EXH. CKC-3T
DOCKETS UE-170033/UG-170034
2017 PSE GENERAL RATE CASE
WITNESS: DR. CHUN K. CHANG

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, Complainant, v. PUGET SOUND ENERGY, Respondent.	Docket UE-170033 Docket UG-170034

PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF

DR. CHUN K. CHANG

ON BEHALF OF PUGET SOUND ENERGY

AUGUST 9, 2017

PUGET SOUND ENERGY

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PUGET SOUND ENERGY

PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF DR. CHUN K. CHANG

I. INTRODUCTION

Q. Are you the same Dr. Chun K. Chang who submitted prefiled direct testimony on January 13, 2017, on behalf of Puget Sound Energy ("PSE" or "the Company") in this proceeding?

A. Yes. I submitted my prefiled direct testimony regarding electric and gas sales temperature normalization, Exh. CKC-1T, and an attachment for my professional qualifications, Exh. CKC-2.

Q. What is the purpose of your rebuttal testimony?

A. My rebuttal testimony serves to oppose the approaches followed and the recommendations made by the Staff witness, Jing Liu, in her prefiled response testimony regarding the temperature normalization of electric and gas sales and revenues.[1]

Q. What do you recommend through your rebuttal testimony?

A. I recommend that the Commission disregard the temperature adjustments of test-year electric and gas sales and revenues presented in Ms. Liu's testimony. Her analysis and modeling results are misleading and less reliable than the results

[1] Liu, Exh. JL-1CT at 3-23.

presented in my prefiled direct testimony and do not justify the reasons she listed for the Commission to accept her estimates of temperature adjustments. I will discuss several critical reasons why I believe her recommendations were not derived from reliable and acceptable analyses and why the Commission should reject Staff's proposed temperature adjustments.

II. ELECTRIC TEMPERATURE ADJUSTMENTS

Q. What is the major difference between the electric modeling and temperature adjustment processes followed by you and Ms. Liu?

A. I have followed a two-model approach. First, I developed system-level and schedule-level model equations using the most recent four-year history of daily temperature and electric energy use per customer variables. I then estimated temperature adjustments of energy use for the whole system and each rate schedule by using the corresponding model coefficients of the temperature variables. In the next step, the temperature adjustment estimated for the system total energy use was allocated among the rate schedules in proportion to the temperature adjustment estimated for each rate schedule.

In contrast to my approach, Ms. Liu used PSE's historical data of daily temperature and energy use per customer to develop schedule-level model equations only and used just the schedule-level modeling results to estimate the temperature adjustment by rate schedule.

Q. Why do we have to go through the two-model approach as you did?

A. As explained in PSE's Response to WUTC Staff Data Request No. 011, the two-model approach is necessary because there is a significant data quality gap between the daily energy use data collected for the system and the data collected for rate schedules. See Exh. CKC-4 at 3.

The most accurate and reliable measures of daily energy use are obtained at the system level. The source for daily system energy use data is hourly system energy input called GPI (generated, purchased and interchanged) load, which covers 100 percent of the energy use by PSE service population. GPI loads are metered and monitored on a real-time basis.

The source for daily energy use data used for schedule modeling, on the other hand, is customer usage data collected from the sampled customers for the large rate schedules such as 07, 08, 24, 25 and 26. For the small rate schedules such as 05, 10, 11, 12, 29, 31, 40 and 43, the source for daily energy use data is customer usage data from all of the customers whose service start dates are prior to January 1, 2012. Although rigorous efforts were made to enable the collected schedule-level data to represent the energy use behavior of its corresponding rate-schedule population, it is still inappropriate if we use the temperature sensitivity measured with the schedule-level data and modeling results alone to calculate the temperature adjustment by rate schedule.

Q. Why is it inappropriate to use the temperature sensitivity measured with only the schedule-level data and modeling results?

A. It is inappropriate for three reasons. First, the customer population by rate schedule used for sampling and data collection does not cover the entire population. Instead, it is only the population of customers who received PSE electric service continuously throughout the historical data period of January 1, 2012 through December 31, 2015. Customers whose service started after January 1, 2012 or who moved or closed their accounts before the end of 2015 are excluded. It is necessary to screen these customers to secure the full four years of energy use history for modeling from all of the customers selected for data collection. However, using the screened customer data to represent the whole rate-schedule population unavoidably introduces a certain level of bias.

Second, a tolerance level of five percent error at a 95 percent confidence limit was set for sample design and drawing to collect the daily energy use data from the customers in the large rate schedules. Although this level of error tolerance is commonly accepted in statistical practice, it should be noted that an error margin of up to five percent is embedded in the sampled data, but the system energy use data is free of such sampling error.

Third, the biggest source of bias originates from the schedule-level metering data. Daily energy use data for most of the retail service customers are collected through PSE's wireless automatic meter reading network. Due to occasional failures in wireless data communication, the daily energy use data collected involve missing observations or erroneous readings. After running a validation test with the daily metering data compiled for each of the sampled or screened customers, the customer sites with bad readings were dropped from the modeling database for the day. Table 1 below shows the original sample size and the average numbers of sampled sites included in the modeling database by rate schedule. As seen in the bottom row of Table 1, a significant number of the sampled sites were excluded from the modeling database. 4.8 to 6.2 percent of the initial samples were dropped from any further analysis due to the metering data quality issues.

Table 1
Average Number of Sampled Customers Included in Modeling

Rate Schedule	RS 07	RS 08	RS24	RS 25
Avg. No. of samples Used	1,142	5,620	3,598	1,002
Original Sample Size	1,200	5,994	3,804	1,053
Difference	-58	-374	-206	-51

Table 2 below provides the average, minimum and maximum numbers of customer sites covered by the modeling database for the schedules with no sampling involved. The table indicates that a significant number of customer sites were excluded from the schedule-level modeling database.

Table 2
Minimum and Maximum Number of Customers Covered by Modeling

Rate Schedule	*RS 05*	*RS 10*	*RS 11*	*RS 12*	*RS 26*	*RS 29*
Avg.	9	9	280	10	327	343
Min.	8	3	204	6	223	235
Max.	9	9	289	10	340	362

Rate Schedule	*RS 31*	*RS 43*	*RS 4025*	*RS 4026*	*RS 4031*
Avg.	356	150	31	61	28
Min.	238	27	18	31	19
Max.	368	156	33	68	29

A significant number of customer sites initially selected for data collection were abandoned due to missing or bad readings, resulting in another layer of bias to the daily energy use data used for schedule modeling.

Due to the unavoidable bias inherent in the schedule modeling data, and considering that the system modeling data and results are free of bias and mirror the energy usage behaviors of the entire population, it is inappropriate to use only the schedule modeling results to estimate the temperature adjustment. The schedule modeling data and results are adequate for use as supplementary information when allocating the system total adjustment to rate schedules.

To maximize the quality of data and minimize bias, PSE uses the two-model approach. PSE has used such methodology since its 2004 general rate case, and such approach has never been contested by any intervenor in any of the numerous rate proceedings since it was introduced.

Q. How do you respond to Ms. Liu's assertion that the system model results of temperature adjustment and the schedule-model results are irreconcilable?

A. Ignoring the bias inherent in schedule modeling data and results, Ms. Liu claims that the schedule-level models produce the exact sales adjustment that belongs to each weather-sensitive rate schedules. [2] In addition, she argues that the system model produces "extra" or "deficient" adjustment and, therefore, the system-level adjustment cannot be spread over rate schedules using the schedule-level modeling results.

However, the opposite is true. The modeling results are as good as the input data used for modeling. Unlike the system daily energy use data, which have no data quality issue, the schedule-level data involve three layers of bias potentials. With no better source of data available, the schedule model coefficients are necessarily estimated with lower quality data than the data used for system modeling. Furthermore, statistical test results of the system model equation are better than most of the schedule modeling results produced by either Ms. Liu or myself.[3] Therefore, the greater the difference between the temperature adjustments estimated with the system and the schedule model coefficients, the more important it is to reconcile the schedule model adjustments to the system-model adjustment. Given the current data availability and limitations, the two-model

[2] Liu, Exh. JL-1CT at 11:19-23.

[3] The Company's electric system and schedule modeling results are provided in Exh. CKC-5. For Staff's schedule modeling results, see Exh. JL-2.

approach is a better way to achieve the goal of producing accurate and equitable estimates of temperature adjustment for the weather-sensitive rate schedules.

Ms. Liu argues that the temperature adjustment produced by the system model would produce some extra or deficient adjustments, while the schedule-level models produce the exact sales adjustment that belongs to each weather-sensitive rate schedule. She further states that system load per customer is not as meaningful a measure as the usage per customer at schedule level because the system data reflect the aggregate of energy usage by heterogeneous groups including non-temperature sensitive schedule customers.[4]

Q. How do you respond?

A. I disagree. System load per customer is a meaningful measure to reflect the average energy use per customer in the system, just like a schedule-level use per customer reflects the average use per customer in the rate schedule. Both the system-level and the schedule-level use per customer are an aggregate of heterogeneous energy uses. Consider that various uses of energy are categorized by only two types: weather-sensitive use and non-weather-sensitive use (also called "base" use). Even if a customer belongs to a weather-sensitive rate schedule, the customer's energy use is still a combination of temperature-sensitive load, such as space heating and cooling, and base load, such as lighting and cooking. Whether for the system level or the schedule level, the goal of temperature sensitivity model development is exactly the same to find the best

[4] Liu, Exh. JL-1CT at 12:14-17.

model specification and structure to match the temperature variables with the variations in weather-sensitive energy use to the maximum possible extent and to estimate the coefficients of temperature variables as accurately as possible. Therefore, accuracy and reliability of the temperature sensitivity estimated through the system and the schedule modeling are to be evaluated by the modeling input data quality and the statistical robustness of the model equation and its temperature variables reflected in the model's statistical test results.

Q. Are the Company's schedule-level model equations properly specified?

A. Yes. Contrary to Ms. Liu's claim on page 14 of Exh. JL-1CT, PSE's schedule-level model equations are properly specified. Ms. Liu is concerned that simplified models at the schedule level do not provide a reasonable basis for allocation and could produce misleading results. While the schedule model specifications are simpler than the system model specification, they are still sufficient to provide a reasonable basis for allocation. Since the system temperature adjustment is allocated on the basis of the rate schedules' <u>relative</u> magnitudes of temperature sensitivity, a fair allocation is achieved only when the same yardstick is used to measure the schedules' temperature sensitivity. Therefore, the schedule model specifications must be simplified to succeed in developing the model specifications, for all of the weather-sensitive rate schedules, which are consistent not only with their explanatory variables but also with the ways the model equations are structured.

The Company's rate schedule model specifications and statistical test results are provided in Exh. CKC-5. Judging from the statistical test results of the model specifications, the model coefficients of temperature variables are statistically robust enough to be used for the rate-schedule allocation. In statistics, the value of R-squared measures the portion of total variance of the target variable (Y variable) explained by the explanatory variables (X variables) included in the model equation. In this case, Y variable is daily energy use per customer and X variables are the intercept terms and the temperature variables included in the schedule model equations. If the value of R-squared is 1.0, the model equation provides the perfect fit and 100 percent of the variations in energy use per customer is explained by the model's explanatory variables. The value of R-squared gets smaller when explanatory power of the model equation becomes weaker. Table 3 below compares the values of R-squared calculated for PSE's schedule model equations with the R-squared values of Staff's model equations.

Table 3

Comparison of the Values of R-Squared from Staff's and PSE's Electric Schedule Model Equations

Rate Schedule	RS 05	RS 07	RS 08	RS 10	RS 11	RS 12	RS 24	RS 25
Staff's	0.9815	0.9663	0.6110	0.8891	0.9482	0.9258	0.9282	0.8436
PSE's	0.9793	0.9619	0.6062	0.8590	0.9407	0.9182	0.9189	0.8408
Difference	0.0022	0.0044	0.0048	0.0301	0.0075	0.0076	0.0093	0.0028

Rate Schedule	RS 26	RS 29	RS 31	RS 43	RS 4025	RS 4026	RS 4031
Staff's	0.9387	0.3844	0.9324	0.8959	0.9017	0.8074	0.7208
PSE's	0.9386	0.3630	0.9289	0.8949	0.9005	0.8065	0.7215
Difference	0.0001	0.0214	0.0035	0.0010	0.0012	0.0009	-0.0007

As illustrated in Table 3, the Company's schedule model specifications are as good as Staff's. For 13 out of 15 weather-sensitive rate schedules, Ms. Liu could increase the explanatory power of model equations by less than one percent, even after adding many variables and monthly details into the model specifications. For the two remaining rate schedules (RS 10 and RS 29), the level of improvement she made was only 2-3 percent. Since RS 10 (Agricultural Primary General Service) and RC 29 (Irrigation and Drainage Pumping Service) are fairly small rate classes, this improvement is even less significant. Despite a negligible gain in the models' explanatory power, Ms. Liu concluded that Staff's schedule model coefficients are so superior that they should solely be used to estimate the schedule-level temperature adjustments, claiming that the Company's schedule model coefficients are incorrectly specified and not proper to be used even as the basis of allocation.[5]

Q. Should the Commission require PSE to exclude Schedule 29 from the temperature normalization adjustment, as Staff proposes?

A. No. The electric energy sales to Schedule 29 customers are used for seasonal irrigation and drainage pumping. The need for irrigation and its energy use increases on summer days as the weather gets warmer and the moisture in soil evaporates faster. Therefore, the variation in Schedule 29 customers' usage is clearly affected by weather, and Ms. Liu's recommendation to remove Schedule 29 sales from the temperature normalization is perplexing and unsupported.[6]

Because irrigation energy sales are highly seasonal and volatile, developing a good-fit model equation is a big challenge. Furthermore, a substantial number of

[5] Liu, Exh. JL-1CT at 14:10-21 and 15:1-2.
[6] Liu, Exh. JL-1CT at 18:6-7.

Schedule 29 customers close their accounts during the winter and shoulder months to save their electricity bills and re-open them when the irrigation season begins. Table 4 below illustrates how the monthly number of irrigation customers fluctuated during the test-year period.

Table 4
Monthly Number of Schedule 29 Customers During the Test Year

Month	Customers
Oct-15	556
Nov-15	518
Dec-15	501
Jan-16	496
Feb-16	493
Mar-16	500
Apr-16	538
May-16	610
Jun-16	642
Jul-16	658
Aug-16	663
Sep-16	656
Max.	663
Min.	493
Diff.	170

The difficulty in developing a good-fit model equation is not a valid reason to ignore the summer weather sensitivity of irrigation energy use. The major reason for poor fitness of PSE's and Staff's Schedule 29 model equations is the models' ineffectiveness of explaining the non-weather related changes in daily energy use per customer, such as the non-summer seasonal shut-downs and the irrigation energy use for indoor farming. The low R-squared values are due to a lack of some important variables used to explain those non-weather related variations in irrigation energy use. Poorly fit model equations tend to produce high forecast errors as indicated by a high mean absolute percentage error ("MAPE"). However, the low R-squared value and the high MAPE do not necessarily mean that the temperature variable included in the model equation and its estimated coefficient are also ineffective and inaccurate to explain the weather-sensitive portion of irrigation energy use.

Citing the low value of adjusted R-squared and the high MAPE, Ms. Liu concludes that the estimated coefficient of temperature variable (CDD60) is inaccurate and unreliable to use for the irrigation sales temperature normalization.[7] However, her conclusion is based on irrelevant statistical measures. The two statistical measures she cites are appropriate when evaluating the model equation for energy sales forecasting, not for evaluating the effectiveness of the model coefficient of the temperature variable (CDD60) as the supplementary information to determine Schedule 29's share of the summer temperature adjustment at the system level. In this case, a more appropriate evaluation measure is the value of t-statistics calculated for the temperature variable. The t-statistics value calculated for CDD60 is 4.28, which is much higher than the critical value of 1.96 set for a 95 percent confidence limit to declare that the temperature variable is really significant to explain the weather-related variations in irrigation energy use per customer. The significance test result gives almost 100 percent assurance that the irrigation energy use is temperature sensitive, and the model coefficient of CDD60 variable is sufficiently reliable to be used for the summer temperature adjustment allocation.

[7] Liu, Exh. JL-1CT at 17:1-22 and 18:1-2. Ms. Liu used the value of R-squared adjusted for the model's degree of freedom, which is equal to the number of observations minus the number of explanatory variables included in the model equation. However, there is no significant difference between the unadjusted and the adjusted values of R-squared when a high number of observations (1,461 in this case) are used for modeling.

III. GAS TEMPERATURE ADJUSTMENTS

Q. What is the major difference between the gas modeling and temperature adjustment processes followed by you and Ms. Liu?

A. I followed the same two-model approach for gas temperature adjustments as I did for electric temperature adjustments. First, I developed system-level and schedule-level model equations using the most recent four-year history of daily temperature and gas energy use per customer for system modeling and the most recent five-year history of monthly temperature and gas energy use per customer for schedule modeling. Three system-level model equations were developed for the firm, interruptible, and transportation service classes. Schedule-level model equations were developed for the twelve weather-sensitive rate schedules, which consist of five firm service rate schedules, three interruptible rate schedules and four transportation service rate schedules. I then estimated temperature adjustments of energy use for the three different service classes and for the twelve rate schedules by using the corresponding model coefficients of the temperature variables. In the next step, the temperature adjustment estimated at the system level was allocated among the rate schedules based on the relative magnitudes of the estimated temperature adjustment by schedule in each of the firm, interruptible, and transportation service classes.

In response, Ms. Liu argues that PSE should use only the schedule-level modeling results to estimate the temperature adjustment by rate schedule.[8] Her schedule-level model equations were estimated with a ten-year history of monthly temperature and gas energy use per customer.[9] After evaluating the model equations' statistical test results, she chose PSE's schedule model equations over Staff's to estimate the temperature adjustment by schedule.[10]

Q. Why is it necessary to use the two-model approach for the gas temperature normalization?

A. Accurate and reliable data of daily gas use is available only at the system level. Since the coverage of daily gas readings at the schedule level is not as complete as in the case of electricity, calendar-month data of gas use per customer was used for the schedule modeling. As explained in PSE's Response to WUTC Staff Data Request No. 009, calendar-month gas usage data by schedule is estimated by prorating the billing-cycle sales on the basis of how many days in each billing cycle fall under the current month and summing the prorated volumes for all of the billing cycles.[11] One important assumption made for this estimation method is that daily gas use in a given billing cycle stays the same. While this estimation method yields a good approximation of energy use on a calendar-month basis, quality of the schedule-level data is expected to be much lower than the case of system energy use data. As the variance of daily energy use in the same billing

[8] Liu, Exh. JL-1CT at 20:5-7.
[9] Liu, Exh. JL-5.
[10] Liu, Exh. JL-1CT at 22:1-4.
[11] Exh. CKC-4 at 2.

cycle period gets higher, the estimation error becomes larger. This is especially true for the transitional months like April, May and October.

Due to the unavoidable risk of errors in the schedule modeling data, it is inappropriate to use only the schedule modeling results to estimate the temperature adjustment by schedule, especially considering that the system modeling data is free of errors. However, the schedule modeling data and results provide a fair and reasonable basis for allocating the system total adjustment to rate schedules.

Q. Why did you limit the historical data period to four to five years for the system and the schedule modeling databases?

A. PSE has actively promoted various energy efficiency and conservation programs over the last ten or more years and increases in the number of program participants and the program impacts on gas and electric energy use have been accelerating. In addition, energy efficiencies of new appliances and buildings have been improving continuously. Therefore, the temperature sensitivity of energy use per customer estimated with historical energy usage data tends to overstate the sensitivity for the test year. The risk of over-estimation will increase as the historical data period for modeling is stretched to include more distant past years. In the meantime, developing a stable and reliable temperature sensitivity model equation requires a sufficient number of observations to cover various possible circumstances. To some extent, determining the optimum number of years for historical data period is a judgment call. The data period should be short enough to stay relevant to the test-year energy use behavior and yet long enough to provide a sufficient number of observations for modeling. Therefore, PSE set four years of daily history for electric system and schedule modeling and gas system modeling (1,461 observations) and five years of monthly history for gas schedule modeling (60 observations).

Q. Is Chow's Breakpoint Test an appropriate statistical tool to determine an optimum number of years for historical data period?

A. No. Ms. Liu ran Chow's Breakpoint Test for each weather-sensitive rate schedules to evaluate the use of historical monthly data for ten years, instead of five years.[12] She used January 2012 as the breakpoint and split the ten-year period of January 2007 through December 2016 into two five-year periods, defining the first five-years as the pre-breakpoint period and the second five-years as the post-breakpoint period.

The purpose of her Chow's Tests was to determine whether there was no significant change in weather sensitivity between the pre- and post-breakpoint periods. However, I believe she made a wrong application of the statistical test. As the name of the test method implies, Chow's "Breakpoint" Test is to determine whether there was a sudden shift in energy use behavior at the breakpoint assumed for testing. The purpose of Chow's Test is to check whether there was a structural change in relationship between the dependent variable (Y variable) and the explanatory variables (X variables) due to an exogenous shock or a major

[12] Liu, Exh. JL-1CT at 21:8-15.

event, such as a war or the energy crisis that occurred in 1973-1974. The test is not applicable to this case, where the impacts of energy efficiency and conservation programs and the energy market transformation have been accumulated gradually and continuously over the last ten years without an obvious breakpoint.

IV. REVISIONS TO EXH. CKC-1T

Q. Have you made any revisions to your prefiled direct testimony since it was filed with the Commission on January 13, 2017?

A. Yes. As explained in PSE's Responses to WUTC Staff Data Requests Nos. 006 and 046, and as stated in the prefiled supplemental testimony of Jon A. Piliaris, Exh. JAP-34T, an incorrect historical data period was picked for the original gas rate-schedule modeling.[13] This was due to a glitch in the way Eviews (the econometric modeling software used) selected the historical data period. The gas schedule model coefficients were re-estimated with the input data for the correct historical data period. The temperature adjustment of gas sales by rate schedule was then re-calculated with the revised model coefficients. While the results of this correction were discussed in detail and filed as Exh. JAP-36, the correction has prompted the following three minor changes to pages 13-15 of my prefiled direct testimony:

1) The last sentence (lines 9 - 10) in page 13 should read: "The residential class represented 68.3 percent of the total temperature adjustment,

[13] *See* Exh. CKC-4 at 1 and 4-5.

increasing by 56,673,771 therms." The original percentage and therm figures were 68.5 percent and 56,828,702 therms.

2) The statement made in lines 3-5 of page 15 should state: "The positive adjustment to volume had the effect of increasing pro forma revenue by $58,038,526 as shown on page 2 of the third exhibit to Prefiled Supplemental Direct Testimony of Susan E. Free, Exhibit No. ___(SEF-11)." The original dollar figure was $58,088,570.

3) Table 4 presented in page 14 should be replaced with the following table:

Table 4

Temperature Adjustment of Test Year Gas Sales by Rate Schedule

Month	Residential (Sch.23) Actual	Normalized	Adjustments	General service - commercial (Sch.31) Actual	Normalized	Adjustments	Large volume - commercial (Sch.41) Actual	Normalized	Adjustments	Trans. large volume - commercial (Sch.41T) Actual	Normalized	Adjustments
Oct-15	33,579,055	42,897,331	9,318,276	12,275,932	14,337,785	2,061,853	3,789,962	4,241,811	451,849	767,064	814,694	47,630
Nov-15	68,116,459	62,231,323	(5,885,136)	21,666,240	20,134,387	(1,531,853)	5,675,551	5,384,407	(291,144)	943,467	924,955	(18,512)
Dec-15	90,893,644	96,653,308	5,759,664	28,885,283	30,436,098	1,550,815	6,905,082	7,185,727	280,645	1,003,435	1,025,062	21,627
Jan-16	85,755,690	91,595,599	5,839,909	27,959,875	29,591,261	1,631,386	6,784,594	7,082,362	297,768	1,001,568	1,025,091	23,523
Feb-16	64,160,071	77,635,007	13,474,936	21,315,956	24,843,476	3,527,520	5,559,170	6,208,005	648,835	883,343	936,348	53,005
Mar-16	57,987,038	65,304,168	7,317,130	19,716,825	21,624,884	1,908,059	5,456,896	5,847,432	390,536	954,951	999,982	45,031
Apr-16	32,880,811	45,772,321	12,891,510	12,422,878	15,575,923	3,153,045	3,904,814	4,583,899	679,085	792,787	860,573	67,786
May-16	22,995,261	28,825,585	5,830,324	9,877,099	11,230,900	1,353,801	3,333,812	3,677,961	344,149	784,988	801,403	16,415
Jun-16	17,774,336	19,259,250	1,484,914	8,485,848	8,756,017	270,169	2,844,983	2,943,456	98,473	780,208	780,208	0
Jul-16	14,047,510	14,539,363	491,853	7,677,068	7,677,068	0	2,501,771	2,501,771	0	718,891	718,891	0
Aug-16	13,454,917	13,454,917	0	7,480,555	7,480,555	0	2,440,094	2,440,094	0	759,239	759,239	0
Sep-16	19,212,587	19,362,978	150,391	8,692,626	8,716,597	23,971	2,876,166	2,881,578	5,412	738,568	738,568	0
Test Year	520,857,380	577,531,151	56,673,771	186,456,185	200,404,951	13,948,766	52,072,896	54,978,504	2,905,608	10,128,510	10,385,015	256,505

Month	Trans. interrupt with firm option - com (Sch.85T) Actual	Normalized	Adjustments	Trans. non-exclus inter w/ firm option - com (Sch.87T) Actual	Normalized	Adjustments	Interruptible with firm option - com (Sch.85) Actual	Normalized	Adjustments	Limited interrupt w/ firm option - com (Sch.86) Actual	Normalized	Adjustments
Oct-15	1,915,364	2,030,730	115,366	1,401,283	1,596,732	195,449	1,104,599	1,253,947	149,348	584,641	793,439	208,798
Nov-15	2,207,664	2,164,784	(42,880)	1,907,649	1,817,504	(90,145)	1,544,361	1,489,119	(55,242)	1,035,220	966,331	(68,889)
Dec-15	2,374,311	2,425,237	50,926	2,169,714	2,258,421	88,707	1,841,314	1,911,937	70,623	1,244,314	1,324,534	80,220
Jan-16	2,247,063	2,301,685	54,622	2,056,259	2,171,151	114,892	1,864,923	1,950,575	85,652	1,229,752	1,320,646	90,894
Feb-16	1,979,452	2,075,861	96,409	1,780,763	2,053,395	272,632	1,551,216	1,737,153	185,937	970,264	1,191,520	221,256
Mar-16	2,045,131	2,133,346	88,215	1,834,998	1,998,704	163,706	1,551,126	1,667,703	116,577	934,290	1,062,259	127,969
Apr-16	1,796,330	1,945,606	149,276	1,376,208	1,663,093	286,885	1,114,867	1,313,698	198,831	569,633	785,759	216,126
May-16	1,834,280	1,917,455	83,175	1,273,969	1,432,692	158,723	888,069	986,245	98,176	409,297	521,401	112,104
Jun-16	1,719,440	1,739,316	19,876	1,151,746	1,151,746	0	693,500	726,715	33,215	298,096	351,433	53,337
Jul-16	1,652,963	1,652,963	0	1,091,625	1,091,625	0	684,020	684,020	0	211,648	211,648	0
Aug-16	1,701,216	1,701,216	0	1,053,948	1,053,948	0	657,181	657,181	0	200,004	200,004	0
Sep-16	1,750,045	1,750,045	0	1,096,161	1,096,161	0	554,907	554,907	0	303,869	311,274	7,405
Test Year	23,223,258	23,838,243	614,985	18,194,323	19,385,172	1,190,849	14,050,084	14,933,201	883,117	7,991,029	9,040,249	1,049,220

Month	Non-excl interrupt w/ firm option - com (Sch.87) Actual	Normalized	Adjustments	General service - industrial (Sch.31) Actual	Normalized	Adjustments	Large volume - industrial (Sch.41) Actual	Normalized	Adjustments	Special contracts - ind (Sch.SC) Actual	Normalized	Adjustments
Oct-15	1,635,697	1,828,874	193,177	797,474	1,071,326	273,852	989,415	1,032,448	43,033	2,606,277	3,057,947	451,670
Nov-15	2,244,803	2,169,692	(75,111)	1,464,652	1,310,838	(153,814)	1,086,769	1,067,029	(19,740)	3,814,923	3,637,675	(177,248)
Dec-15	2,549,000	2,645,547	96,547	2,064,974	2,211,944	146,970	1,047,274	1,063,328	16,054	3,984,679	4,152,219	167,540
Jan-16	2,673,883	2,779,903	106,020	2,025,303	2,181,458	156,155	1,062,942	1,082,244	19,302	4,055,477	4,268,862	213,385
Feb-16	2,188,620	2,404,527	215,907	1,520,580	1,878,675	358,095	941,456	979,025	37,569	3,421,158	3,939,511	518,353
Mar-16	2,193,232	2,315,574	122,342	1,380,951	1,577,276	196,325	999,050	1,029,267	30,217	3,687,973	4,038,379	350,406
Apr-16	1,753,163	1,977,000	223,837	810,001	1,174,451	364,450	870,580	919,553	48,973	2,710,026	3,356,298	646,272
May-16	1,571,481	1,668,820	97,339	550,078	759,469	209,391	810,833	834,281	23,448	2,400,467	2,699,135	298,668
Jun-16	1,372,126	1,372,126	0	456,413	546,530	90,117	751,542	751,542	0	2,165,598	2,249,234	83,636
Jul-16	1,364,669	1,364,669	0	418,638	496,780	78,142	726,665	726,665	0	1,956,144	1,956,144	0
Aug-16	1,339,088	1,339,088	0	427,025	427,025	0	754,257	754,257	0	1,845,611	1,845,611	0
Sep-16	1,445,560	1,445,560	0	513,500	523,501	10,001	772,506	772,506	0	2,001,842	2,022,223	20,381
Test Year	22,331,323	23,311,381	980,058	12,429,589	14,159,273	1,729,684	10,813,290	11,012,146	198,856	34,650,174	37,223,237	2,573,063

Month	Total weather normalized portion of volume Actual	Normalized	Adjustments
Oct-15	61,446,763	74,957,064	13,510,301
Nov-15	111,707,759	103,298,045	(8,409,714)
Dec-15	144,963,026	153,293,364	8,330,338
Jan-16	138,717,329	147,350,837	8,633,508
Feb-16	106,272,049	125,882,503	19,610,454
Mar-16	98,742,461	109,598,974	10,856,513
Apr-16	61,002,098	79,928,174	18,926,076
May-16	46,729,636	55,355,349	8,625,713
Jun-16	38,493,837	40,627,574	2,133,737
Jul-16	33,051,611	33,621,606	569,995
Aug-16	32,113,134	32,113,134	0
Sep-16	39,958,338	40,175,899	217,561
Test Year	913,198,042	996,202,524	83,004,482

V. CONCLUSION

Q. Please summarize your findings.

A. After evaluating the Temperature Normalization section of Ms. Jing Liu's prefiled response testimony, I have found that:

1) Since a two-model approach followed by the Company for both electric and gas temperature normalization was necessitated by a significant gap in data quality between the energy use per customer data used for the system modeling and the schedule modeling, the single-model approach recommended by Ms. Liu is destined to produce an inaccurate and unreliable estimate of temperature adjustment by schedule.

2) The Company's electric schedule model equations are properly specified and statistically robust to provide a reasonable basis for allocating the system-level temperature adjustment among the weather-sensitive rate schedules.

3) Schedule 29 electric sales are summer weather-sensitive and should not be excluded from temperature normalization.

4) The historical data periods of four to five years selected for the electricity and the gas temperature sensitivity modeling are reasonable to have the estimated model coefficients relevant to the test-year sensitivity and yet to provide a sufficient number of observations to cover various underlying circumstances.

5) The analyses presented by Ms. Liu are misleading and do not support or justify any of her recommendations regarding the temperature adjustments of electric and gas sales and revenues.

Q. Does this conclude your rebuttal testimony?

A. Yes.