3b at 67.

[37] *Id.* at Table B.3b at 67 and Table B.6b at 73.

#2 is not provided, Duke Kentucky reports that the annual savings that would have occurred increase from 25,590 MWh in 2018 to 382,273 MWh in 2032.[38]

Peak Load Forecast

Historically, Duke Kentucky has been a summer peaking utility and is expected to remain so throughout the planning period. Including the effects of EE programs in Case #1, peak load is projected to increase from 848 MW to 989 MW over the forecast period. The EE programs in Case #1 are projected to have 1.2 MW annual savings by 2032.[39] Duke Kentucky projects that Case #2 would produce 70 MW of total annual savings by 2032.[40]

Sensitivity Analysis

Duke Kentucky ran multiple alternative scenarios to test its forecasting results under differing assumptions. Duke Kentucky adopted alternatives to the business-as-usual (BAU) economic scenario obtained from Moody's Analytics. The high load growth scenario models a short term, stronger than expected, growth in the economic variables leading to stronger energy sales. The low load growth scenario models a mild recession in the short run leading to lower sales.[41] In the BAU Case #1 scenario, energy consumption increases from approximately 4,345 GWh to 5,117 GWh, and peak load increases from 848 MW to 989 MW over the 2018–2038 forecast period. Over the forecast period, the optimistic high load growth scenario raises energy consumption over the BAU case from 43 MWh to 105 MWh. Similarly, peak load increases from 8 MW to 22 MW. In the pessimistic low load growth scenario relative to BAU Case #1, energy consumption falls from approximately 42 GWh to 105 GWh over the forecast period. Similarly, peak load falls by 8 MW to 22 MW over the forecast period.[42]

SIGNIFICANT CHANGES

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[38] IRP at 17 and Table D.1a at 82. However, for Case #1, the energy consumption savings reported in Table D.1a at 81 and at 17 does not match the calculated energy use savings from Tables B.3a and B.3b at 66-67.

[39] *Id.* at 17 and Appendix B Tables B.4b, B.6a, B.6b at 69, 72, and 73, respectively. It should be noted that the figures in Table B.4a appear to be incorrect, as presented. The figures in Table B.4a (before EE) should not be an exact match for those found in Table B.4b (after EE) and should match comparable figures in Table B.6a at 72. In addition, the footnote in Table B.6b incorrectly labels the Peak Load Forecast as including controllable load, the effects of which are included in Case #2.

[40] *Id.* at 17 and Table D.1a at 82.

[41] *Id.* at 71.

[42] *Id.* Table B.6b at 73.

Duke Kentucky continued to use the same forecasting methods as in the 2014 IRP. In the current IRP, SAE regression models are the principle modeling technique for capturing behavioral and economic relationships for the residential and commercial customer classes.[43]

INTERVENOR COMMENTS

The Attorney General stated that it was not clear whether Duke Kentucky's load forecast reviewed wind or storage distributed energy resources (DER), and therefore recommended that Duke Kentucky's next IRP filing provide more granular data regarding the type, penetration, and impact of DERs. The Attorney General asserted that more insight into DERs in future IRP filings would assist in resource planning to meet Duke Kentucky's customer needs.

RESPONSES TO PREVIOUS STAFF RECOMMENDATIONS

In the 2014 IRP, staff had several recommendations regarding load forecasting.

- The impact of existing and future environmental regulations on the price of electricity and other economic variables continues to be a subject of great interest in the electric utility industry. Accordingly, the effects of such regulations should continue to be examined as a part of Duke Kentucky's load forecast and sensitivity analysis.
- The potential for future increases in electricity prices due to stricter environmental regulations to be large enough to affect consumer behavior and energy consumption continues to exist. An updated analysis/discussion of how such price increases may impact the elasticity of customer demand should be included in the next IRP.
- Weather continues to have an impact on Duke Kentucky's forecasting. In its forecasting discussion, Duke Kentucky should identify the period it uses for weather normalization in its forecasting models and explain how Duke Kentucky determined that this period is reasonable.

Duke Kentucky addressed these concerns and Staff is satisfied with, and accepts the responses to the forecasting recommendations.

DISCUSSION OF REASONABLENESS

Staff has concerns regarding the consistency of reported results and the level of detail presented in the report. However, Staff is satisfied with the overall reasonableness of Duke Kentucky's load forecast.

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[43] *Id.* at 64.

RECOMMENDATIONS FOR DUKE KENTUCKY'S NEXT IRP

In its next IRP, Duke Kentucky should ensure that figures reported in tables are consistent throughout the IRP. Any differences in figures and tables should be clearly explained. Additionally, there are several observations regarding the report that should be taken into account for Duke Kentucky's next IRP.

- Duke Kentucky has altered the format of the current IRP from the 2014 IRP in an effort to make the current version more reader-friendly and customer accessible.[44] Staff appreciates Duke Kentucky's efforts. However, for the Commission's purposes, using a report format similar to what has been used historically is more appropriate. At a minimum, the report should contain a rigorous and detailed discussion of each forecasting model, including the final model equation and the derivation of each variable used in each model equation. This discussion should be organized around each forecasting model. In the current report, the Itron 2018 Residential and Commercial SAE Updates were helpful in this regard.
- There is insufficient discussion of the importance and uses of weather normalization and how that has been utilized with respect to sector or to total company forecasts.
- Staff notes that not all of the figures reported and or represented in Tables appear to be consistent throughout the IRP. For example:
    - Table B.2 contains energy usage categories that are not listed in Tables B.3a and B.3b. It is not clear whether the differences between the figures represented in the Tables are attributable to weather normalization only and where the additional energy usage categories reported in Table B.2 are accounted for in Tables B.3a and B.3b.
    - Tables B.3a and B.3b on pages 66-67 contain identical residential energy usage for the years 2013-2017 for "before" and "after' EE and DSM program implementation.
    - Calculating the impacts of EE and DSM programs on residential energy usage reported in Tables B.3a and B.3b and comparing to the EE and DSM impacts reported in Table D.1a on page 81 and on page 17 yields two different impact results.
    - The Summer Peak forecast in Table B.4b on page 69 matches the Most Likely Peak Load forecast in Table B.6b on page 73. However, footnote b for both Tables is inconsistent regarding controllable load.
    - Table B.4a on page 68 (before EE) is an exact match for Table B.4b on page 69 (after EE Case #1). In addition, the Summer Peak load in Table B.4a does not match the Most Likely peak load reported in Table B.6a.
- There should be a greater explanation of information found in Tables and in any underlying assumptions driving particular results. In addition, when there

[44] IRP at 10.

are differences between Tables purporting to illustrate the same result, there should be sufficient explanation of each Table to enable the reader to make distinctions and understand the differences.

- There should be a greater explanation of each forecasting model, the specific data used for each customer class forecast, the explanation of each customer class and total forecast for energy usage, peak load, and the sensitivity analysis should be organized in a manner more specific to each customer class. An analysis of possible changes in customer class elasticities should also be included in the sensitivity analyses.

SECTION 3

DEMAND-SIDE MANAGEMENT AND ENERGY EFFICIENCY

INTRODUCTION

DSM and EE programs are designed to make the production and delivery of energy more cost-effective with the goal of increasing the efficient use of electricity. Through applications by Duke Kentucky and in conjunction with its DSM/EE Collaborative,[45] the Commission has approved expansions and revisions of Duke Kentucky's DSM/EE efforts over the course of time.

Prior to the IRP filing, the Commission had approved Duke Kentucky's portfolio of DSM/EE programs in Case No. 2016-00289.[46] On August 15, 2017, Duke Kentucky filed Case No. 2017-00324[47] requesting approval to amend one of its DSM programs, increase its non-residential DSM rate, and revise its Rider DSM. Later that year, on November 15, 2017, Duke Kentucky filed Case No. 2017-00427,[48] which included Duke Kentucky's annual status report, adjustment of the DSM cost-recovery mechanism, amended tariff sheets, and an update to all of its DSM programs. On January 8, 2018, Duke Kentucky filed a third DSM application, Case No. 2018-00009,[49] with several proposed updates to the Non-Residential Smart Saver Prescriptive Program.

On February 14, 2018, the Commission issued an order for Case Numbers 2017-00324, 2017-00427, and 2018-00009, finding that each of the DSM applications raised issues of whether or not the existing or revised DSM programs were cost-effective.[50] The Commission had been investigating the cost-effectiveness of DSM programs on a case-by-case basis examining the extent to which a DSM program is affordable and useful and

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[45] The Residential and Commercial & Industrial Collaborative includes the Attorney General, People Working Cooperatively, Kentucky Need Project, Northern Kentucky University Small Business Development, Northern Kentucky Chamber of Commerce, Department of Energy Development and Independence, Kenton County Schools, Wiseway Supply, Monohan Development Company, Kentucky Energy Smart Schools, Northern Kentucky Community Action Commission, Campbell County Fiscal Court, Brighton Center, Boone County Fiscal Court, Northern Kentucky Legal Aid , Boone County Fiscal Court, Kenton County Fiscal Court, Greater Cincinnati Energy Alliance, and Duke Energy Kentucky.

[46] Case No. 2016-00269, *Electronic Application of Duke Energy Kentucky, Inc., to Amend its Demand Side Management Program* (Ky. PSC Jan. 24, 2017).

[47] Case No, 2017-00324, *Electronic Application of Duke Energy Kentucky, Inc. to Amend its Demand Side Management Programs.* (Ky. PSC August 15, 2017).

[48] Case No. 2017-00427. *Electronic Annual Cost Recovery Filing for Demand Side Management by Duke Energy Kentucky, Inc.,* (Ky. PSC November 15, 2017).

[49]Case No. 2018-00009, *Application of Duke Energy Kentucky, Inc. to Amend its Demand Side Management Programs.* (Ky. PSC January 8, 2018).

[50] Case No. 2017-00427 (Ky. PSC Feb. 14, 2018) Order.

believed that an investigation into the reasonableness of Duke's DSM programs was necessary.[51] In this February 14, 2018 Order, the Commission suspended all of Duke Kentucky's existing DSM programs except Low-Income Services and Low-Income Neighborhood Programs, while an investigation was undertaken to determine whether the costs of DSM programs benefit all ratepayers. The February 14, 2018 Order also consolidated Case Numbers 2017-00324 and 2018-00009 into Case No. 2017-00427. The findings in Case No. 2017-00427 include the termination of the EE Education Program for Schools and a tariff amendment for the MyHER.[52]

Due to the DSM programs being suspended at the time this IRP was prepared, Duke Kentucky evaluated two DSM case scenarios. Case #1 assumes that only the Low-Income programs continue. Case #2 assumes that all 16 programs existing prior to the suspension would continue through the forecast period.[53] Case #1 has a minimal impact on energy consumption over the forecast period. By 2032, energy consumption in Case #1 is reduced by 9,000 MWh and demand by 1.2 MW. Case #2 has a greater impact,[54] in that the conservation DSM programs are projected to reduce energy consumption and peak demand by approximately 382,000 MWh and 37.0 MW, respectively, by 2032.[55] The Residential Direct Load Control Program (Power Manager) is projected to reduce peak demand by 15.2 MW and the PowerShare®, and Power Manager for Business programs are projected to reduce peak demand by 17.8 MW, resulting in a total peak reduction across all programs of approximately 70 MW by 2032.[56]

The 16 programs modeled by Duke Kentucky in Case #2 are as follows[57]:

- Program 1: Residential Smart $aver® Energy Efficient Residences Program
- Program 2: Residential Smart $aver® Energy Efficient Products Program
- Program 3: Residential Energy Assessments Program
- Program 4: Energy Efficiency Education Program for Schools Program
- Program 5: Low Income Services Program

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[51] *See* Case No. 2017-00097, Electronic Investigation of the Reasonableness of the Demand Side Management Programs and Rates of Kentucky Power Company (Ky. PSC Jan. 18, 2018); Case No. 2018-00044, *Electronic Investigation of the Reasonableness of the Energy Efficiency and Conservation Rider of Columbia Gas of Kentucky, Inc.* (Ky. PSC Oct. 25, 2018); Case No. 2017-00424, *Application of Atmos Energy Corporation to Extend Its Demand-Side Management Program, as Amended, and Cost Recovery Mechanism, as Amended for Three (3) Years* (Ky. PSC Dec. 18, 2018); 2018-00029, *Electronic Investigation of the Reasonableness of the Conservation/Energy Efficiency Program of Delta Natural Gas Company, Inc.* (Ky. PSC Jun 28, 2029).

[52] *Id.*

[53] IRP at 16.

[54] *Id.* at 17.

[55] *Id.* at 17 and Table D.1a at 82.

[56] *Id.*

[57] See IRP, Appendix D, for a complete description of all programs.

- Program 6: Residential Direct Load Control - Power Manager® Program
- Program 7: Smart $aver® Prescriptive Program
- Program 8: Smart $aver® Custom Program
- Program 9: Smart $aver® Energy Assessments Program
- Program 10: Peak Load Manager (Rider PLM) - PowerShare® Program
- Program 11: Low Income Neighborhood Program
- Program 12: My Home Energy Report Program
- Program 13: Small Business Energy Saver Program
- Program 14: Non- Residential Pay for Performance
- Program 15: Power Manager® for Apartments
- Program 16: Power Manager® for Business

INTERVENOR COMMENTS

There were no intervenor comments in this case regarding DSM or energy efficiency.

DISCUSSION OF REASONABLENESS

Duke Kentucky states in the IRP that the reinstatement of the DSM programs would help to satisfy PJM requirements.[58] In Case No. 2017-00427, Duke Kentucky explained the requirements of membership in PJM. As a member of PJM, Duke Kentucky participates as a Fixed Resource Requirement (FRR) Entity in the PJM capacity market. Under the FRR plan, Duke Kentucky is considered a load-serving entity (LSE) and must submit an annual plan that covers a preliminary three-year forward and a final current year FRR capacity load that meets the customer capacity obligation as defined by PJM. PJM determines the forecasted load of Duke Kentucky's customers and the reserve requirement. Duke Kentucky relies on the demand-response capacity benefits to lower peaks during times of increased demand and as a capacity resource to meet the generation requirements of PJM.[59] Duke Kentucky relies upon the availability of its DSM programs to manage capacity and energy requirements by reducing or temporally shifting customer load to meet its FRR obligation.[60] In particular, two of its DSM load management programs, the PowerShare, and Power Manager qualify as DR programs in PJM and are included in Duke Kentucky's FRR plan as capacity resources. In the absence of its DSM programs, additional capacity purchases would be required to ensure that its FRR plan is not deemed deficient. A deficiency would result in financial penalties, additional reserve margin penalties on the load forecast, and perhaps a forced exit from the FRR arrangement.[61] The Commission found that Duke Kentucky offered evidence supporting the importance and the need to continue certain DSM programs as they are

[58] IRP at 42.

[59] Case No. 2017-00427, Duke's Post-Hearing Brief. (filed June 27, 2018) at 2.

[60] Case no. 2017-00427, Direct Testimony of John Verderame (filed Apr. 12, 2018) at 21.

[61] *Id.* at 23.

recognized by PJM as capacity resources. For those DSM programs not directly used in the PJM reserve margin calculation, the Commission found that Duke Kentucky provided evidence that they too provide a benefit by reducing customer consumption and enabling Duke Kentucky to meet its forecasted PJM load obligation. The Final Order in this case also noted that reducing Duke Kentucky's load requirements through DSM programs is a less costly alternative than either purchasing captivity or installing additional capacity.

RECOMMENDATIONS

- Duke Kentucky's next IRP should include the DSM Programs approved by the Commission in Case No. 2017-00427.
- Duke Kentucky should continue to scrutinize the results of each existing DSM program measure's cost-effectiveness test and provide those results in future DSM cases, along with detailed support for future DSM program expansions and additions. Duke 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.

SECTION 4

SUPPLY SIDE RESOURCES AND ENVIRONMENTAL COMPLIANCE

This section summarizes, reviews, and comments on Duke Kentucky's evaluation of existing and future supply-side resources. It also includes discussion on various aspects of Duke Kentucky's environmental compliance planning.

EXISTING CAPACITY

Duke Kentucky's net installed summer generation capacity consists of a 600 MW coal-fired plant at the East Bend Generating Station (East Bend 2),[62] six natural gas simple cycle combustion turbines (SCCTs) at the Woodsdale generating station comprising 476 MW summer peaking capacity,[63] and two solar photovoltaic (PV) stations. The solar capacity consists of a 4 MW fixed-tilt array at the Walton Solar Facility and a 2.7 MW fixed-tilt array at the Crittenden Solar facility.[64] Table 1 below lists each generation facility and various other information.

[62] In Case No, 2014-00201, Duke Kentucky was granted a Certificate of Public Convenience and Necessity (CPCN) to acquire the remaining 31 percent interest in East Bend 2. Case No. 2014-00201, *Application of Duke Energy Kentucky, In. for (1) A Certificate of Public Convenience and Necessity Authorizing the Acquisition of the Dayton Power & Light Company's 31% interest in the East Bend Generating Station; (2) Approval of Duke Energy Kentucky, Inc.'s Assumption of Certain Liabilities in Connection with the Acquisition; (Deferral of Costs Incurred as Part of the Acquisition; and (4) All other necessary Waivers, Approvals, and Relief* (Ky. PSC Dec. 4, 2014). Miami Fort Unit 6 was retired in mid-2015 and that capacity was replaced with the acquisition of the remaining 31 percent of East Bend 2.

[63] IRP at 17. The SCCTs have historically used propane as a back-up fuel. Duke Kentucky is in the process of constructing a new dual-fuel system consisting of low-sulfur diesel due to the decommissioning of a nearby propane storage cavern due to structural integrity issues caused by propane leaking into the soil. The Commission Granted the CPCN for this project is Case No. 2017-00186, *Electronic Application of Duke Energy Kentucky, Inc. for a Certificate of Public Convenience and Necessity for Construction of a Number 2 Distillate Fuel Oil System at the Company's Woodsdale Natural Gas-Fired Generation Station* (Ky. PSC Dec. 21, 2017).

[64] IRP at 17. Also, in Case No. 2017-00155, the Commission found that the Solar Facilities, as proposed and discussed in this case, were properly classified as an ordinary extension of existing systems in the usual course of business and a CPCN, pursuant to KRS 278.020(1), was not required for their construction. Case No. 2017-00155, *Electronic Application of Duke Energy Kentucky, Inc. for an Order Declaring the Construction of Solar Facilities is an Ordinary Extension of Existing Systems in the Usual Course of Business* (Ky. PSC Jul. 10, 2017).

TABLE 1
EXISTING GENERATION FACILITIES[65]

Station	Unit No.	Status	Location	Commercial Operation Year	Planned Retirement Date	Type	Primary Fuel	Secondary Fuel	Summer Rating (MW)	Winter Rating (MW)
East Bend	2	Existing	Boone County, KY	1981	Unknown	ST	Coal	None	600	600
Woodsdale	1	Existing	Trenton, OH	1993	Unknown	CT	Gas	Oil	78	94
Woodsdale	2	Existing	Trenton, OH	1992	Unknown	CT	Gas	Oil	80	94
Woodsdale	3	Existing	Trenton, OH	1992	Unknown	CT	Gas	Oil	80	94
Woodsdale	4	Existing	Trenton, OH	1992	Unknown	CT	Gas	Oil	78	94
Woodsdale	5	Existing	Trenton, OH	1992	Unknown	CT	Gas	Oil	80	94
Woodsdale	6	Existing	Trenton, OH	1992	Unknown	CT	Gas	Oil	80	94
Walton Solar		Existing	Kenton County, KY	Dec, 2017	Unknown	PV	Sunlight	None	1.4	0
Crittenden Solar		Existing	Grant County, KY	Dec, 2017	Unknown	PV	Sunlight	None	1.0	0

Duke Kentucky stated that its 2018 IRP is similar to the 2014 IRP in that it does not include retirement of East Bend 2 and Woodsdale stations during the term of its analysis.[66] However, increasing customer preference for renewable energy, potential additional industrial load, and pending matters regarding its DSM programs have led to minor changes from the 2014 plan. The impact of the changes is the addition of greater amounts of renewable resources, which result in a reduction of market purchases, which in turn lessens fuel cost variability and reduced emissions of CO associated with serving its customer load.[67]

As a member of PJM, Duke Kentucky must meet certain Capacity Performance (CP) requirements or, effective June 1, 2019, it will be subject to penalties for non-compliance with the CP requirements for generating resources. With the improvements to East Bend 2, which will be discussed in more detail later in this report, and the completion of the dual fuel operations at Woodsdale station, the Staff believes Duke Kentucky has lowered the risk associated with Duke Kentucky's CP requirements.

As of 2017, coal supplied approximately 87 percent of Duke Kentucky's energy needs, natural gas supplied about 0.3 percent and the remaining 13 percent was purchased from the PJM energy market.[68]

RELIABILITY CRITERIA

Duke Kentucky assembles a generation resource portfolio to reduce reliability risks. At the same time, the selection of resources that make up this portfolio must

[65] IRP, Appendix A, at 49 Table A.1. IRP, page 17, the solar summer rating (MW) represents the contribution to peak of solar photovoltaic capacity rather than installed capacity. IRP at 51, solar contribution is 35% of nameplate capacity in the summer and 0% in winter.

[66] IRP at 10.

[67] *Id.*

[68] *Id.* at 18 and Duke Kentucky's response to Staff's Second Request, Item 8.

consider the impact on rates. To safeguard portfolio reliability, Duke Kentucky also includes a rigorous maintenance schedule to ensure generation performance at above-average levels.[69]

Baseload coal units receive regularly scheduled major maintenance on a six- to ten-year interval. The Woodsdale peaking units, on the other hand, are utilized more during peak load demand and as such, are maintained on an as-needed support schedule.

Duke Kentucky addresses system reliability and resource adequacy in the planning process by targeting a planning reserve margin for use in its IRP models.[70] The IRP models utilize full installed capacity (ICAP) unit ratings to estimate dispatch, so the reserve margin is set on an ICAP basis.[71] PJM coordinates the movement of wholesale electricity, and operates a capacity and energy market and sets the planning reserve margin requirements for its member generating entities. Duke Kentucky's customers benefit from greater energy reliability due to the availability of numerous existing generating sources at any given time. Duke Kentucky's planning reserve margin for 2017 is 13.7 percent,[72] consistent with the reserve margin in its 2014 IRP. Table 2 denotes the summer projection of load, capacity, and reserves for Duke Kentucky at different years in the planning horizon.

TABLE 2[73]

	2017	2018	2019	2022	2027	2032
System Peak (MW)	841	848	853	868	902	939
Adjusted Peak (MW)[74]	807	848	853	868	902	939
Generating Capacity(MW)[75]	1,076	1,078	1,082	1,092	1,110	1,127
Generating Reserve (MW)	154	114	112	106	85	60
Percent Reserve Margin	32	27	27	26	23	20

[69] 2014 Staff Report at 19.

[70] IRP at 20.

[71] *Id.*

[72] *Id.*

[73] *Id.* at 51.

[74] This is the system peak less demand response resources.

[75] This is the sum of the existing generation at the time of filing of the IRP (1,076 MW) and planned utility-owned resource additions.

SUPPLY-SIDE EVALUATION

In addition to utilizing load and price forecasts, Duke Kentucky forecasts capital costs of the various generation technologies being considered as potential generation resource options. Capital cost projections are based on data from the U.S. Energy Information Administration's 2017 Annual Energy Outlook (AEO). For solar and battery storage technical options, third party cost projections are blended with the AEO projections for greater precision.[76] In addition, Duke Kentucky relied upon information from its Project Management and Construction Department, Emerging Technologies Department, and Generation and Regulatory Strategy Department, as well as the Electric Power Research Institute's Technical Assessment Guide, and Burns & McDonnell and Navigant engineering studies.[77]

Initially, Duke Kentucky considers a wide variety of resource options in developing its optimal resource plan, including repowering or maintaining its existing units, market or bilateral purchases, conservation and demand response, and new construction technologies from nuclear to renewables. There are three assessment screens that resource/technologies must pass to be considered as potential long-term resource options. The first two screens are technical and commercial viability screens. Duke Kentucky eliminated technologies such as small modular nuclear reactors, liquid air energy storage, fuel cells, and solar steam augmentation from consideration on technical grounds. Technologies including geothermal, landfill gas, offshore wind, and pumped storage hydro were eliminated as either being not feasible or not available in Duke Kentucky's service territory. Technologies and resource supply options that are both technically and commercially viable and available are then screened for economic viability. Duke Kentucky's economic optimization process evaluated multiple fuel and electric generation technologies, including pulverized coal, natural gas SCCTs and combined cycle CTs, reciprocating engines, nuclear, solar, onshore wind, and battery storage.[78]

MODELS

Duke Kentucky utilizes a variety of models to develop its supply-side resource options. System Optimizer is a linear programming optimization model used to evaluate cost-effectiveness and reliability of resource investments by varying loads from DSM programs or adding supply-side resources based upon present value revenue requirement calculations. Planning and Risk is a detailed production cost model simulating the optimal operation of Duke Kentucky's generation facilities. Data inputs include generation unit data, fuel, load, DSM, emission and allowance cost data, transaction data, and operating data. PROMOD is a generation portfolio model that

[76] IRP at 24.

[77] See Duke Kentucky's response to Staff's Second Request, Item 11.f., dated March 27, 2019 and to Attorney General's Second Information Request, Item 4, dated March 28, 2019.

[78] IRP at 25.

simulates the electric market and provides a least-cost, supply-side resource portfolio based upon locational marginal price forecasts and transmission constraint analyses.[79]

In addition to the Load forecast, discussed previously, various price forecasts are considered in the economic screening process in order to obtain an optimal least-cost generation resource portfolio. The BAU forecast is for continued low natural gas prices and then gradually increasing prices after the early 2020s. This forecasted increase in natural gas is being driven in part by demand growth from continued coal unit retirements and LNG exports. As oil markets strengthen, the associated supply of natural gas is also expected to rise to partially offset price increases. Coal prices are expected to remain weak as utility demand continues to fall over the forecast horizon. Duke Kentucky's High and Low fuel price forecasts are based upon forecasts from the 2018 AEO report and applied to its BAU reference case.[80]

For Duke Kentucky to produce an optimal least-cost, supply-side resource portfolio generation expansion plans for the entire Eastern Interconnect were modeled to obtain simulated PJM hourly energy prices. Two scenarios were modeled, one with future carbon regulation and one without any future carbon regulation. In the carbon-constrained scenario, carbon prices were assumed to begin at $5 per ton beginning in 2025, and an annual increase of $3 per ton was assumed for sensitivity analyses.[81] All else equal, the Eastern Interconnect expansion plan exhibits strong solar PV and wind growth over the forecast horizon. The resulting energy prices remain relatively flat through the mid-2020s and then nearly double by the end of the forecast horizon.[82]

In the no carbon regulation scenario, new capacity additions are more balanced between solar and wind renewables and natural gas CC and CT technologies. Power price growth is relatively flat in this scenario through the mid-2020s and then climbing more moderately through the early 2030s.[83]

There were multiple technologies that passed the technical and commercial availability screens and included in Duke Kentucky's economic viability screen. The resource options considered included a 2,234 MW nuclear station (90% capacity factor), 850 MW Ultra-supercritical pulverized coal (70% capacity factor), 620 MW integrated coal gasification CC (70% capacity factor), 706 MW CC (70% capacity factor), 215 MW CT (10% capacity factor), 17 MW reciprocating engine (10% capacity factor), 150 MW wind (35% capacity factor), 5 MW nameplate solar PV (25% capacity factor), and 5 MW nameplate 4-hour lithium battery storage (15% capacity factor). Of the possible

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[79] *Id.* at 25–26.

[80] *Id.* at 29–30.

[81] *Id.* at 32.

[82] *Id.* at 31.

[83] *Id.* at 31–32.

technology options, natural gas technologies had the least expensive estimated capital costs, and the nuclear option had the highest.[84]

COGENERATION, NET METERING, AND DISTRIBUTED GENERATION

As was discussed in the Staff Report on the 2014 IRP, Duke Kentucky has two cogeneration tariffs on file with the Commission that allow qualifying facilities to sell excess power back on the grid at published rates. Duke Kentucky is willing to work with and supply customers interested in cogeneration with a copy of the tariff, yet it currently has no customers who have indicated an interest. Duke Kentucky states that it will continue to promote cogeneration and evaluate Duke Kentucky owned cogeneration co-located at customers sights as opportunities arise.[85]

From the information listed in the filing of the 2014 IRP and the 2018 IRP, Duke Kentucky's net metering customers increased from 29 to 72 with a cumulative connected capacity of 0.06 MW 1.24 MW, respectively, with all of the capacity supplied by PV generation.[86] Most of the customers are residential; however, the largest system is 0.39 MW, which is located at a school.[87]

RENEWABLES

As was discussed in the supply-side evaluation, Duke Kentucky is incorporating renewables in its portfolio by adding 10 MW of solar PV and 2 MW of battery storage each year over the planning horizon of this IRP. Other renewable options were considered but were eliminated as being unfeasible or not cost-effective.

ENVIRONMENTAL COMPLIANCE PLANNING

Duke Kentucky is required to remain in compliance with numerous state and federal regulations. The Company consistently monitors current programs and regulatory requirements as well as new regulations that are in various stages of implementation and development that will impact it over time.[88]

Duke Kentucky stated that it had taken all necessary, prudent, and economic actions to attain full compliance with respect to existing fully implemented air emission regulations.[89] This has been accomplished over the years through various means

[84] *Id.* at 33, Table 4.1.

[85] *Id.* at 95.

[86] *Id.* at 96.

[87] *Id.*

[88] *Id.* at 78

[89] *Id.*

including completing a performance upgrade on the East Bend 2 original flue gas desulfurization to reduce SO_2 emissions for compliance with the evolution of Acid Rain, Clean Air Interstate Rule (CAIR), Cross State Air Pollution Rule (CSAPR) and sulfur dioxide National Ambient Air Quality Standards (NAAQS) requirements.[90] The Company also retrofitted East Bend 2 with selective catalytic reduction for control of nitrogen oxide emissions for compliance with the CAIR, CSAPR, and Ozone NAAQS requirements.[91] These actions, combined with the existing electrostatic precipitator (ESP) for particulate control matter, produce co-results for reduction of acid gases and mercury for compliance with the Mercury and Air Toxics Standards Rule.[92]

Duke Kentucky stated that potential ongoing reductions of the Ozone NAAQS, coupled with the eventual loss of the Miami Fort 6 emission allowances five years after retirement, may lead to additional reductions in NO_x emission allocations, potentially necessitating the need for an SCR performance upgrade.[93] The Company included a placeholder for such project cost in the IRP analysis for East Bend 2 in the early-2020s timeframe as well as the costs for ongoing routine SCR catalyst replacement.

Duke Kentucky stated that East Bend 2 is well-positioned to continue with full compliance with waste and water environmental regulations.[94] The Company maintains the East Bend 2 has minimal exposure to cooling water discharge and intake related regulations (Clean Water Act 316(a) thermal and 316(b) aquatic impingement and entrainment) requirements since it uses a closed-loop cooling tower system.[95] The Company will complete the requisite aquatic studies and reports through about 2020 but anticipates no significant findings.

With respect to the Steam Electric Effluent Limitation Guidelines (ELG) for wastewater discharge, in compliance with the Coal Combustion Residuals (CCR) Rule, East Bend 2 has recently completed the installation of a dry bottom ash management system (flyash was already dry collected for utilization in the FGD product waste fixation system),_along with other on-site water management equipment to enable cessation of all waste and water flows to the existing dry bottom ash pond.[96] The Company also has

[90] *Id.*

[91] *Id.*

[92] *Id.* The ESP underwent a complete refurbishment during the Spring 2018 planned maintenance outage.

[93] *Id.*

[94] *Id.* at 79.

[95] *Id.*

[96] *Id.* This project was approved in Case No. 2016-00268, *Electronic Application of Duke Energy Kentucky, Inc. for a Certificate of Convenience and Public Necessity for Dry Bottom Ash Conversion of the East Bend Generating Station* (Ky. PSC Feb. 23, 2017).

recently developed a new lined on-site landfill footprint at East Bend that is designed to accept and safely manage the CCR from East Bend 2, including the bottom ash, and flyash-fixated FGD product (calcium sulfite) for years to come.[97] In Case No. 2016-00398,[98] the Commission approved a CPCN for the construction of a new water redirection and wastewater treatment processes and to close and repurpose its existing coal ash impoundments and East Bend 2. Finally, Duke Kentucky's view of future potential wastewater requirements point to an ongoing evolution of the ELG for additional discharge limitations (such as bromides), may ultimately necessitate additional waste processing changes and/or equipment installations.[99] Duke Kentucky included a placeholder for the project cost in the IRP analysis for East Bend 2 in the early-2030s timeframe.

Overall, Duke Kentucky avers that its generation fleet is well-positioned for compliance with all current and anticipated environmental regulations.[100] It should be noted that the United States Supreme Court stayed the implementation of the CPP on February 9, 2016. Currently, there is a proposal to replace the CPP with the Affordable Clean Energy Rule, which, if enacted, could change the requirements related to environmental compliance for fossil fuel generation as well as the most cost-effective means for future capacity.

EFFICIENCY IMPROVEMENTS – GENERATION

To determine the most prudent capital spend, Duke Kentucky evaluates its generation facilities for cost-effective improvements, which affect both efficiency and reliability during its capital project development and approval process. Since the filing of the 2014 IRP, several projects have been installed or are planned for installation in the near future to improve unit efficiency. In 2016, a temporary test lime injection system was installed at East Bend 2 that provided an approximately one percent improvement in heat rate.[101] A permanent system is planned for installation in 2019, and Duke Kentucky expects increased efficiency improvements after that installation.[102] Also, several improvements were made to the circulating water/condenser system, including one loop

[97] *Id.* This project was approved in Case No. 2015-00089, *Application of Duke Energy Kentucky, Inc. for a Declaratory Order that the Construction of a New Landfill Constitutes an Ordinary Extension in the Usual Course of Business or, in the Alternative, for a Certificate of Public Convenience and Necessity* (Ky. PSC July 24, 2015).

[98] Case No. 2016-00398, *Electronic Application of Duke Energy Kentucky, Inc. for a Certificate of Public Convenience and Necessity Authorizing the Company to Close the East Bend Generation Station Coal Ash Impoundment and for all Other Required Approvals and Relief* (Ky. PSC June 6, 2017).

[99] IRP at 79.

[100] *Id.* at 12.

[101] *Id.* at 96

[102] *Id.*

of the condenser, was retubed, cooling tower headers were replaced, and the coating in the Circulating Water piping was replaced.[103] Duke Kentucky anticipates that these improvements should improve the heat rate by approximately 1.0–1.5 percent.[104] Finally, improvements to the Secondary Air Heater have been made with replacement seals as well as adjustments to sealing surfaces to reduce bypassing the heat exchanger.[105]

TRANSMISSION

Duke Kentucky owns a 69-kV electric transmission and distribution system in Kenton, Campbell, Boone, Grant, and Pendleton counties. Duke Kentucky, Duke, and Duke Energy Indiana, Inc., in the Midwest are interconnected with East Kentucky Power Cooperative, Kentucky Utilities, Louisville Gas and Electric Company, American Electric Power, Dayton Power and Light, Ohio Valley Electric, Hoosier Energy, Ameren, Indianapolis Power and Light, Southern Indiana Gas and Electric, Northern Indiana Public Service, and the Tennessee Valley Authority.[106] Duke Kentucky's transmission system utilizes its transmission substations to transmit 69-kV electric power from its generation and feeder sources to the substations placed across its 300 square miles of service territory. The distribution substations are located such that the voltage is reduced to energize an appropriate number of circuits at each substation in order to serve that area's portion of Duke Kentucky's total retail customers.

Duke Kentucky transferred its transmission assets from MISO to PJM for dispatching and will continue to operate within PJM, consistent with its operation prior to the transfer on January 1, 2012. No additional utility interconnections or transmission projects were identified in the IRP.

Current transmission facilities are designed to provide adequate capacity and supply the reliable transport of current generating resources. Typically, any changes to Duke Kentucky's transmission system are based on planning criteria intended to provide reliable performance to the system in the most cost-effective manner.

Transmission costs associated with bringing any new resource online varies considerably by project and location, making it difficult to forecast. For IRP purposes, Duke Kentucky included $10 million in the cost of new projects connected at 345 kV to account for new transmission infrastructure.[107] In addition, a cost of $100/kW (2018$)

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[103] *Id.*

[104] *Id.* at 96–97.

[105] *Id.* at 97.

[106] Case No. 2014-00273, *2014 Integrated Resource Plan of Duke Energy Kentucky, Inc.* (filed July 31, 2014) at 29.

[107] Duke Kentucky's response to the Attorney General's First Request for Information, Item 3.c.

was added to the cost of new solar facilities and $60/kW to the cost of new battery storage systems to account for interconnection costs.

In Case No. 2017-00410,[108] the Commission approved the pre-approval of the sale or purchase of utility-owned transformers with original book values in excess of $1 million and ancillary equipment pursuant to the Agreement for Regional Equipment Sharing for Transmission Outage Restoration (RESTORE Agreement). The Commission found that granting pre-approval of these transactions related to the RESTORE Agreement will permit the applicants to participate in and benefit from a program designed to ensure that utilities in the applicants' region have access to spare infrastructure necessary to restore the transmission grid in a timely manner following the disruption caused by a catastrophic event.

DISTRIBUTION

As with changes to the transmission system, distribution projects are based on the need for an increase in the number of customers to be served and to provide more reliable, cost-effective performance and resilience in the system.

Overall, Staff is satisfied with Duke Kentucky's description of its current supply-side resources and its modeling of its future resource needs, given different environmental assumptions, and used state of the art modeling techniques. Its environmental analysis reflected the uncertainty surrounding pending federal regulations, and its sensitivity analysis encompassed both economic and environmental shocks to test the reasonableness of its modeling conclusions. However, Staff is concerned that, while the modeling and analytical techniques are robust, the level of detail in the discussion, especially in the areas of transmission and distribution systems, was not up to the level exhibited in previous IRPs.

INTERVENOR COMMENTS

There were no intervenor comments in this case regarding supply-side resources and environmental compliance.

RESPONSES TO 2014 RECOMMENDATIONS

Commission Staff made several recommendations concerning Duke Kentucky's Supply Side Resources and Environmental Compliance programs. In its report on the prior IRP, Staff recommended that Duke Kentucky discuss and provide information on several issues. The information and a discussion of those issues were incorporated into this IRP, and most of the items have been referenced and summarized in other portions of this section. Following are the recommendations from the 2014 IRP:

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[108] Case No. 2017-00410, *Electronic Joint Application of Duke Energy Kentucky, Inc., East Kentucky Power Cooperative, Inc., Kentucky Utilities Company, and Louisville Gas and Electric for Approval of Transactions Related to the RESTORE Agreement*, (Ky. PSC Feb. 22, 2018).

- Duke Kentucky should continue to provide a discussion of its efforts to promote cogeneration and its consideration of various forms of renewable and distributed generation.
- Duke Kentucky should continue to provide information related to customers' net metering statistics and activities.
- Duke Kentucky should continue to provide discussion of options considered in the IRP, especially improvements to and more efficient utilization of existing facilities.
- Compliance issues, actions, and plans relating to current and pending environmental regulations should be included in the next IRP, as these are of utmost importance in deciding future utility actions.
- Duke Kentucky should provide an update on the Miami Fort 6 retirement, its facilities' status, any razing and/or property restoration involved in its shuttering situation, and any issues affecting environmental compliance. Concerning recent reports on Duke Energy's coal ash ponds in North Carolina, and the fact that substantial fines have been paid for spills, etc., Duke Kentucky should provide a discussion of the status, inspections and any other pertinent information about the condition of similar ponds at the East Bend Station, unless a circumstance of a critical nature requires expedited notification to the Commission prior to its next IRP filing.

Duke Kentucky addressed these recommendations in its direct responses to the recommendations and, in part, in the Supply Side Resources and Environmental Compliance sections of the IRP. Staff is generally satisfied with Duke Kentucky's responses to these recommendations. However, Staff is of the opinion that the discussion of many of the 2014 recommendations is not as robust as it could be.

RECOMMENDATIONS FOR DUKE KENTUCKY'S NEXT IRP

- Duke Kentucky should continue to provide a discussion of its efforts to promote cogeneration and its consideration of various forms of renewable and distributed generation.
- Duke Kentucky should provide a discussion on its compliance with PJM CP requirements and identify any non-compliance situations and the reasons for the non-compliance.
- Duke Kentucky should provide a detailed discussion of any environmental law changes and their impacts as well as an update to its compliance with existing laws and regulations.
- Duke should have a preliminary discussion on its future plans for supply-side resources as the East Bend and Woodsdale Stations are approaching the end of their service lives at the end of the planning period in the current IRP.
- Staff expects a more robust discussion on transmission and distribution as Duke Kentucky had in its previous IRPs.
- Duke Kentucky should include a discussion on other non-utility supply sources, as there was no discussion of this topic in the current IRP.

- Duke Kentucky should provide how the utility will meet the sustainability goals of commercial and industrial customers.
- Duke Kentucky should provide how the utility is modeling for impacts that occur behind the meter, specifically with renewable energy sources.

SECTION 5

INTEGRATION AND PLAN OPTIMIZATION

The final step in the IRP process is to integrate the supply-side and demand-side options to achieve the optimal resource plan. This section will discuss the integration process and the resulting Duke Kentucky plan.

THE INTEGRATION PROCESS

Duke Kentucky's 2018 IRP is the result of an analysis that began with BAU conditions and incorporated evaluations of the probability and impact of several factors that could drive changes to the portfolio.[109] Duke Kentucky utilized the models and sensitivity analyses discussed in Section 4 of this Report to determine its preferred portfolio for BAU conditions, as well as the changes that could occur in response to a variety of alternative assumptions. The preferred portfolio for the IRP includes the addition of renewable resources over time and continued operations of East Bend 2 and Woodsdale station.[110]

Duke Kentucky made its selections based upon its expectations for near-term market stability and the promulgation over time of increasingly restrictive carbon regulations.[111] In addition, the Company maintains that the market trend toward renewable generation and storage would be prudent for its system. Duke Kentucky states that the utility stays abreast of the issues and challenges associated with the growing presence of intermittent resources on its system and so that the utility can be better prepared for larger investments in renewables as costs continue to decline and the likelihood of CO_2 regulation increases.[112]

Duke Kentucky's preferred portfolio plan does not commit to a large future capital spending budget, which Duke Kentucky believes will allow for quick response to changes in both the market and regulatory environments. Duke Kentucky avers the inclusion of additional renewable energy resources in the plan will help diversify the portfolio to mitigate downside risk from any future regulation imposing a price on carbon emissions and help to lessen the impact to customers if East Bend 2 is forced to retire.[113]

Also, Duke Kentucky's preferred portfolio is well–positioned for future fuel prices that are above or below the Company's expectations. East Bend 2 provides a strong

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[109] IRP at 45.

[110] *Id.*

[111] *Id.*

[112] *Id.*

[113] *Id.* at 46.

hedge against higher gas prices, and access to the PJM market will allow customers to take advantage of low-cost energy resulting from lower gas prices.[114]

SYSTEM OPTIMIZER AND PORTFOLIO ANALYSIS

Under the BAU reference case, Duke Kentucky assumed no carbon regulation and its DSM programs remain suspended. The fuel price and load growth remain moderate. With these assumptions, Duke Kentucky's existing generation portfolio remains unchanged over the planning horizon. East Bend 2 remains cost-competitive, and Woodsdale provides needed capacity and energy when economically competitive. The present value revenue requirement (PVRR) for the business-as-usual (BAU) scenario is $1,493 million. Duke Kentucky's heavy reliance on coal generation could be at risk if, in the future, carbon were to be regulated or if natural gas prices were to drive down power prices. Either development could make East Bend 2 less competitive in the market.

Duke Kentucky modeled various scenarios by varying the assumptions behind its BAU reference case. Two scenarios anticipate carbon regulation. When a carbon tax is imposed on the BAU case, there would be a decrease in output from Duke Kentucky's coal unit and increased market purchases. It would lead to an earlier retirement of East Bend 2 with the capacity to be replaced by natural gas combined cycle (NGCC) generation. With a carbon tax, the PVRR increases by approximately $254 million to $1,747 million over the BAU case.[115] Alternatively, adding 10 MW of solar PV and 2 MW of battery storage capacity annually to the Duke Kentucky system would not affect the overall makeup of Duke Kentucky's generation fleet. At the margin, it would reduce the carbon output by an average of 1,000 tons per year over the planning horizon and increase the BAU PVRR to $1,557 million.[116]

Duke Kentucky evaluated scenarios with variances in load growth. Duke Kentucky purchases about 13 percent of its energy from the market currently. One scenario models accelerated load growth over the BAU case. Higher load growth leads to increased market purchases. The eventual need for additional capacity results in the construction of NGCC. The PVRR increases to $1,530 million from the BAU case.[117] Lower load growth results in lower market power purchases and lowering the PVRR about $34 million from the BAU case to $1,459 million. There would be no changes in Duke Kentucky's generation fleet output from the BAU levels.[118] Holding the underlying load growth assumptions unchanged, but reinstating Duke Kentucky's DR and EE programs result in lower load growth as compared to the BAU reference case. Even though market energy

114 *Id.*

115 *Id.* at 36.

116 *Id.* at 37.

117 *Id.* at 39.

118 *Id.* at 40.

purchases decline, increased DSM spending results in PVRR increasing to $1,522 million.[119]

Duke Kentucky evaluated scenarios with alternating fuel prices. Duke Kentucky assumed greater uncertainty associated with natural gas prices than coal prices. Higher than expected gas prices results in an incremental shift toward coal generation. Market purchases decrease as East Bend 2 is economically dispatched more often. Carbon emissions increase and the overall PVRR increases to $1,530 million.[120] Natural gas prices remaining low relative to coal prices results in a decrease in coal generation and an increase in market energy purchases. The PVRR decreases to $88 million, and carbon emissions decrease an average of 1.3 million tons annually.[121]

INTERVENOR COMMENTS

There were no intervenor comments in this case regarding supply-side resources and environmental compliance.

RESPONSE TO STAFF'S 2014 RECOMMENDATION

Staff had one recommendation in the Staff Report for the Integration and Optimization section of the 2014 IRP:

- Unless otherwise addressed before filing its next IRP, Duke Kentucky should report on the effectiveness of its recently approved back-up power supply plan and discuss whether it intends for its future plans to include insurance products or other means to address its concentration of supply.

Duke Kentucky has operated with back-up power supply plans (Plan) for a number of years. The Plan is necessary to provide electric service in the event that Duke Kentucky experiences outages with its generating facilities. Duke Kentucky's most recent back-up power supply plan (Plan) was approved in Case No. 2017-0017 with a commencement date of June 1, 2017, and a termination date of May 31, 2020.[122] Duke Kentucky asserts that, based on realized forced outage cost and planned outage hedging results, the Plan has been effective.[123] Between June 1, 2017, and June 1, 2018, Duke Kentucky incurred $2,162,641 in purchased power costs during forced outages and derates in excess of East

[119] *Id.* at 41.

[120] *Id.* at 42–43.

[121] *Id.* at 44.

[122] *Id.* at 98; Case No. 2017-00117, *Back-Up Power Supply Plan of Duke Energy Kentucky, Inc.* (Ky. PSC May 31, 2017).

[123] IRP at 98.

Bend units generation cost.[124] This amount is lower than the $4,270,090 average annual forced outage cost between 2007 through 2017.[125] Duke Kentucky incurred $90 to $100 million in cost at East Bend 2, which has been in an extended planned outage for a major overhaul of the unit, which should result in improved performance.[126] Financial hedges were purchased in advance to mitigate price volatility during the period of the planned outage resulting in a profit of $3.1 million. Finally, forced outage insurance products were analyzed, but considering the outage data at East Bend 2 and how it affects the pricing of insurance products, it was not deemed feasible at this time.[127]

DISCUSSION OF REASONABLENESS

Staff is generally satisfied with Duke Kentucky's integration process as well as its risk analysis and plan optimization. The BAU plan, including the addition of renewables and the environmental compliance steps to be taken over by the planning horizon, contains a revenue requirement that is significantly less than the other modeled plans. In addition, the BAU plan reduces the risk of revenue requirement volatility over the planning period.

Staff commends Duke Kentucky for the steps it has taken in order to comply with PJM's CP requirements. The East Bend overhaul and the completion of the new dual fuel capability at Woodsdale should prepare it for compliance with the CP requirements over the planning period.

All recommendations for Duke Kentucky's next IRP filing, the timing of which will be determined by the Commission, are contained in Sections 2, 3, and 4 of this report.

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[124] *Id.*

[125] *Id.*

[126] *Id.* at 98–99.

[127] *Id.* at 99.

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