BEFORE THE
CORPORATION COMMISSION OF THE STATE OF OKLAHOMA

IN THE MATTER OF THE APPLICATION OF **OKLAHOMA GAS AND ELECTRIC COMPANY** FOR AN ORDER OF THE COMMMISSION AUTHORIZING APPLICANT TO MODIFY ITS RATES, CHARGES, AND TARIFFS FOR RETAIL ELECTRIC SERVICE IN OKLAHOMA	))))))	Cause No. PUD 200800398

Direct Testimony

of

Philip R. Bartholomew

on behalf of

Oklahoma Gas and Electric Company

February 27, 2009

Q. **Would you please state your name and business address?**

A. My name is Philip Robert Bartholomew. My business address is 321 N. Harvey Ave., Oklahoma City, Oklahoma 73102.

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

A. I am employed by Oklahoma Gas and Electric Company ("OG&E") as Manager of Load Data Solutions.

Q. **Would you please summarize your education and professional background?**

A. I graduated from Bentley University (formerly Bentley College) in 1983 with Bachelor of Science degree in Management and concentrations in Economics and Computer Science. I received my Masters in Business Administration with high honors from Oklahoma City University in 1999.

I have been working in the Utility Load Research field for the last 26 years starting as an analyst in 1983. I was promoted to senior analyst in 1986. I became a lead analyst for OG&E in 1995 and was promoted to Manager in 2002. I have completed numerous load research and regulatory courses including:

- Association of Edison Illuminating Companies Advanced Statistics in Load Research (Georgia State University -1986)
- Edison Electric Institute's "EEI Electric Rate Fundamentals Course" (Indiana University – 1996)

I am the Vice-Chairman of the Association of Edison Illuminating Companies Load Research Committee. I have made numerous presentations to Commissioners and Commission Staff and supported OG&E's positions during the recent demand program rulemaking collaborative.

Q. **Have your credentials been accepted by this Commission?**

A. No. I respectfully request that the Commission accept my credentials to testify in this cause.

Q. **What is the purpose of your Direct Testimony?**

A. The purpose of my testimony is to discuss OG&E's method for determining normalized weather. Such normalized weather is used by OG&E in setting rates. First, OG&E determined the effect of weather on monthly energy sales and adjusted its test-year's monthly energy sales to reflect "normal" weather. Second, OG&E conducted a separate analysis to determine the effect of weather on hourly demand and adjusted its test-year's hourly demand to reflect normal weather. My testimony is organized into two parts – Weather Normalization of Monthly Energy Sales and Weather Normalization of Hourly Demand.

Q. **Has OG&E traditionally weather normalized monthly energy sales and hourly demand?**

A. No. While OG&E has traditionally weather normalized monthly energy sales, this is the first time OG&E is using weather normalized demand allocators. As part of the Redbud settlement,[1] OG&E agreed to "analyze and develop" weather normalized demand allocation in its next general rate case. Weather normalization of hourly demand is addressed in Part II of this testimony.

PART I: WEATHER NORMALIZATION OF MONTHLY ENERGY SALES

Q. Why does OG&E weather normalize monthly energy sales?

A. Oklahoma weather fluctuates significantly from month to month and year to year. Exhibit PRB-1 details these fluctuations in terms of Heating Degree Days (HDD) and Cooling Degree Days (CDD) in the test year. The calculation of HDD and CDD is relatively complicated, but it is basically designed to provide a relative level of heating or cooling needs on days across the year compared to normal. Heating or cooling needs affect energy usage, which in turn affects how OG&E operates its generation facilities and the production costs in a given month. Weather normalizing monthly energy sales removes unexpected fluctuations in temperatures. "Normal" temperatures and corresponding "normal" energy sales volumes are used to calculate future revenue requirements.

Q. For which customer classes does OG&E weather normalize monthly energy sales?

A. OG&E weather normalized monthly energy sales for most secondary loads (*i.e.*, most Service Level 5 customer classes) and all FERC customer classes. Table 1, details these customer classes.

[1] Cause No. PUD 200800086, Order No. 559892, August 24, 2008.

Table 1

Weather Normalized Customer Classes		
Rate Class		Service Level
Residential	R-1	5
General Service	GS-1	5
Schools - Non-Demand		5
Schools – Demand		5
Power and Light	PL-1	5
Municipal Accounts		All
Cooperative Accounts		All

Q. **Why does OG&E not weather normalize other rate classes?**

A. The remaining rate classes do not demonstrate statistically relevant correlations between temperature and energy usage. For example, municipal pumping customers (PM-1) are driven by the need for water, not temperature and Large Power and Light customers are driven by production schedules.

Q. **Please explain how weather can affect energy sales in summer months.**

A. During periods of extreme high temperatures in the summer months, total energy sales tend to be higher than expected (or normal). Conversely, when temperatures are milder than expected, total sales will tend to be lower than expected. OG&E uses a regression analysis to quantify how much energy usage is dependent upon or explained by temperature. For example, as explained more fully below, OG&E's regression analysis for monthly energy sales shows that there is a 98.99 percent probability that there is a relationship between residential energy sales and temperature. Statistically, this 98.99

percent refers to the correlation coefficient which is a measure on how closely related a dependent variable (energy usage) is to an independent variable (temperature).

Q. **Does a weather normalization of customer class energy sales remove unexpected fluctuations in energy usage?**

A. Yes. Weather normalization adjusts monthly energy sales appropriately across the test period. Energy sales during the summer months are adjusted downward when actual weather is hotter than normal and upwards when it is cooler than normal. Conversely, winter sales are adjusted upwards when the weather is hotter than normal and downward when it is colder than normal.

Q. **Is weather normalization of monthly energy sales a new process for OG&E?**

A. No. OG&E has performed weather normalization of its monthly energy sales in support of rate case filings and other key business functions like SEC reporting for many years.

Q. **Is OG&E proposing any changes in its weather normalization process for monthly energy sales?**

A. Yes. OG&E is proposing to make two changes in its method for weather normalizing monthly energy sales. First, OG&E is expanding the amount of data used in its regression modeling. Second, OG&E is proposing to use more recent weather data in determining normal weather.

Q. **Can you be more specific about the first change -- OG&E's increase in the amount of data used in the regression analysis?**

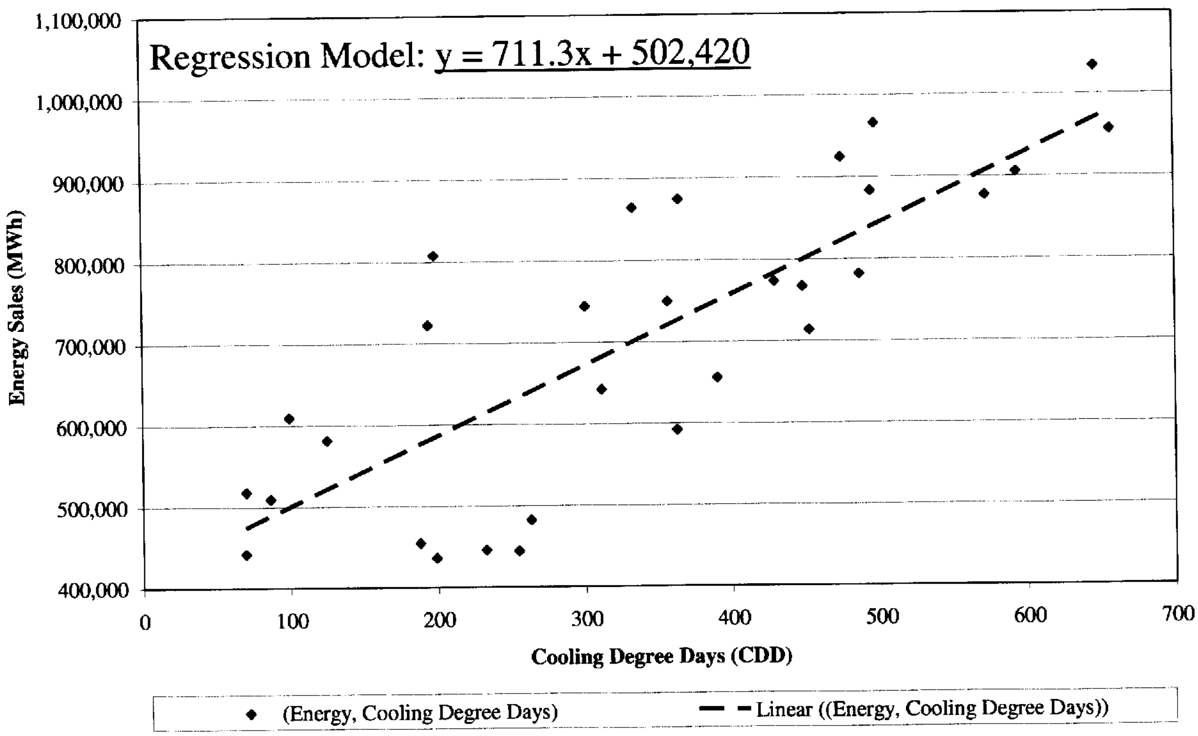
A. Yes. OG&E increased the number of years used in the regression model. Instead of using only one year (12 months) of energy sales and weather data, OG&E used five (5) years of historical data. In addition, instead of using only Cooling Degree Days (CDD) for each month of data used in the model, OG&E also incorporated into the model Heating Degree Days (HDD) information for all months. The use of HDD information allows OG&E to more accurately model non-summer month periods for purposes of estimating energy sales.

Q. **Why is the increased number of years important?**

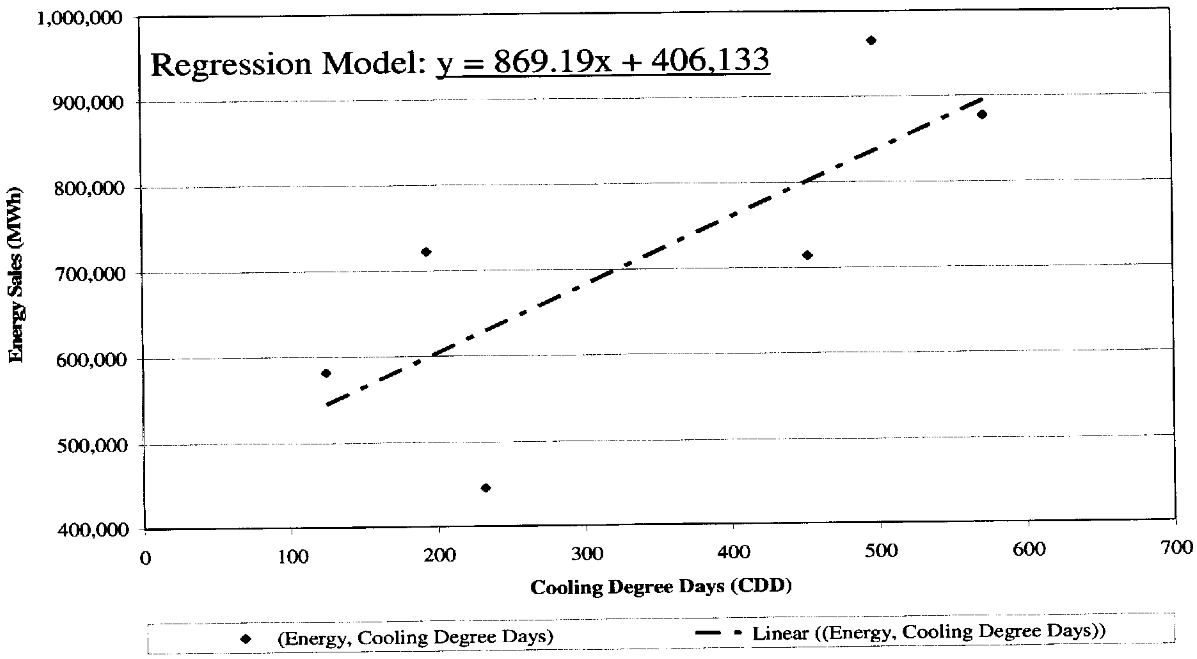
A. The increased number of years provides more data points from which a regression model can determine the relationship between energy sales and weather. Essentially, regression modeling graphs pairs sets of data (load and weather) and draws a line (the regression model) between these data points so that the distance between the line and all data points is minimized. Having 60 data points (*i.e.*, 5 years of monthly sales and weather data points) provides a more precise line than 12 data points. Table 2 contains two graphics that illustrate the modeling differences between using 30 summer data points from 5 consecutive years to using 6 data points from the summer months in the test year.

1 **Table 2**

Example - 5 Year Summer Months
Scatter Plot - Paired Data Points



Example - Test Year Summer Months
Scatter Plot - Paired Data Points



Q. **What is the second change??**

A. In previous weather normalization analyses, OG&E used the National Oceanic and Atmosphere Administration's ("NOAA") thirty (30) year, decade-ending, normal weather values. Thus, in calculating normal weather in 2009, OG&E would have used NOAA weather values from 1971 to 2000. Use of NOAA's decade-ending data means that a rate case filed in 2009 will be deprived the benefits of having the most recent weather data included in the weather normalization analysis. In an effort to use more recent data in its weather normalization analysis, OG&E has decided to replace the NOAA data with the most recent thirty years of weather values ending November 2007. This data comes from NOAA as well. The only difference is that, instead of NOAA calculating the normal values, OG&E has generated the HDD and CDD normal values using the exact same method as NOAA and using more recent years of data.

Q. **Why did OG&E make these changes?**

A. During recent conversations between staff at the Oklahoma Corporation Commission and the Arkansas Public Service Commission and OG&E's Regulatory Affairs department, it became clear that OG&E could improve the weather normalization processes by (i) using a larger amount of data (*i.e.*, five years of monthly energy sales and weather data instead of one year) in the regression analysis; and (ii) including more recent years in determination of normal weather estimates.

Q. **Please describe the weather normalization of energy sales process used in this case.**

A. The first step is to develop the regression model using 5 years of monthly energy sales for each customer class identified in Table 1 above and 5 years of weather data. Using this regression model, OG&E determines what energy sales would have been over the course of the test year ("Predicted Actual Sales"). Then, OG&E uses the most recent thirty (30) years of weather data to determine "normal" weather for each month. For example, OG&E takes the average of the most recent thirty (30) Novembers to determine the "normal" November temperature. These normal weather values are then plugged into the regression model to estimate the weather normalized energy sales for each month of the test year ("Estimated Weather Normal Sales"). OG&E next calculates the difference between the Predicted Actual Sales and the Estimated Weather Normal Sales in each month of the test year ("Sales Difference"). That Sales Difference is the value of how weather affects energy sales. The final step in the analysis is to adjust actual monthly energy sales during the test year by the Sales Difference to determine weather normalized energy sales for each month.

Q. **Why does OG&E use its regression model to determine the relationship between monthly energy sales and weather?**

A. OG&E uses the regression model to determine the relationship between monthly energy sales and weather because such models have been extremely successful in pinpointing just how dependent/sensitive energy sales are to temperature. As one can see in Table 3 below, the regression models are performing very well. Model performances are generally measured by their Correlation Coefficients, Pearson's r-squared test and Mean Absolute Percent Error (MAPE).

Table 3

	Model Performance Results				
Jurisdiction	Rate Class		Correlation Coefficient	Pearson Correlation Coefficient Squared	Mean Absolute Percent Error
			Pearson	r-square	MAPE
Oklahoma	Residential	R-1	0.9899	0.988	2.27%
	General Service	GS-1	0.9899	0.985	1.46%
	Power and Light	PL-1	0.9899	0.981	1.42%
	Schools Demand		0.9899	0.985	1.28%
	Schools Non-demand		0.9844	0.969	2.54%
	Power and Light (TOU)		0.9592	0.959	1.62%
FERC	All Municipal		0.9894	0.979	2.68%
	All Cooperative		0.9752	0.951	3.73%

Note: See W/P M-7 Part II for more information.

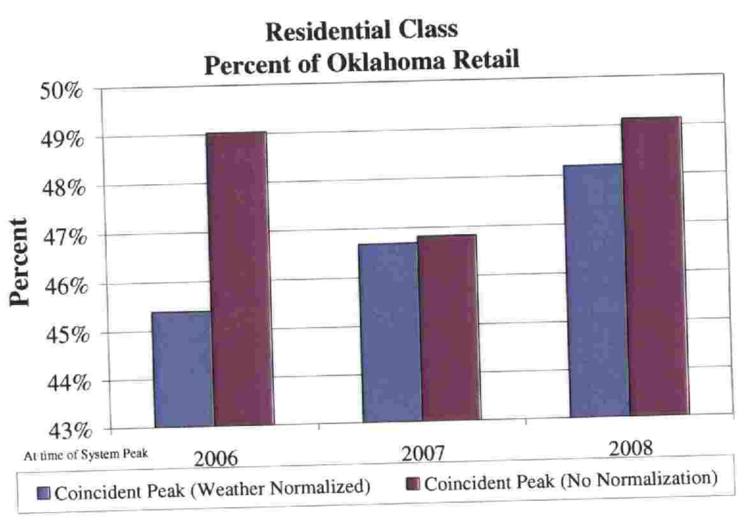
The Correlation Coefficient is a value between 0 and 1 that indicates if there is a relationship between the dependant variable (sales) and the independent variable (weather). The r-square test determines how much of the relationship is explained by the independent variable. The MAPE measure of accuracy in a fitted time series value (what is the average error observed when the model uses actual weather as an input). Table 3 shows that there is a close relationship between energy sales and weather and the MAPE percentages confirm the accuracy of these calculations by showing a small amount of error. For example, the model shows that (i) there is a 98.99% relationship between general service sales and weather; (ii) the independent variable (weather) explains 98.5% of this relationship; and (iii) when actual weather is used with the model, the average error for all months was 1.46%.

PART II: WEATHER NORMALIZATION OF HOURLY DEMAND

Q. Why did OG&E decide to weather normalize hourly demand?

A. As a result of the Redbud settlement, OG&E analyzed and developed a weather normalization methodology for hourly demand. The goal of this analysis, as set out in the settlement, was "assigning the appropriate costs to customer classes" and "eliminating inter-class subsidies."[2] OG&E has determined that weather normalizing hourly demand indeed stabilizes cross-class and intra-class contributions to the Company's system peak from year-to-year. Table 4 below demonstrates how weather normalization stabilizes the Oklahoma Residential Class. The weather normalized percentages reveal a constant growth in the residential class' contribution to the Company's system peak. The non-weather normalization contributions to system peak vary from 49%, down to 46% and then back up to 49%. Calendar year 2006 was the hottest year this decade, which drove usage in the Residential class much higher than normal. Had costs been allocated on that percent, it is unlikely that residential customers would demand as much power in the next couple of years.

Table 4



---

[2]Cause No. PUD 200800086, Order 559892, Attachment A, Joint Stipulation & Settlement Agreement, Section 3.I.

Q. Is hourly demand weather normalization similar to the monthly sales weather normalization discussed above?

A. Yes. It is a similar process. However, where the monthly energy sales normalization process estimates <u>monthly</u> effects on energy sales due to normalized weather, the hourly models are designed to estimate <u>hourly</u> effects on demand due to normalized weather. Thus, instead of identifying 12 monthly values of weather normalized energy sales, the hourly model calculates a weather normalized demand value for 8,784 hours in the test year for each customer class analyzed. Since OG&E needs to estimate every hour in the test year, we developed twenty four (24) regression models, one for each hour of the day. For example, one model was developed to estimate loading for the first hour (00:01 through 01:00) of each day. Various independent variables were used in each regression model.

Q. What is the first step in performing hourly demand weather normalization?

A. First, OG&E identified what rate classes were going to be subject to weather normalized hourly demand. In order to select these rate classes, OG&E performed a regression analysis for all customer rate classes to determine how sensitive such rate classes were to weather. Customer rate classes were categorized with either low, medium or high sensitivity to weather. OG&E excluded any customer rate classes with low sensitivity to weather from its weather normalization efforts, as it is only appropriate to weather normalize hourly loads for customer classes who are likely to change their usage because of weather.

Q. How many customer rate classes were determined to be weather sensitive?

A. OG&E has seventy five (75) total customer rate classes.[3] Based on its series of regression analyses, OG&E determined that thirty-three (33) of our 75 rate classes and service level categories had medium to high weather sensitivity. OG&E conducted weather normalization of hourly demand for each of the 33 customer rate classes.

Q. What is the next step in performing hourly demand weather normalization?

A. After determining which customer rate classes would be included in the weather normalization analysis, OG&E developed twenty-five (25) regression models for each of the 33 customer rate classes (one daily model and 24 hourly models). The daily model estimates each customer class' total energy use in a given day and is used as an independent variable for each of the 24 hourly models. Each of the 24 hourly models incorporates the independent variables listed in the following table to estimate hourly loads.

Table 5 - Regression Variables

Independent Variable	Comment
Day of the week	Monday = 1, Tuesday = 2, …etc
Month of year	January = 1, February = 2, …etc
Holiday	Y or N
Hours of darkness	NOAA
Heating Degree Days (HDD)	NOAA (base 65)
Heating Degree Days Previous Day	Cold Build Up
Cooling Degree Days (CDD)	NOAA (base 65)
Cooling Degree Days Previous Day	Heat Build Up
Significant Weather Events	Y or N (Ice Storm, etc)
Daily Energy	From Daily Model

[3] For purposes of this testimony, "rate classes" includes customer rate classes and service level categories.

Q. **After developing the 25 regression models for each applicable customer rate class, what was the next step in OG&E's weather normalization process?**

A. Much like the weather normalization analysis for monthly energy sales, OG&E substitutes actual weather data from the test year into the regression models. This results in a series of "predicted" demand curves for each hour of the test year. These predicted demand curves is the baseline used to determine the effect of normal weather on actual load.

Q. **What is the next step?**

A. As with weather normalization of monthly energy sales, OG&E next determines "normal" hourly temperatures for each hour of the test year. OG&E determined these normal hourly temperature values by looking at the most recent twenty (20) years of hourly temperatures and then using a "rank and average" process. "Rank and Average" refers to two processes whose outputs are combined at the very end. The first process is known as Rank and Average by Temperature and is used to develop typical daily weather profiles. Ranking is the process where each day in a month is sorted from highest to lowest by its maximum temperature and average temperature. Each day is then assigned a rank from 1 to 30 (or 28, 29 or 31 depending on the number of days in a given month) with 1 being the highest temperature day and 30 being the lowest. This same ranking is done for each of the twenty (20) historical years for the same month. The result is a typical hottest day for the month, a typical second hottest day, and so on through to the typical coldest day. This process is performed for each of the 12 months.

The second process is known as Rank and Average by Day. This process averages the days in each month according to temperature using twenty years of historical data (*i.e.*, average temperatures for all July 1st, then all July 2nd, etc.). These average day values are then sorted and ranked from highest to lowest. The result is 12 months of chronologically sorted days with an associate rank assigned to it.

The two processes are then combined into the chronologically sorted file by month and ranked order. For example January 1st may be ranked as the sixth hottest day (Rank and Average by Day) and therefore the 24-hour temperature profile for the sixth hottest day (from Rank and Average by Temperature) is assigned to that date. July 14th may historically be the hottest day in July and, therefore, the 24-hour temperature profile for the number one ranked hottest day is assigned to that date. This merging is done for each month. The result is a typical year of hourly weather values.

Q. **After developing hourly normal temperatures for each day of the year, what is the next step in the weather normalization of hourly demand?**

A. OG&E then substitutes the typical hourly temperatures into the regression models for each customer rate class to "estimate" normal weather-adjusted demand curves for each day in the test year. By looking at the difference between the "predicted" hourly demand curves using actual temperatures and the "estimated" hourly demand curves using "normal" hourly temperatures, OG&E was able to determine the effect of temperature on hourly demand from each customer class. This difference was then used to develop a set of weather-adjusted demand curves (*i.e.*, weather normalized hourly demand curves) for each customer rate class.

Q. **Why does OG&E use regression modeling to determine the relationship between hourly demand and weather?**

A. OG&E uses regression modeling to determine the relationship between hourly demand and weather because such models have been extremely successful in pinpointing just how dependent/sensitive demand is to temperature. Model performances are generally measured by their coefficient of determination (R-squared). The R-square is the fraction of the total variation of the load in a given hour explained by the independent variables in the model (*i.e.*, temperature or weather). The R-squared ranges between 0 and 1 where 1 is a perfect fit. Table 6, below, details the R-square values for each hours model for the Residential class. As you can see, weather explains a larger percentage of hourly demand in the residential customer class.

Table 6

Hourly R-square (Residential Class)

Hour Ending	Coefficient of Determination	Hour Ending	Coefficient of Determination
	R-squared		R-squared
Hour 1	0.95	Hour 13	0.9
Hour 2	0.84	Hour 14	0.92
Hour 3	0.83	Hour 15	0.93
Hour 4	0.82	Hour 16	0.93
Hour 5	0.81	Hour 17	0.93
Hour 6	0.78	Hour 18	0.93
Hour 7	0.72	Hour 19	0.93
Hour 8	0.75	Hour 20	0.91
Hour 9	0.79	Hour 21	0.91
Hour 10	0.83	Hour 22	0.9
Hour 11	0.85	Hour 23	0.89
Hour 12	0.88	Hour 24	0.89

Q. **Why is regression modeling helpful to the regulatory process?**

A. Weather normalization more accurately reflects the contribution to system peak for each rate class during a "normal" year. This mitigates inter-class subsidies in the ratemaking process.

Q. **Does this conclude your testimony?**

A. Yes.

Oklahoma Gas and Electric
Summary of Heating Degree Days and Cooling Degree Days
Test Year: October 2007 through September 2008

	2007			**2008**									
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual
HDD (BASE 65)													
Total this Month	109	365	798	766	660	385	192	33	0	0	0	2	3,310
Departure from Normal	-43	-117	18	-118	12	-61	-5	-10	-1	0	0	-28	-353
% Departure from Normal[1]	-39%	-32%	2%	[redacted]	2%	-16%	-3%	-30%	NA	NA	NA	-1400%	-11%
Normal	**152**	**482**	**780**	**884**	**648**	**446**	**197**	**43**	**1**	**0**	**0**	**30**	**3,663**
CDD (BASE 65)													
Total this Month	130	8	0	1	0	10	37	240	460	581	507	200	2,174
Departure from Normal	72	5	0	1	-1	3	-1	95	100	54	10	-71	267
% Departure from Normal[1]	55%	NA	NA	NA	NA	NA	-3%	40%	[redacted]	9%	2%	-36%	12%
Normal	**58**	**3**	**0**	**0**	**1**	**7**	**38**	**145**	**360**	**527**	**497**	**271**	**1,907**

Note: 1 Excludes months with HDD or CDD values less than 15.

Data Source: National Oceanic and Atmospheric Administration