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Witness: Eric Fox
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Before the Public Service Commission
of the State of Missouri

Direct Testimony

of

Eric Fox

on behalf of

Liberty Utilities (Midstates Natural Gas) Corp. d/b/a Liberty

February 9, 2024

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LIBERTY UTILITIES (MIDSTATES NATURAL GAS) CORP. D/B/A LIBERTY
BEFORE THE MISSOURI PUBLIC SERVICE COMMISSION
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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Eric Fox. My business address is 20 Park Plaza, 4th Flr, Boston, Massachusetts, 02116.

Q. By whom are you employed and in what capacity?

A. I am employed by Itron, Inc. ("Itron"),[1] as Director, Forecast Solutions.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of Liberty Utilities (Midstates Natural Gas) Corp. d/b/a Liberty ("Liberty" or the "Company").

Q. Please describe your education and professional and work experience.

A. I received my M.A. in Economics from San Diego State University in 1984 and my B.A. in Economics from San Diego State University in 1981. While attending graduate school, I worked for Regional Economic Research, Inc. ("RER") as a SAS programmer. After graduating, I worked as an Analyst in the Forecasting Department of San Diego Gas & Electric. I was later promoted to Senior Analyst in the Rate Department. I also taught statistics in the Economics Department of San Diego State University on a part-time basis.

[1] Itron is a leading technology provider and critical source of knowledge to the global energy and water industries. More than 3,000 utilities worldwide rely on Itron technology to deliver the knowledge they require to optimize the delivery and use of energy and water. Itron provides industry-leading solutions for electricity metering; meter data collection; energy information management; demand response; load forecasting, analysis and consulting services; distribution system design and optimization; web-based workforce automation; and enterprise and residential energy management.

In 1986, I was employed by RER as a Senior Analyst. I worked at RER for three years before moving to Boston and taking a position with New England Electric as a Senior Analyst in the Forecasting Group. I was later promoted to Manager of Load Research. In 1994, I left New England Electric to open the Boston office for RER, which was acquired by Itron in 2002.

Over the last 30 years, I have provided support for a wide range of utility operations and planning requirements including forecasting, load research, weather normalization, rate design, financial analysis, and conservation and load management program evaluation. My clients include traditional integrated utilities, distribution companies, independent system operators, generation and power trading companies, and energy retailers. I have presented various forecasting and energy analysis topics at numerous forecasting conferences and forums. I also direct electric and gas forecasting workshops that focus on estimating econometric models and using statistical-based models for monthly sales and customer forecasting, weather normalization, and calculation of billed and unbilled sales. Over the course of my career, I have provided forecast training to several hundred utility analysts as well as analysts in other businesses.

I have implemented and directed numerous weather normalization studies and applications used for utility sales and revenue variance analysis and reporting. These weather normalization studies include normalizing sales for tracking forecast performance, developing normalized load shapes for long-term forecasting, estimating booked and unbilled sales for financial reporting, and developing weather-normal test-years sales supporting rate case filings. Recent studies include developing weather normalized class profiles for cost allocation and rate design, weather normalizing

historical billing sales for analyzing historical sales trends, developing customer class and weather normalized end-use profiles as part of a utility integrated resource plan, and developing normal daily and monthly weather data to support sales and system hourly load forecasting. My resume is included as **Direct Schedule EF-1**.

Q. What are your responsibilities as Director, Forecast Solutions?

A. I am responsible for directing forecast and load analysis work to support electric and gas utility operations and planning. I manage the day-to-day work of Itron's Boston office. I work with utilities and regulatory organizations across the country and in Canada to address a range of long-term and short-term forecasting and load analysis issues. My work also includes directing the activity of Itron's Energy Forecasting Group (a long-term energy forecasting data and analysis service with over 60 participating utilities), conducting forecast workshops and web-based presentations on specific forecasting and analysis topics.

Q. Have you provided testimony in support of regulatory proceedings before the Missouri Public Service Commission ("Commission" or "MPSC") and other regulatory bodies?

A. Yes. I have provided testimony and supporting workshops for numerous regulatory proceedings that involved test-year weather normalization and forecasts and developing long-term forecasts for Integrated Resource Plans. In Missouri, I have provided testimony related to weather normalization for The Empire District Electric Company in July 2019 (Docket No. ER-2019-0374), August 2020 (Docket No. ER-2020-0396), and May 2021 (Docket No. ER-2021-0312).

Q. What is the purpose of your Direct Testimony?

A. The purpose of my testimony is to support the Company's 2022 test-year weather normal sales. I oversaw the development of rate class weather normalization models, constructed actual and normal test-year heating degree days, reviewed estimated weather-normal models, and calculated test-year weather normal sales.

Q. What are the test-year normalization results?

A. On a billing month basis (heating degree days that correlates with reported billed sales), test-year heating degree-days are slightly above normal in the Northeast Division ("NEMO") service area, and below normal in Southeast ("SEMO") and Western ("WEMO") service areas. As a result, NEMO sales are adjusted down slightly and SEMO and WEMO sales are adjusted up. Table 1 shows the weather normalization results.

Table 1: Test Year Actual and Weather Normal Sales

CCF				
		Residential		
Division	Actual	Weather Normal	Adjustment	Pct
NEMO	11,736,243	11,591,332	(144,911)	-1.2%
SEMO	15,161,969	15,889,166	727,197	4.8%
WEMO	2,212,672	2,343,727	131,055	5.9%
Total	**29,110,884**	**29,824,225**	**713,341**	**2.5%**
		Small Commercial		
Division	Actual	Weather Normal	Adjustment	Pct
NEMO	3,671,467	3,624,260	(47,207)	-1.3%
SEMO	5,226,302	5,458,335	232,033	4.4%
WEMO	784,893	836,320	51,428	6.6%
Total	**9,682,661**	**9,918,916**	**236,255**	**2.4%**
		Medium Commercial		
Division	Actual	Weather Normal	Adjustment	Pct
NEMO	3,552,609	3,518,202	(34,407)	-1.0%
SEMO	4,155,165	4,345,222	190,057	4.6%
WEMO	550,805	576,444	25,639	4.7%
Total	**8,258,578**	**8,439,868**	**181,290**	**2.2%**

II. WEATHER NORMALIZATION OVERVIEW

Q. Please describe the weather normalization process.

A. The objective of weather normalization is to remove the variance in monthly sales that is weather-related. This provides a sales basis for determining revenue needs and a means to fairly collect revenues across the customer base. The weather-normalization process entails calculating the difference between actual and expected or normal weather conditions for the test-year period and translating the difference into a therm weather impact (*WthrImpact*). Weather normal use (*WthrNrm_AvgUse*) is then derived by subtracting the weather impact from actual average use. For test-year month (m) and customer class (c) weather normal average use is calculated as:

$$WthrNrm\_Avguse_{mc} = AvgUse_{mc} - WthrImpact_{mc}.$$

Differences between actual and normal weather conditions are captured by heating degree-days ("*HDD"*). HDD is a cumulative measure of heating requirements that has a positive value when temperatures are below a reference temperature (a common reference point is 65 degrees) and is 0 when the temperature is above the reference temperature:

$$HDD = 65 - temperature, \text{ if temperature is below 65, else } HDD = 0$$

HDD are calculated on a daily basis and then summed up over the days to get monthly HDD.

Estimated weather coefficients are used to translate differences between actual and normal HDD into a monthly centum cubic feet ("CCF") weather impact. The weather coefficients are derived from a set of average use models that relates monthly average billed sales (sale / customers) to billing month HDD and other binary variables used to capture seasonal variation that is not weather related and model outliers. Separate

models are estimated for Residential (Res), Small Commercial (SmlCom), and Medium Commercial (MedCom) customer classes; the relationship between gas use and weather differs across customer classes. The HDD model coefficients show how a change in HDD translates into a change in gas usage. The estimated model HDD coefficient (B_h) is used to calculate the monthly weather impact. For test-year month (m) and rate class (c), the weather impact is calculated as:

$$WthrImpact_{mc} = B_h * (HDDactual_{mc} - HDDnormal_{mc}).$$

Q. Please describe test year weather conditions.

A. Test year sales are estimated for the three service divisions that are in separate parts of the state: NEMO primarily serves in the northeast corner of the state, SEMO which is in the southeast corner of the state, and WEMO in the western part of the state near Kansas City. Each division is represented by a weather station that reflects the division area weather conditions. Table 2 lists the weather stations.

Table 2: Division Weather Stations

Division	Weather Stations
NEMO	CAPE GIRARDEAU MUNICIPAL AIRPORT, MO US
SEMO	KIRKSVILLE REGIONAL AIRPORT, MO US
WEMO	KANSAS CITY INTERNATIONAL AIRPORT, MO US

The weather stations are selected based on their proximity to the service area, historical coverage period, and completeness of recorded daily temperatures. Table 3 shows 2022 calendar HDD and 20-year normal HDD.

Table 3: 2022 Calendar-Month HDD

2022 Calendar HDD				
Divisions	Actual	Normal	Difference	Pct
NEMO	6,115	5,719	396	6.5%
SEMO	4,363	4,202	161	3.7%
WEMO	5,014	4,946	68	1.3%

On a calendar-month basis, test-year HDD are above normal. However, when adjusted to reflect the billing period, HDD are just slightly above normal in NEMO, and below normal in SEMO and WEMO. Table 4 shows the estimated billing-month HDD.

Table 4: Estimated 2022 Billing-Month HDD

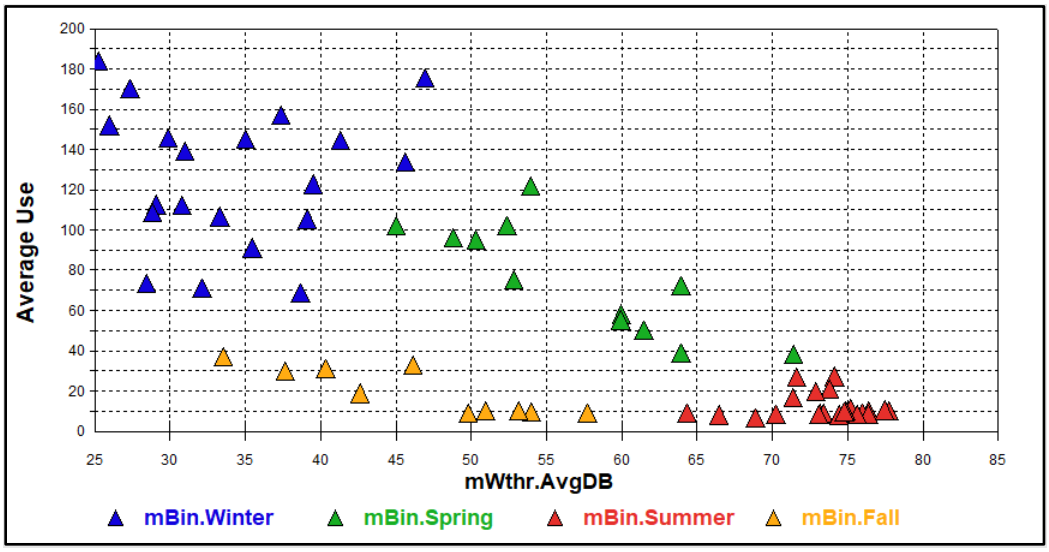
2022 Weighted HDD				
Divisions	**Actual**	**Normal**	**Difference**	**Pct**
NEMO	5,783	5,719	64	1.1%
SEMO	4,014	4,202	(188)	-4.7%
WEMO	4,683	4,946	(263)	-5.6%

As a result, NEMO sales are normalized slightly lower while SEMO and WEMO sales are weather-normalized up.

Q. Please describe how billing month HDD are calculated.

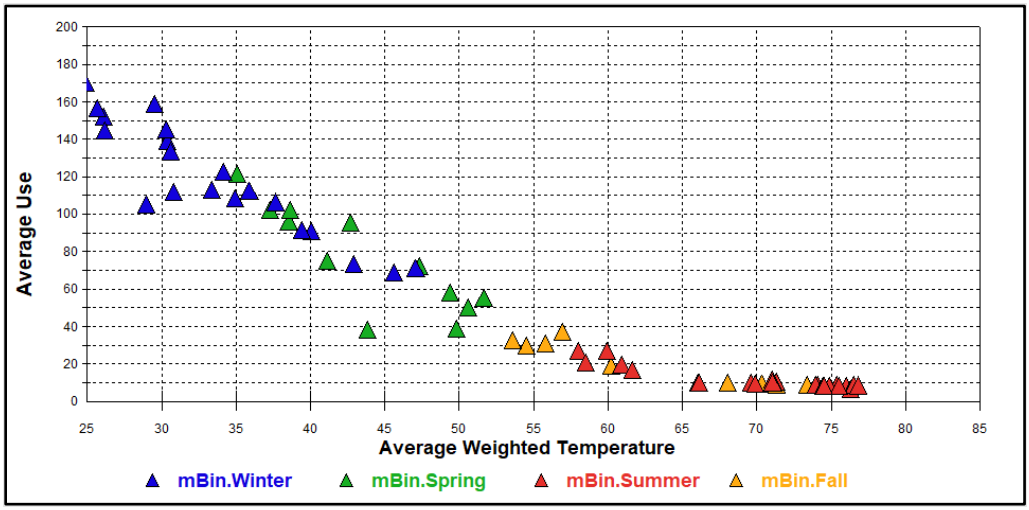
A. Billing-month weather reflects the meter read and billing schedule. For example, January 2022 billed sales is primarily usage that occurred in December and November 2021. There is no measurable relationship between January billed sales and January weather; this can be seen in Figure 1 that shows NEMO monthly average use (on the Y axis) against monthly average temperature (on the X axis).

Figure 1: NEMO Residential Average Use Vs. Average Temperature



Sales are strongly correlated with temperatures in the prior month and prior two-month period. Figure 2 shows NEMO residential average use against a weighted average of the prior month (0.78) and two-month prior period (0.22).

Figure 2: NEMO Residential Use Vs. Prior-Month Weighted Temperature



Billing month HDD is estimated from the relationship between reported billed monthly use as well as current and prior month HDD. Using a simple regression model, monthly average use is regressed on current month, prior-month (lag1), and prior 2-month (lag2) period HDD. Current month HDD proved to be statistically insignificant indicating that current month billed sales have no relationship with current month calendar weather. Billed average use is strongly related to lag1 and lag2 HDD. Estimated coefficient on the lag1 and lag2 HDD variables are used to construct a weighted HDD that correlates with billed sales. The relationship between billed sales and the weighted HDD varies by service area and rate class (a 60-degree based HDD is used in the commercial models). Table 5 shows the calculated HDD weights:

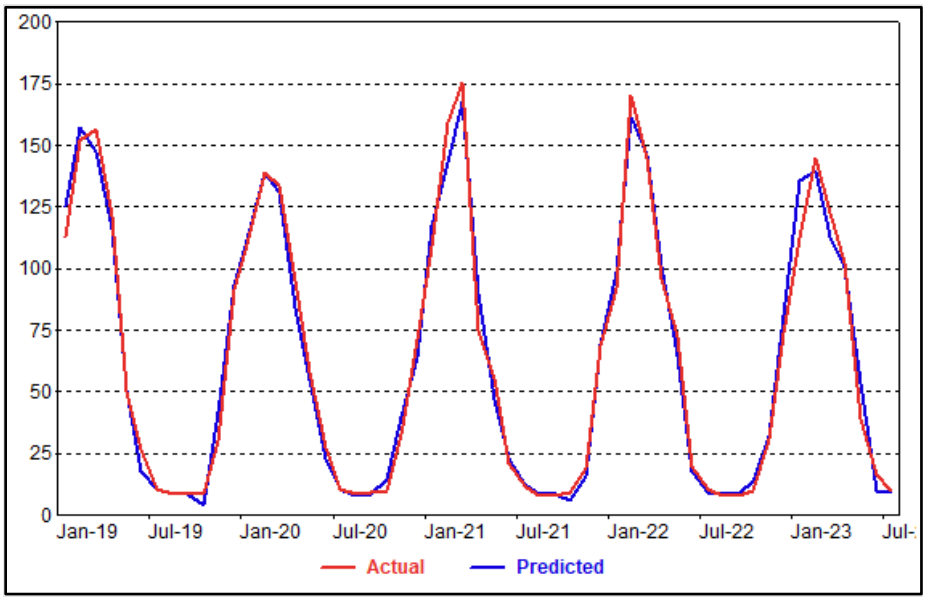
Table 5: Billing Month HDD Weights

Residential Cycle HDD65 Weights			
Division	**Current Month**	**Lag1 Month**	**Lag2 Month**
NEMO	0.00	0.78	0.22
SEMO	0.00	0.81	0.19
WEMO	0.00	0.76	0.24
Small Commercial HDD60 Cycle Weights			
Division	**Current Month**	**Lag1 Month**	**Lag2 Month**
NEMO	0.00	0.77	0.23
SEMO	0.00	0.67	0.33
WEMO	0.00	0.74	0.26
Medium Commercial HDD60 Cycle Weights			
Division	**Current Month**	**Lag1 Month**	**Lag2 Month**
NEMO	0.00	0.90	0.10
SEMO	0.00	0.89	0.11
WEMO	0.00	0.74	0.26

Q. Please describe how the weather coefficients are estimated.

A. The weather coefficients are estimated with simple linear regression models that relate rate class average monthly use to the weighted HDD variable, monthly binaries to capture non-weather-related seasonal variation, shift variables to capture any change in gas use levels over the estimation period, and specific monthly binaries to isolate large outliers; the objective is to isolate the strongest possible HDD coefficient. Models are estimated over the period January 2019 to July 2023. Separate models are estimated for each division and rate class. Figure 3 shows the typical model fit.

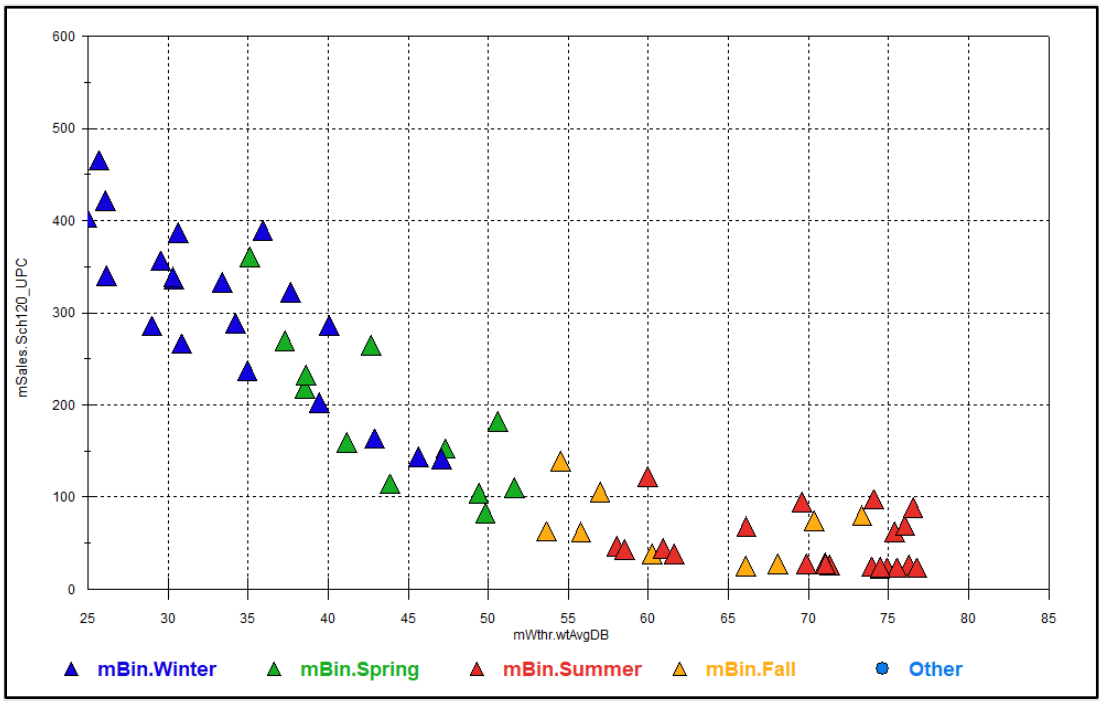
Figure 3 : NEMO Residential Average Use Model



Red is actual and blue is predicted. The primary variable is the estimated bill-month HDD. The HDD65 variable is highly statistically significant and graphically shows that it explains monthly usage variation well. For this model, the HDD coefficient is 0.142 indicating that a one-degree change in HDD will result in a 0.142 change in average use.

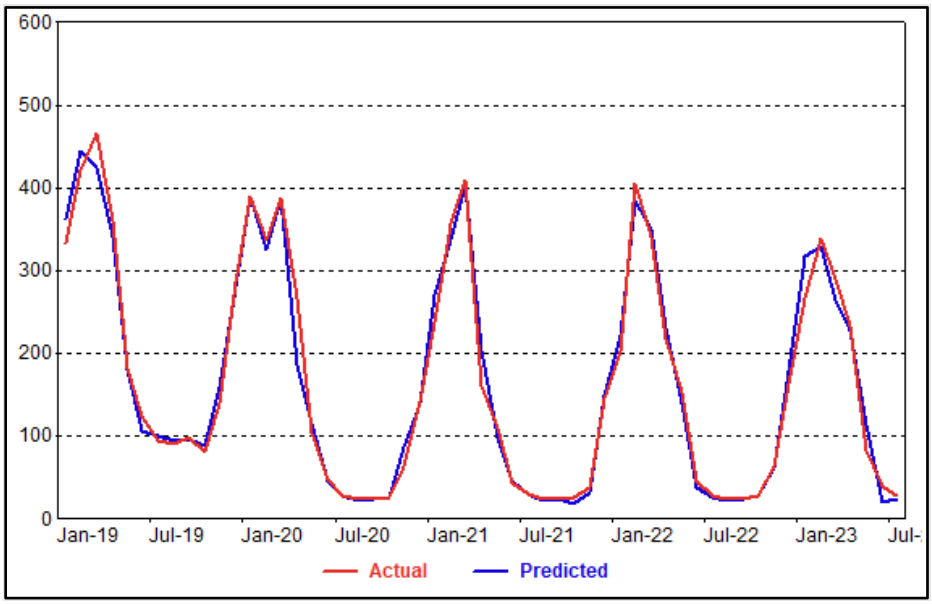
While 65 degrees is a common breakpoint for defining HDD and works well in the Residential model, we have found that we can often improve on the regression model fit using HDD of different breakpoints. The commercial rate class models use HDD defined with a 60-degree breakpoint as commercial heating generally starts at a lower temperature point. Figure 4 shows Small Commercial average use against average monthly temperature.

Figure 4: NEMO Small Commercial Average Use vs Temperature



There is no visible heating related load until the average monthly temperature is below 60 degrees. The weighted HDD60 degree variable fits the data well as illustrated in Figure 5.

Figure 5: NEMO Small Commercial Average Use Model

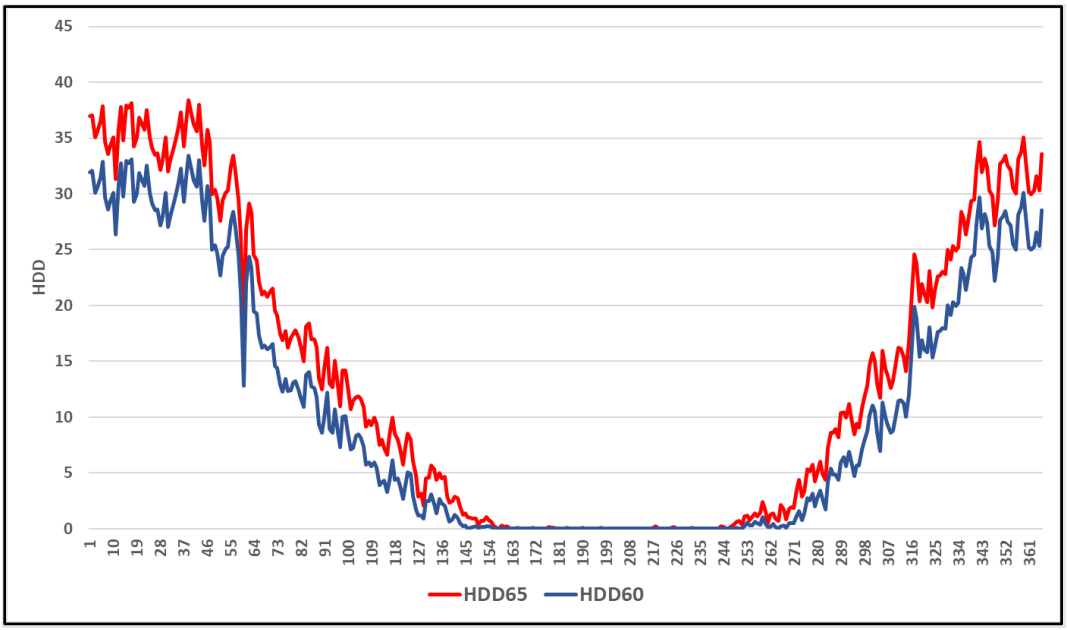


The estimated HDD coefficients are used to calculate the weather impact as explained earlier in my testimony. All the estimate models have high Adjusted R-Squared values (0.96 and higher); this indicates the models explain the monthly variation well. Estimated HDD coefficients are highly statistically significant as measured by the variable T Statistics. The T Statistic is a measure of statistical significance. Weather impact calculations are included in **Direct Schedule EF-2.**

Q. Please describe how normal Heating Degree-Days are calculated?

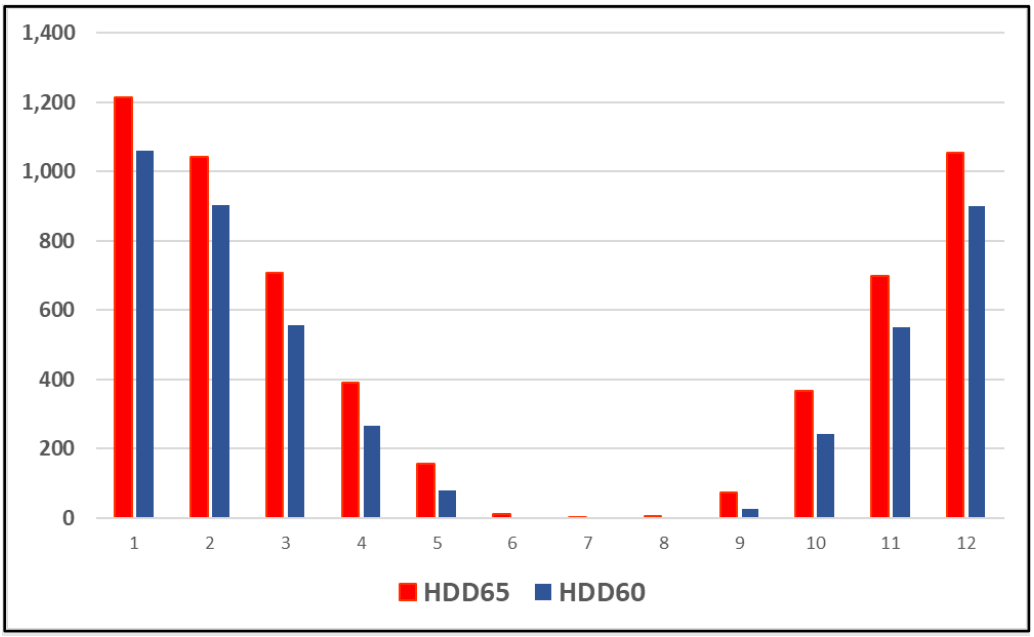
A. Normal HDD are based on twenty years of daily temperature data for the three weather stations. The time period used is 2003 to 2023. The process entails first calculating daily HDD from the average daily temperature (both with a 60 and 65 degree temperature base) and then averaging the daily HDD across years by date. All of the January 1st are averaged, January 2nd, January 3rd, through December 31st. This results in 366 (one for leap year) daily normal HDD60 and HDD65. Figure 6 shows the resulting daily normal degree-day series for WEMO.

Figure 6: WEMO Daily Normal HDD



Monthly normal HDD is then calculated by summing the daily normal HDD by month. WEMO monthly normal HDD are depicted in Figure 7.

Figure 7: WEMO Normal Calendar Month HDD



Similarly normal data series are calculated for SEMO and WEMO. This approach is similar to how NOAA calculates monthly HDD. NOAA's approach uses a thirty-year period with a fixed time period that is updated every ten years. The current NOAA time frame is 1991 – 2020. To capture warming temperatures, normal HDD are based on a twenty-year rather than a thirty-year period and include the most recent full year period, 2022.

Like actual HDD, normal HDD are also weighted to reflect the billed sales period. The same weights used in calculating actual billed HDD are used in calculating weighted normal HDD. On an annual basis, calendar-month and billing-month HDD are the same. Table 6 compares the NEMO calendar and weighted normal HDD (Billing).

Table 6: NEMO Test-Year Normal HDD (65 degrees)

Year	Month	C alendar	Billing
2022	1	1,214.3	975.9
2022	2	1,043.6	1,179.2
2022	3	707.1	1,081.2
2022	4	389.5	781.1
2022	5	155.1	459.4
2022	6	11.2	206.6
2022	7	1.9	42.9
2022	8	4.7	4.0
2022	9	74.1	4.1
2022	10	365.6	58.8
2022	11	697.2	301.5
2022	12	1,054.5	624.3
Total		**5,718.7**	**5,718.7**

On a calendar month basis, the coldest weather on average occurs in January, while on a billing month basis, the coldest weather occurs in February.

Q. Please summarize your results.

A. The normalized 2022 test-year sales provide a reasonable basis for determining revenue requirements and allocating costs. Results reflect expected weather conditions for the most recent twenty-year period. Sales are normalized using a standard modeling approach that entails estimating weather response models and using the estimated model coefficient to calculate monthly billed weather adjustments. Separate models are estimated for each customer class and across the three divisions. Bill-month actual and normal HDD are based on the statistical relationship between billed average use and HDD for the prior-month, and prior 2-month periods; the models explain monthly average use well as measured by the model Adjusted R-Squared. The HDD model coefficients used in normalizing sales are statistically strong as measured by the HDD variable T Statistic.

Q. Does this conclude your Direct Testimony at this time?

A. Yes.

VERIFICATION

I, Eric Fox, under penalty of perjury, on this 9th day of February 2024, declare that the foregoing is true and correct to the best of my knowledge and belief.

/s/ Eric Fox