DUKE ENERGY OHIO EXHIBIT_____

BEFORE

THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Duke Energy Ohio, Inc., for an Increase in Natural Gas Rates.	)))	Case No. 22-507-GA-AIR
In the Matter of the Application of Duke Energy Ohio, Inc., for Approval of an Alternative Form of Regulation.	)))	Case No. 22-508-GA-ALT
In the Matter of the Application of Duke Energy Ohio, Inc., for Tariff Approval.	)))	Case No. 22-509-GA-ATA
In the Matter of the Application of Duke Energy Ohio, Inc., for Approval to Change Accounting Methods.	)))	Case No. 22-510-GA-AAM

DIRECT TESTIMONY OF

BENJAMIN W.B. PASSTY, PH.D.

ON BEHALF OF

DUKE ENERGY OHIO, INC.

_________ Management policies, practices, and organization

_________ Operating income

_________ Rate Base

_________ Allocations

_________ Rate of return

_________ Rates and tariffs

____X____ Other: Load Forecasting

July 14, 2022

TABLE OF CONTENTS

PAGE

ATTACHMENTS:

I. INTRODUCTION AND PURPOSE

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Benjamin W.B. Passty. My business address is 526 South Church Street, Charlotte, North Carolina 28202.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Duke Energy Business Services LLC (DEBS) as a Principal Load Forecasting Analyst in the Load Forecasting group. DEBS provides various administrative and other services to Duke Energy Ohio, Inc. (Duke Energy Ohio or Company) and other affiliated companies of Duke Energy Corporation (Duke Energy).

Q. PLEASE BRIEFLY SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I received a Bachelor of Arts degree in Economics and a Bachelor of Science degree in Mathematics from Trinity University in 2002, a Master of Arts degree in Economics from Northwestern University in 2003, and a Doctor of Philosophy degree in Economics from Northwestern University in 2008.

I joined Duke Energy in July 2013 as a Lead Forecaster in the Load Forecasting Department. I was then employed as Lead Load Forecasting Analyst from 2013 to 2022. I am currently Principal Load Forecasting Analyst.

Q. ARE YOU A MEMBER OF ANY PROFESSIONAL ORGANIZATIONS?

A. I am a dues-paying member of the Charlotte Economics Club, a local chapter of the National Association for Business Economists.

Q. PLEASE BRIEFLY DESCRIBE YOUR DUTIES AND RESPONSIBILITIES AS PRINCIPAL LOAD FORECASTING ANALYST IN THE LOAD FORECASTING GROUP.

A. My primary responsibility is to develop Duke Energy's long-term electric and natural gas forecasts for portions of its Midwest service area—currently Ohio, Kentucky, and Indiana. These forecasts and analyses are provided to departments throughout Duke Energy and are used for budgeting, generation planning, and regulatory filings, such as long-term forecast reports, integrated resource plans, and rate cases. In addition to my primary duties, I regularly support special projects requiring statistical analysis and forecasting, including assessments of current economic conditions.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO?

A. Yes. I recently provided testimony in support of Duke Energy Ohio's Application for an increase in electric distribution rates, tariff approval, and change in accounting methods in Case Nos. 21-0887-EL-AIR, *et al.*

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THESE PROCEEDINGS?

A. My testimony presents and explains Duke Energy Ohio's long-term natural gas volume forecast prepared and utilized in this rate case filing. My testimony explains the Company's process of weather normalizing Duke Energy Ohio's test period natural gas sales. In addition, my testimony discusses the "normal" weather data used to weather normalize the three-months actual natural gas sales for the test period. This same normal weather is also used to produce the nine-month forecast portion of the test period. I also sponsor Supplemental Filing Requirement (D)(13).

II. LOAD FORECAST

Q. DID YOU PREPARE THE COMPANY'S NATURAL GAS VOLUME FORECAST FOR THESE PROCEEDINGS?

A. Yes, I did.

Q. HOW IS DUKE ENERGY OHIO'S NATURAL GAS VOLUME FORECAST DEVELOPED?

A. Generally speaking, the natural gas volume forecast is developed in three steps: first, a service area economic forecast is obtained; second, a customer forecast is obtained; and third, a volume forecast is prepared.

The forecast methodology is essentially the same as that used to calculate projections for past forecasts prepared by Duke Energy Ohio, with a major difference being that the models have been updated to include more recent data.

Q. PLEASE DESCRIBE HOW THE SERVICE AREA ECONOMIC FORECAST IS OBTAINED.

The economic forecast for the greater Cincinnati region (which includes areas of northern Kentucky and southeastern Indiana) is obtained from the nationally recognized economic forecasting firm Moody's Analytics' (Moody's) portal *ECONOMY.COM*. Based upon its forecast of the national economy, Moody's prepares a forecast of key economic measures specific to the greater Cincinnati area, including the portion served by Duke Energy Ohio. This forecast provides detailed projections of employment, income, wages, industrial production, inflation, prices, and population for that region. This information serves as an input into the volume forecast models.

Duke Energy Ohio sells natural gas to customers located in several counties in southwest Ohio, including the City of Cincinnati.[1] this area is contained within the Cincinnati Primary Metropolitan Statistical Area (PMSA) and is an integral part of the regional economy.

Q. HOW IS THE CUSTOMER FORECAST OBTAINED?

A. A high-level customer growth forecast is delivered to me by Duke Energy's Natural Gas Residential and Commercial Sales group. I calculate growth rates from this forecast, applying them to historical data to produce forecasts for a more detailed set of customer classes. This includes dividing between "full service" customers and "firm transportation" customers. Shares for this division are computed such that recent historical shares and growth rates can be extended into the forecast period.

Q. HOW IS THE NATURAL GAS VOLUME FORECAST DEVELOPED?

A. The natural gas volume forecast projects the natural gas load required to serve Duke Energy Ohio's retail customer classes—residential, commercial, industrial, government, and other public authority (OPA). The projected natural gas requirements for Duke Energy Ohio's retail customers are determined through econometric analysis. Econometric models are a means of explaining economic

[1] Duke Energy Ohio provides natural gas service to customers in all or portions of Adams, Brown, Butler, Clermont, Clinton, Hamilton, Highland, Montgomery, and Warren Counties.

behavior through the use of statistical methods such as regression analysis, which attributes historically measured changes in sales to variation in a series of predictive variables.

Q. WHAT ARE THE PRIMARY FACTORS AFFECTING NATURAL GAS USAGE?

A. Weather is a primary driver affecting natural gas usage. All models include weather as measured via a base-59 heating degree day total. This and other economic activity measures are discussed in further detail below.

For the residential sector, the number of residential customers, the average economic output per household, and real natural gas prices paid by the customer predict usage. For the commercial sector, the key predictors include non-manufacturing employment and real prices. The governmental sector model includes real government GDP, as well as real prices. In the industrial sector—as well as a certain group of interruptible customers—the key factors include a weighted average of manufacturing employment and real manufacturing GDP. A group of large industrial customers who are classified as "non-interruptible" customers are modeled using seasonal indicator variables and a base-45 heating degree day measure, which shows greater predictive power. Shifters are applied to mitigate the impact of, or account for, large, idiosyncratic events that might impact sales beyond what these drivers might explain, such as the COVID-motivated shutdowns.

Generally, natural gas use increases with higher economic activity. As natural gas prices increase, energy usage tends to decrease due to customers' conservation activities, although the relationship is not statistically significant for models of all classes of customers. Sometimes, requirements for scenario analysis mean price variables must be included in these models despite meeting less rigorous standards for statistical significance.

Q. ARE THESE FACTORS RECOGNIZED IN THE EQUATIONS USED TO PROJECT THE NATURAL GAS USAGE OF THE COMPANY'S RETAIL CUSTOMERS?

A. Yes, they are. By exposing the forecasting models to these variables, we can project future gas consumption conditional on forecasts of economic and weather conditions.

Q. HOW IS THE FORECAST OF NATURAL GAS REQUIREMENTS FOR THE COMPANY'S RETAIL CUSTOMERS PREPARED?

A. While many economic and weather variables are relevant to the entire greater Cincinnati area, the Duke Energy Ohio sales forecast is developed by maintaining specific forecasting models for sales only to Duke Energy Ohio customers in the residential, commercial, industrial, government, or OPA sectors. If they are needed, projected sales can be allocated between firm transportation and full service customers based on proportions computed for recent years. Forecasts are also prepared for several minor categories, including street lighting.

Q. ARE THERE ANY ADJUSTMENTS MADE TO THE ALLOCATED FORECASTS DERIVED FROM THE ECONOMETRIC MODELS?

A. The Company sometimes adjusts the forecast for anticipated increases in load due to a major new customer or a significant expansion at a current customer's site. The 2022 Test Year Load Forecast did not include any such adjustments.

Q. IS DUKE ENERGY OHIO'S CURRENT LOAD FORECASTING METHODOLOGY SIMILAR TO THAT EMPLOYED AT THE TIME OF THE COMPANY'S LAST NATURAL GAS BASE RATE CASE?

A. Yes, the econometric forecasting methodology used to create the Load Forecast is basically the same as that used by the Company in prior cases. An important change made during the last few years is the implementation of a rolling thirty-year weather normalization period, which I will discuss below. Interactions with industry contacts as well as continued review of the ITRON annual survey of load forecasters give me confidence that our practices are within normal bounds for the industry.

Q. HOW DOES MANAGEMENT JUDGMENT FIT INTO THE LOAD FORECASTS?

A. Under any approach to load forecasting, judgment is an essential element. Each utility must use the approach that, in its judgment, best suits its particular situation, taking into account the various factors. Examples of this would be advice from the sales team about conditions on the ground that are related to regional growth, or advice from the managers of energy efficiency and demand side management programs that provide incentives for customers to reduce usage.

Q. PLEASE DESCRIBE ATTACHMENT BWP-1.

A. Attachment BWP-1 is a summary of Duke Energy Ohio's natural gas sales forecast and five-year growth rates forecast. The projected annualized rate of growth in total retail sales for the five-year period 2022 to 2027 is 0.1% per year.

Gas usage during 2020-2021 rotated out of non-residential accounts and into residential accounts as many people transitioned to working from home because of pandemic concerns. While the current moment is one of dramatic economic growth as the regional economy rebounds from the public health challenges of the last few years, the model is exposed to historical data throughout the economic cycle.

III. DEGREE DAY DATA USED IN THE FORECAST

Q. HOW IS WEATHER MEASURED FOR PURPOSES OF THE FORECAST?

A. Weather is expressed in terms of Heating Degree Days (HDD) and Cooling Degree Days (CDD). For calculations relating to gas volumes, the heating degree days matter most, so my testimony will focus on HDDs.

Q. WHAT ARE HDDs?

A. An HDD is calculated using a base temperature measured on the Fahrenheit scale and accumulates when the daily average temperature is below the base. HDD measures the difference of the daily average temperature and the base temperature. The formula is:

Heating Degree Days = Base Temperature – Daily Average Temperature

If the Daily average temperature exceeds the base temperature, *zero* is used. Duke Energy Ohio typically applies a higher base to Cooling than to Heating such that our measure for most days would only produce one type of degree day.

Q. PLEASE EXPLAIN "NORMAL" WEATHER.

A. The sales forecast projects Duke Energy Ohio's volume sales for the test period. In order to project this, one must make a judgment about the weather conditions expected to occur during the test period. This is known as "normal" weather. The forecast is based on such expected weather conditions, which are forecast from historical weather data. Because this forecast is forward-looking and intended to predict what is likely to happen in the future, an assumption must be made as to what impact weather is likely to have on future volume sales. There is no "actual" weather available for a future period; so, a projection must be used. A reasonable, accepted, and industry standard methodology to factor the impact of weather is to use an average of prior actual weather conditions to predict what future weather patterns are likely to be experienced.

Normal weather is also used in our backward-looking accounting processes, as it provides a basis for calculating the extent to which volumes were affected by weather that occurred to an extent that differed from the normal weather that had been projected *ex ante*.

Q. PLEASE DESCRIBE HOW DUKE ENERGY OHIO CALCULATED NORMAL WEATHER.

A. Duke Energy Ohio uses a rolling thirty-year period to calculate the Normal Weather in its natural gas forecasts.

Q. WHAT SOURCES DOES DUKE ENERGY OHIO USE TO DETERMINE NORMAL WEATHER DATA FOR ITS OHIO SERVICE AREA?

A. The National Oceanic and Atmospheric Administration (NOAA) is responsible for monitoring climate conditions in the United States, and provides normal weather data for Duke Energy Ohio's service area. Additional information about NOAA is available at its website at www.noaa.gov. The standard time period prescribed by the United Nations World Meteorological Organization for measuring climate conditions is thirty years, and NOAA updates its calculations for the United States for these thirty-year periods at the end of each decade. The most current thirty-year period used by NOAA is 1991-2020.

Because of the NOAA's infrequent update schedule, the Company also compiles more contemporaneous weather data in calculating "normal weather," rolling in data for the latest year available at the time of the forecast, where the NOAA procedure involves waiting until ten years are available. The underlying data are the same for both procedures.

Q. WHAT YEARS ARE USED TO CALCULATE THE ROLLING THIRTY-YEAR WEATHER NORMAL FOR THE MOST RECENT DUKE ENERGY OHIO NATURAL GAS VOLUME FORECAST?

A. As a new year of weather data—subject to a delay—becomes available, it is our practice to roll off the oldest year and replace it as part of our annual refresh of the forecast. Because the natural gas volume forecast was prepared in late 2021, the years 1991-2020 were used to calculate normal weather for the forecast provided here. Data reflect measurements taken at the Cincinnati (CVG) airport weather station.

Q. WHAT HAS BEEN THE LONG-TERM TREND IN HDD AND CDD FOR THESE MEASUREMENTS?

A. The most recent thirty years suggest a slight warming trend. Basic econometric analysis confirms that this trend is statistically significant under several different specifications, including ones that use data from years before that period. A slight decreasing trend in HDDs over the same period—while visually hinted at—fails to hold up under statistical testing. The graph in Attachment BWP-2 shows these charts.

Q. WHAT HAS BEEN THE TREND IN HDD FOR THESE MEASUREMENTS OVER THE LAST TEN YEARS?

A. The data on winter HDDs show a very slight declining trend over this period; however, because so few observations are involved, these results are not statistically significant.

Q. HOW DO THE ACTUAL ANNUAL HDDS FOR THE LAST TEN YEARS FOR THE GREATER CINCINNATI METRO AREA COMPARE TO THIRTY-YEAR NORMALS?

A. See Attachment BWP-3 for a graph comparing the annual HDDs to the forecasts of the thirty-year normal scheme, as well as the ten-year normal scheme and the NOAA static thirty-year normal. Annual weather is much more variable than the degree to which the various forecasts vary from each other. The difference between the ten-year normal and thirty-year normal isn't nearly as dramatic with regard to winter weather (HDDs), wherein both methods for calculating normal weather appear to be similar upon visual inspection.

Q. DID YOU MEASURE HOW RELIABLE THE VARIOUS WEATHER NORMALS ARE?

A. Yes. One way to compare the relationship between the expected normal level of degree days to the actual number of degree days is to use a statistic known as the Mean Percent Error (MPE). MPE indicates whether the measure of normal degree days contains any bias to over-estimate or under-estimate the actual weather conditions. If MPE is positive, this indicates that there is a bias for the measure of normal to be higher than the actual. The formula to calculate MPE is the sum of Normal Degree Days minus Actual Degree Days, all divided by Actual Degree Days. That sum is then divided by the number of observations. Mathematically:

$$\text{MPE} = \frac{1}{\text{N}}\sum_{t=1}^{N}\frac{\hat{Y}_t - Y_t}{Y_t}$$

Where $\hat{Y}$ = Normal Annual Degree Days

and Y = Actual Annual Degree Days

A difficulty with using this sum to compare the options for weather normalization is data availability: because so many years are required to compute the thirty-year weather normal, this statistic basically compares normal over a narrow sample space, implying a large standard error relative to any measurement difference. Because standard errors shrink for larger samples, the standard error of a thirty-year forecast for normal weather should have a confidence interval that is 40 percent as large as the confidence interval around ten-year estimates. Therefore, it is only possible to compare accuracy for years beginning with 2011 (which implies too few years for conclusive statistical testing). An informal comparison of the two forecasts for degree days shows slightly greater mean square error for the weather predictions in years beginning with 2011 when using the thirty-year normal instead of the ten-year normal, but with so few data points—ten years as of this filing—we cannot reject the statistical hypothesis that the expected errors are equal.

IV. FILING REQUIREMENTS AND INFORMATION SPONSORED BY WITNESS

Q. DID YOU SUPPLY ANY INFORMATION TO OTHER WITNESSES IN THESE PROCEEDINGS?

A. Yes, I supplied Duke Energy Ohio witnesses Mr. Grady "Tripp" S. Carpenter and Mr. Jeff L. Kern with the gas Mcf sales for the forecasted portion of the test period, consisting of the nine months ending December 31, 2022.

Q. PLEASE DESCRIBE SUPPLEMENTAL FILING REQUIREMENT (D)(13).

A. Supplemental filing requirement (D)(13) requests that a detailed description of the process to forecast the sales used in the forecasted portion of the test year be available and that a witness should be identified to support the description of the forecasted sales. I provide and support the detailed description of the forecasting process in my above testimony.

Q. DO YOU BELIEVE THE FORECAST IS A REASONABLE AND ACCURATE DEPICTION OF THE COMPANY'S ANTICIPATED FUTURE NATURAL GAS LOAD?

A. Yes.

V. CONCLUSION

Q. WERE ATTACHMENTS BWP-1 THROUGH BWP-3, THE INFORMATION YOU PROVIDED TO MR. CARPENTER AND MR. KERN, AND SUPPLEMENTAL FILING REQUIREMENT (D)(13) PREPARED BY YOU OR UNDER YOUR SUPERVISION?

A. Yes.

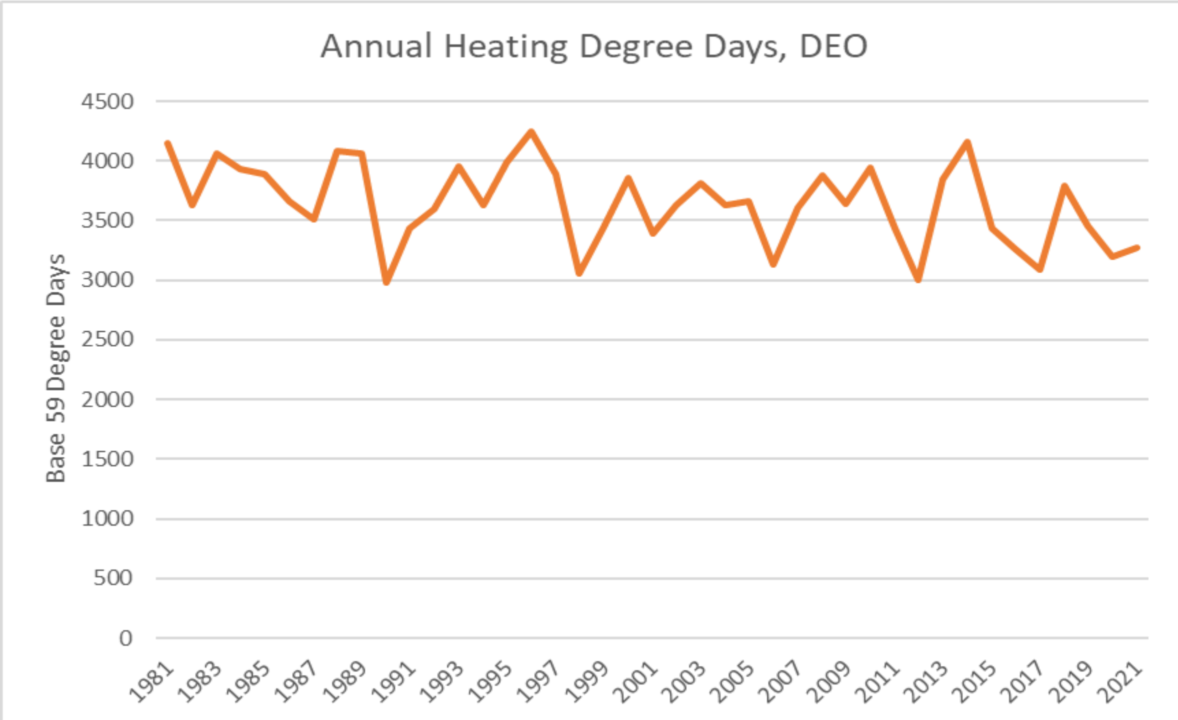
Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?

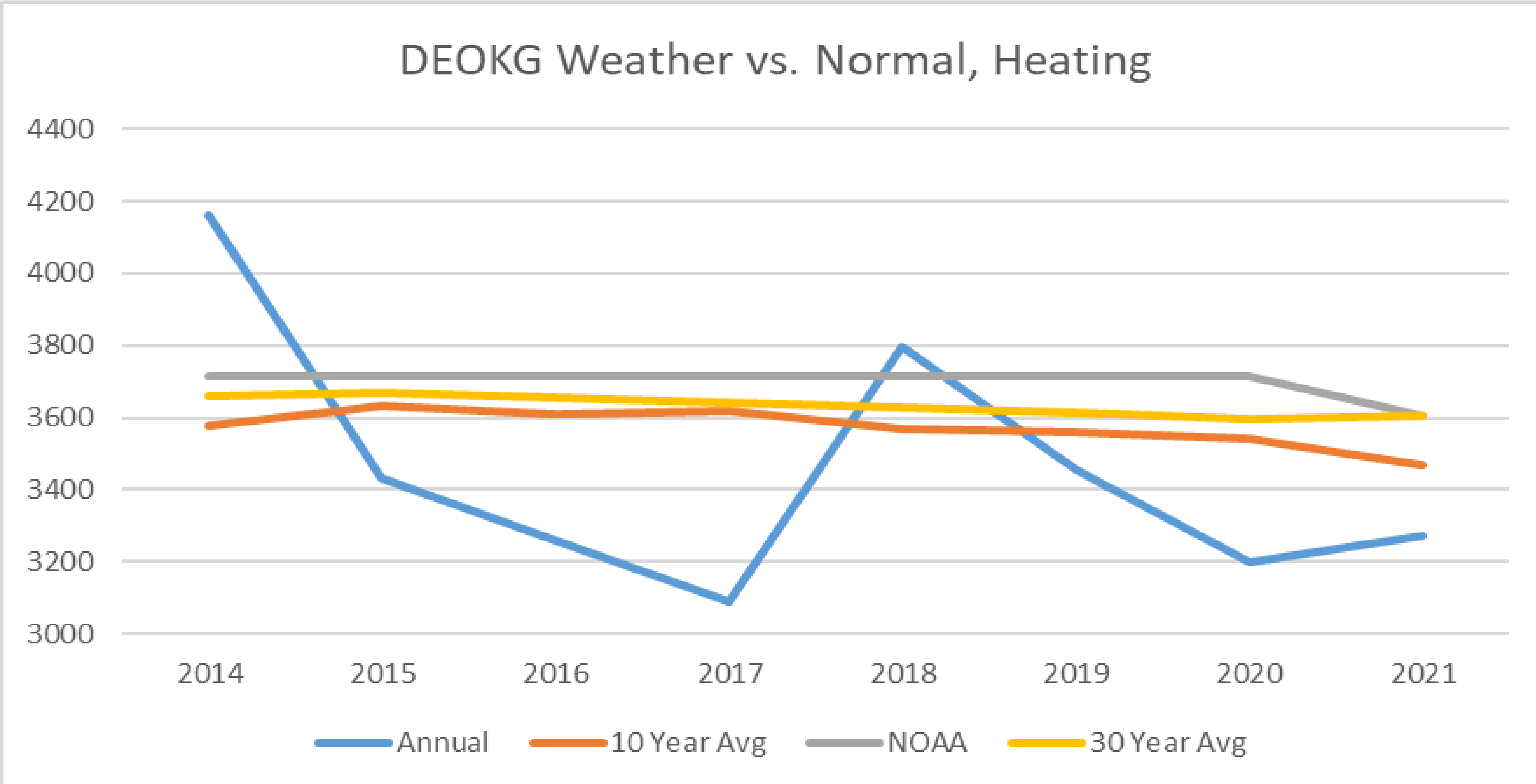
A. Yes.

DUKE ENERGY KENTUCKY
SERVICE AREA ENERGY FORECAST (Volume in MCF) (a)

	YEAR	(1) RESIDENTIAL	(2) COMMERCIAL	(3) INDUSTRIAL	(4) STREET-HWY LIGHTING/ID /OEU	(5) OPA	(6) OTHER	(7) (1+2+3+4+5+6) TOTAL CONSUMPTION
-5	2017	28,728,491	17,241,462	5,105,382	19,667,832	2,100,669		72,843,836
-4	2018	29,596,375	17,979,437	5,404,403	19,779,585	2,077,643		74,837,443
-3	2019	30,549,161	18,596,722	5,174,819	19,812,225	2,142,578		76,275,505
-2	2020	30,883,048	18,247,716	5,407,991	19,389,551	1,988,063		75,916,369
-1	2021	30,098,681	18,246,009	5,456,640	19,730,125	2,092,545		75,624,000
0	2022	30,104,157	18,863,571	5,452,281	19,247,337	2,036,297		75,703,643
1	2023	30,470,604	18,705,875	5,648,305	19,529,897	2,090,090		76,444,771
2	2024	30,538,865	18,312,748	5,686,186	19,532,645	2,109,715		76,180,159
3	2025	30,464,032	18,147,840	5,701,970	19,529,898	2,115,768		75,959,507
4	2026	30,512,068	18,105,538	5,726,515	19,529,898	2,128,808		76,002,827
5	2027	30,541,583	18,012,009	5,756,192	19,529,898	2,139,789		75,979,471
6	2028	30,705,118	17,883,437	5,795,604	19,532,645	2,156,263		76,073,066

(a) Figures in years -5 through -1 are weather-normalized history
(b) Figures in year 0 are 3 months weather-normal actual values, 9 months forecast values


Annual Heating Degree Days, DEO
Base 59 Degree Days
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021


DEOKG Weather vs. Normal, Heating
4400
4200
4000
3800
3600
3400
3200
3000
2014
2015
2016
2017
2018
2019
2020
2021
Annual
10 Year Avg
NOAA
30 Year Avg

This foregoing document was electronically filed with the Public Utilities

Commission of Ohio Docketing Information System on

7/14/2022 9:37:53 AM

in

Case No(s). 22-0507-GA-AIR, 22-0508-GA-ALT, 22-0509-GA-ATA, 22-0510-GA-AAM

Summary: Testimony Direct Testimony of Benjamin W.B. Passty, Ph.D. on Behalf of Duke Energy Ohio, Inc. electronically filed by Mrs. Tammy M. Meyer on behalf of Duke Energy Ohio Inc. and D'Ascenzo, Rocco and Kingery, Jeanne W. and Akhbari, Elyse Hanson and Vaysman, Larisa and Elizabeth M. Brama