Exh. RJA-3
Docket UG-240008
Witness: Ronald J. Amen

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, Complainant, v. CASCADE NATURAL GAS CORPORATION, Respondent.	DOCKET UG-240008

CASCADE NATURAL GAS CORPORATION

SECOND EXHIBIT TO THE
DIRECT TESTIMONY OF RONALD J. AMEN

March 29, 2024

ATRIUM ECONOMICS
CENTERED ON ENERGY

Cascade Natural Gas - Washington

Design Day Load Study

March 29, 2024

Table of Contents

List of Figures

List of Tables

1 Introduction

Atrium Economics LLC ("Atrium"), as part of its Scope of Work for Cascade Natural Gas Corporation ("Cascade" or the "Company"), performed a Load Study analysis for the Cascade system. The purpose of this document is to discuss the data gathering, estimation techniques, supporting documentation, and the current load study results. The objective of the Load Study is to quantify Design Day Peak ("Design Day") and attribute Design Day responsibility of individual rate schedule demands to system demands. Once Cascade has performed its load study for all customer groups, Cascade will be able to assign service costs for individual customer classes based on the class contribution to the system peak.

1.1.1 AMI Deployment

The Company has dramatically expanded its daily metering capability through AMI. Table 1, below shows the availability of daily metered data for the Residential (503), General Commercial (504), General Industrial (505), and Large Volume (511) classes for each of Cascade's four distinct weather zones. However, as with any transition in data and forecasting processes, care must be taken to ensure no undue impacts are levied on customers and a careful review of new practices should be compared to the existing data and methods. Accordingly, Atrium has developed a load study using available daily metered data that is informed by monthly billing data to allocate shared costs in Cascade Washington's COSS.

Table 1: Percent of Core Rate Classes with Daily Meter Readings – Dec. 31, 2023

	Daily Data as % of Total Meters			
	Residential CNGWA503	Commercial CNGWA504	Industrial CNGWA505	Large Volume CNGWA511
Yakima	33.46%	52.54%	48.76%	58.06%
Walla Walla	18.50%	41.68%	42.22%	47.37%
Bellingham	78.31%	80.08%	72.16%	77.78%
Bremerton	19.48%	42.19%	43.64%	36.84%

1.1.2 Customer and Load Characteristics

Cascade serves customers throughout a geographically and economically diverse service territory. There are six primary rate classes: Residential Service (Tariff Schedules 503) or "Residential"; General Commercial Service (Tariff Schedule 504) or "Commercial"; General Industrial Service (Tariff Schedule 505) or "Industrial"; Large Volume General Service (Tariff Schedule 511) or "Large Volume"; Interruptible Service (Tariff Schedule 570) or "Interruptible"; Distribution System Transportation Service (Tariff Schedule 663) or "Transportation"; and Special Contracts. (900 series). Rate classes 503, 504, 505 and 511 are considered to be "Core"[1] and are specifically included in Atrium's load study. The remaining classes, Transportation (663), Special Contracts (900 series), and Interruptible (570) are excluded from the load study. Transportation (663) and Special Contracts (900 series) are specifically designated as "non-Core"[2], whereas Interruptible service (570) is also excluded from the load study since this service could be interrupted under Design Day conditions.

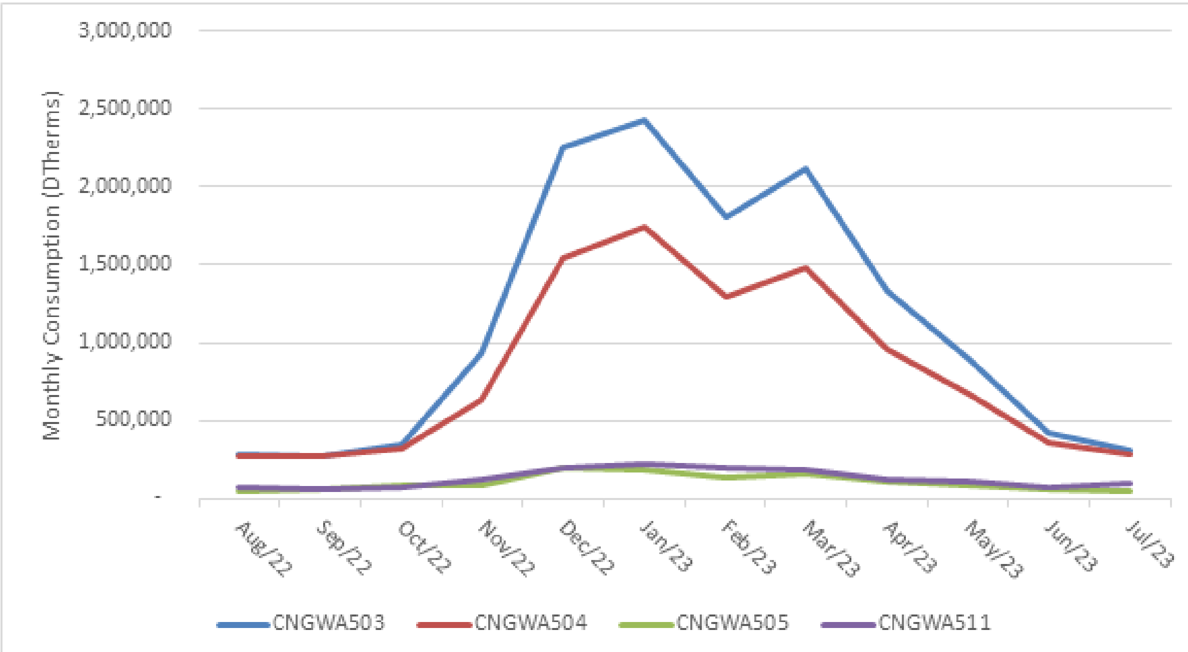
Cascade's customers are spread across four diverse geographic areas with differing weather patterns and elevations (Bellingham, Bremerton, Walla Walla, and Yakima). Bellingham and Bremerton are generally mild with warm dry summers and wet semi-mild winters. They are

[1] "Core" is defined in the Cascade Washington 2023 IRP, as "Residential, firm industrial and commercial gas customers who require utility gas service."

[2] "Non-core" is defined in the Cascade Washington 2023 IRP, as "Large customers who contract with a third party for supply and upstream pipeline capacity. Cascade provides distribution services only. Typical customers include large commercial, industrial, cogeneration, wholesale, and electric generation customers."

comprised of an urban/suburban mix. Yakima and Walla Walla are semi-arid desert and rural. Below is a chart showing total monthly consumption for each Core rate class for the twelve months ended July 31, 2023.

Figure 1: Cascade Monthly Consumption by Rate Class



Cascade's Residential (503) and General Service (504) customers are weather sensitive and are spread across all four weather zones. The Company's General Industrial Service (505) and Large Volume General (511) customers are also spread across all four weather zones and while weather sensitive, they are not as weather driven as the Residential and General Service classes.

Table 2, below, provides a summary of premises and annual consumption projected for the test year ended 2023 as a percentage of Cascade's whole system throughput.

Table 2: 2023 Test Year Premises and Consumption

Classes	Premises	% Premises	Test Year Consumption (Therms)	% Consumption
503 – Residential	204,516	87.78%	129,679,156	10.02%
504 – Commercial	27,660	11.87%	95,464,758	7.37%
505 – Industrial	495	0.21%	12,123,309	0.94%
511 – Large Volume	96	0.04%	14,917,983	1.15%
570 – Interruptible	7	0.00%	2,097,598	0.16%
663 – Transportation	192	0.08%	857,750,139	66.26%
900 – Special Contracts	8	0.00%	182,556,284	14.10%
TOTAL	232,966	**100%**	**1,112,032,943**	**100%**

2 Data and Data Sources

2.1.1 Design Day Weather

The Company's design day represents the coldest temperatures that can be expected to occur during an extreme cold or peak weather event. For upstream forecasting purposes, Cascade uses a stochastic model to develop probability-derived peak HDD values to characterize its design day. The stochastic peak day is a weather zone-specific 99th percentile peak day. The 99th percentile peak day is derived by running 10,000 Monte Carlo simulations on each of the weather zones, based on historical data for December 21st of each year.[3] Once 10,000 draws are gathered and ordered for each weather zone, Cascade can pull the 9,900th draw as the 99th percentile to use in the demand forecast. However, for distribution system planning purposes, Cascade continues to rely on the deterministic coldest day in the 30-year history by weather zone. Atrium has adopted this deterministic peak by weather zone that is reflected in Cascade's most recent IRP that it uses for distribution system planning purposes, for purposes of this Design Day Load Study. The peak heating degree days used in the Load Study by weather zone are shown in Table 3.

[3] The selection of December 21st is mostly arbitrary, though one of Cascade's coldest peak days did occur on a December 21st, with the intention of mimicking a cold winter day. For example, all citygates associated with the Yakima weather station use the 99th percentile peak HDD for Yakima for each December 21st of the forecast period, and similarly for all the other weather stations and citygates.

Table 3: Design Day HDD by Weather Zone[4]

	Bellingham	Bremerton	Walla Walla	Yakima
Design HDD	47	46	66	65

Cascade does not identify "peak wind" for forecasting or planning purposes. For purposes of the Atrium Load Study, peak wind was derived by taking the average wind speed for each weather location for the top 15 sendout days from 2021-2023. The peak wind used in the Load Study by weather zone is shown in Table 4 below.

Table 4: Peak Day Wind by Weather Zone

	Bellingham	Bremerton	Walla Walla	Yakima
Peak Wind	17	11	6	5

2.1.2 Data Inputs

The data inputs for the load study included daily customer usage data, customer counts, and weather data. Customer usage data was examined at multiple frequencies and sources, daily including system sendout ("System Sendout"), monthly billed usage by customer class and weather zone ("Billing Data"), and daily readings from deployed Advanced Metering Infrastructure ("AMI") meters by customer class and weather zone ("AMI Data"). All customer usage data was measured in therms. Cascade's daily AMI Data for the load study was captured at the aggregate customer usage by town and by weather zone. The town level daily AMI Data provided to Atrium was later aggregated by weather zone.

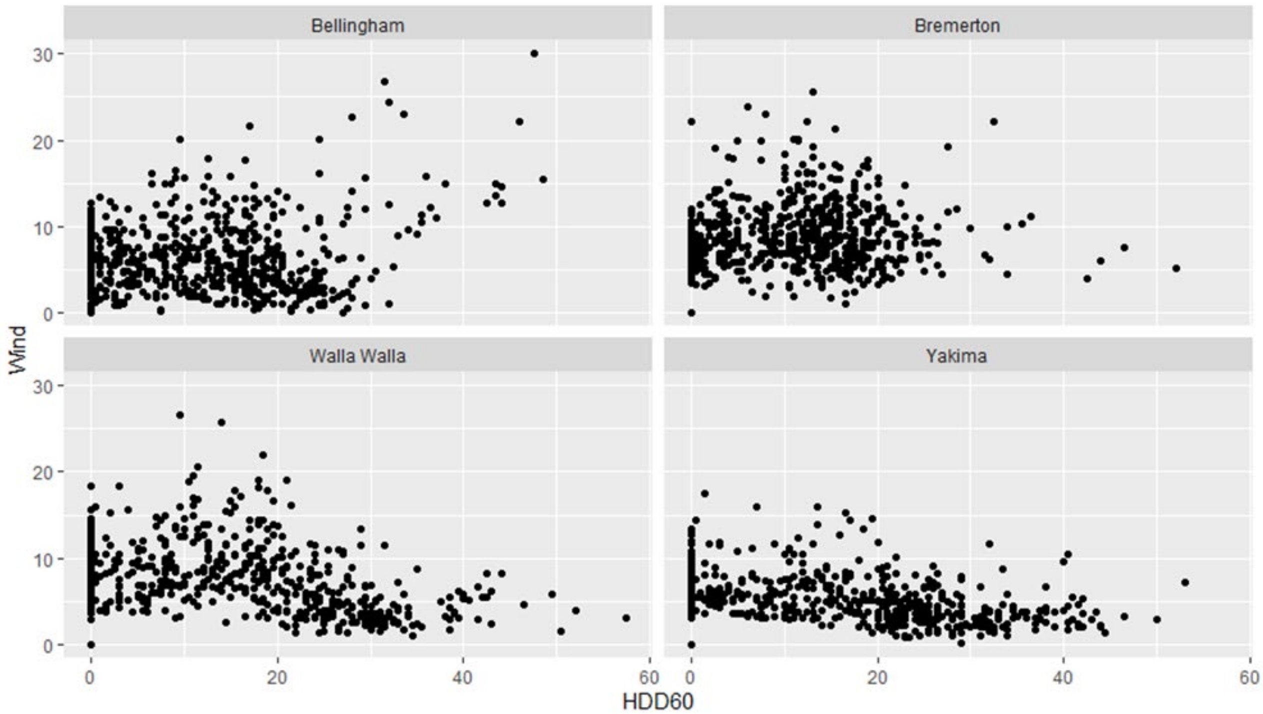
Customer counts for the Billing Data are provided from the Cascade accounting and billing systems. As indicated above, customer counts for the AMI Data represent a subset of the system as the AMI deployment is not yet 100%.

[4] Cascade Natural Gas 2023 Integrated Resource Plan (February 24, 2023), Table 8-1.

Cascade utilized National Oceanic and Atmospheric Administration ("NOAA") to gather daily weather data information for the four Washington weather zones, Bellingham, Bremerton, Yakima, and Walla Walla. The data obtained from NOAA were actual and normal wind and actual and normal weather. Normal wind is defined by NOAA as the average daily wind speed and normal weather is defined as the average daily temperatures of the most recent 30 years of historical data.

The Company uses a heating degree day (HDD) as the unit of measure for temperature. HDD is calculated by taking the average temperature from a day and subtracting it from a reference temperature. If the reference temperature less HDD is negative, then the Company gives that day a 0 value for HDD. The Company uses 60°F as the reference temperature ("HDD Base 60" or "HDD 60"). For example, a 50°F day will result in 10 HDDs (60-50). Cascade provided Atrium with HDD 60 data for the four Washington weather locations as well as daily average wind speed for those same four weather locations. Aside from Bellingham, a coastal region, low temperatures and high windspeed do not exhibit much correlation in the data.

Figure 2: Wind/HDD Scatter Plots by Weather Zone (12-11-2021 to 12-31-2023)



2.1.3 Data Review

Upon receiving the daily AMI data (aggregated at the town level), Atrium reviewed the data removing any days with negative therms, or days where HDD 60 exceeded 10, but therms were zero. These appeared to be data irregularities that would skew load study data analysis and results. Atrium also removed data that was uncharacteristically high and a clear outlier, given weather and data trends for the respective rate class and weather zone.

3 Estimation Techniques

3.1.1 Daily Regression

Atrium conducted its Load Study based on a linear regression model. In Cascade's prior load study, it found linear regression to be the most robust model to build the relationship between weather and usage.[5] Once the obvious data irregularities were removed, Atrium performed regression analyses on the Residential class's (503) daily AMI dataset to identify weather sensitive loads, measuring the historical linear relationship between metered daily volumes per customer, HDD 60, and average wind for the residential customer class in each weather zone. The linear formula for each weather zone and rate class may be characterized as follows:

$$UPC_{R\_Class} = \alpha + \beta_{HDD\ 60} HDD\ 60^{D} + \beta_{Wind} Wind^{D} + \epsilon^{D}$$

Where:

- UPC_{R_Class} = Use-per-customer for the Residential class
- $\beta_{HDD\ 60} HDD\ 60^{D}$= Load response to Daily HDD by weather location
- $\beta_{Wind} Wind^{D}$ = Load response to Daily average wind by weather location
- ϵ^{D} = Residual daily error term

For the Commercial and Industrial classes (504, 505, and 511), in addition to HDD 60 and average wind, a dummy variable was introduced to capture patterns in weekend and weekday usage, where weekend days were assigned a "1" and weekdays were assigned a "0". The linear formula for the commercial and industrial rate classes for each weather zone and rate class is characterized below:

$$UPC_{C\&I\_Class} = \alpha + \beta_{HDD\ 60} HDD\ 60^{D} + \beta_{Wind} Wind^{D} + \beta_{WE} WE^{D} + \epsilon^{D}$$

Where:

- $UPC_{C\&I\_Class}$ = Use-per-customer for the Residential class
- $\beta_{HDD\ 60} HDD\ 60^{D}$= Load response to Daily HDD by weather location
- $\beta_{Wind} Wind^{D}$ = Load response to Daily average wind by weather location
- $\beta_{WE} WE^{D}$= Load response when day of the week falls on a weekend
- ϵ^{D} = Residual daily error term

[5] Cascade Natural Gas Load Study Analysis, Design Document (September 2022) at 9 "Cascade Load Study".

Regressions were performed on all available daily AMI data for the period from December 11, 2021, to December 31, 2023.

The preliminary results of the Daily Regressions are shown in Table 5, below.

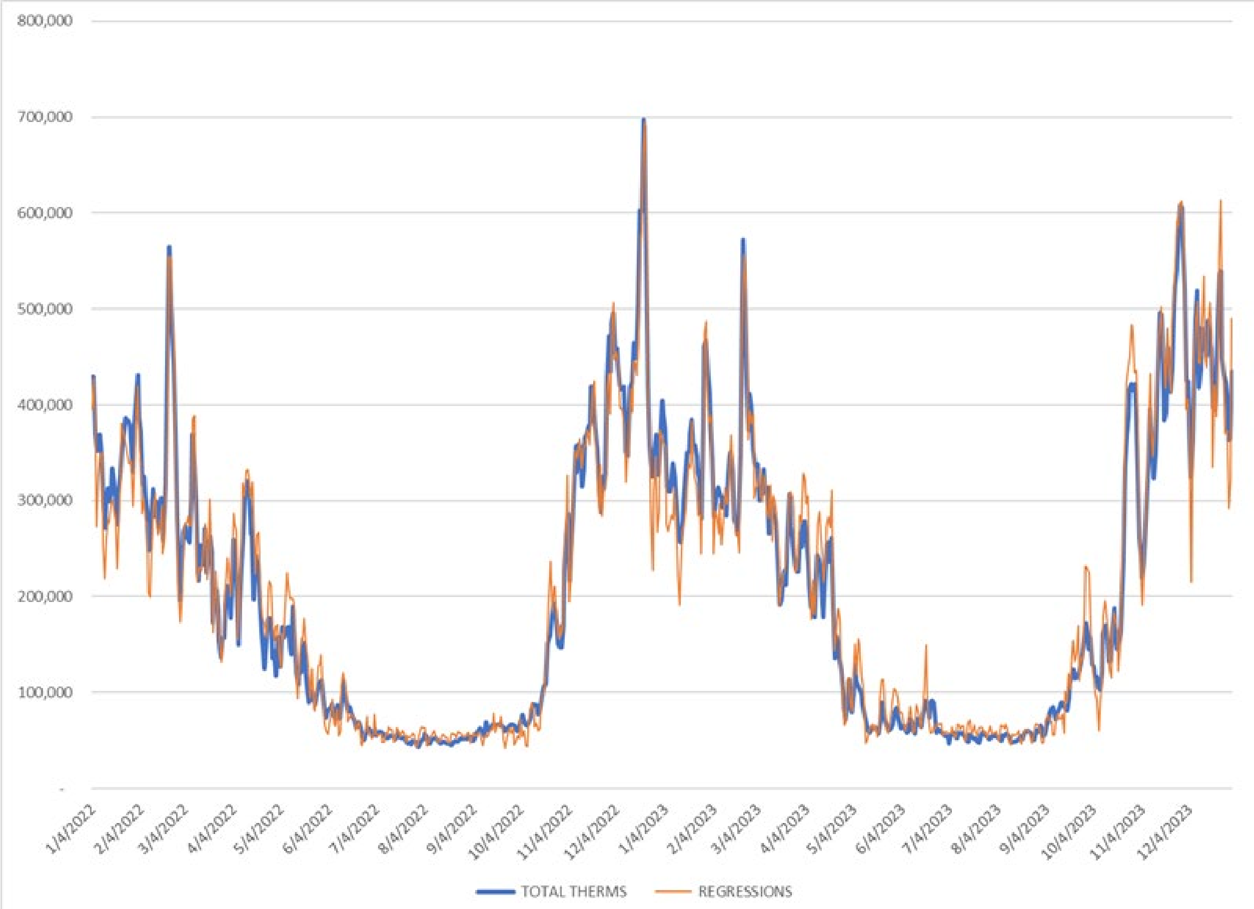
Table 5: Daily Regression Results

				Intercept		HDD		Wind		Weekend Dummy	
Rate	Weather Zone	Adjusted R2	F	Y Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat
CNGWA503	Yakima	0.965	10,278.669	0.188	6.502	0.100	132.359	0.015	3.674		
	Walla Walla	0.924	4,590.426	0.233	6.685	0.102	95.076	0.022	6.023		
	Bremerton	0.933	5,222.089	0.147	4.883	0.139	97.587	0.037	11.756		
	Bellingham	0.966	10,604.320	0.308	19.335	0.113	139.259	0.030	14.853		
CNGWA504	Yakima	0.957	5,582.702	3.094	17.713	0.534	118.810	0.044	1.873	(0.611)	(5.124)
	Walla Walla	0.912	2,576.916	2.846	14.455	0.512	87.018	0.079	3.986	(0.172)	(1.096)
	Bremerton	0.917	2,761.783	2.784	17.551	0.644	86.708	0.160	9.739	(1.099)	(8.762)
	Bellingham	0.959	5,875.660	1.771	25.029	0.433	126.627	0.109	12.664	(0.768)	(10.335)
CNGWA505	Yakima	0.883	1,891.716	35.198	24.265	2.451	65.800	(0.325)	(1.653)	(19.096)	(19.303)
	Walla Walla	0.702	589.022	28.779	21.553	1.569	39.366	0.252	1.867	(13.856)	(13.038)
	Bremerton	0.851	1,426.820	4.356	5.701	2.166	60.553	0.687	8.655	(8.709)	(14.421)
	Bellingham	0.857	1,504.572	17.866	33.946	1.539	60.496	0.367	5.735	(12.333)	(22.329)
CNGWA511	Yakima	0.926	3,126.999	72.787	21.542	7.678	88.397	0.384	0.839	(20.329)	(8.815)
	Walla Walla	0.877	1,788.744	46.000	11.932	8.384	72.772	3.215	8.272	(17.516)	(5.690)
	Bremerton	0.895	2,136.110	43.061	23.483	6.612	77.041	1.251	6.567	(6.686)	(4.613)
	Bellingham	0.936	3,659.413	28.463	22.980	5.962	99.602	1.318	8.742	(18.195)	(13.998)

3.1.2 Daily Regression Model Verification

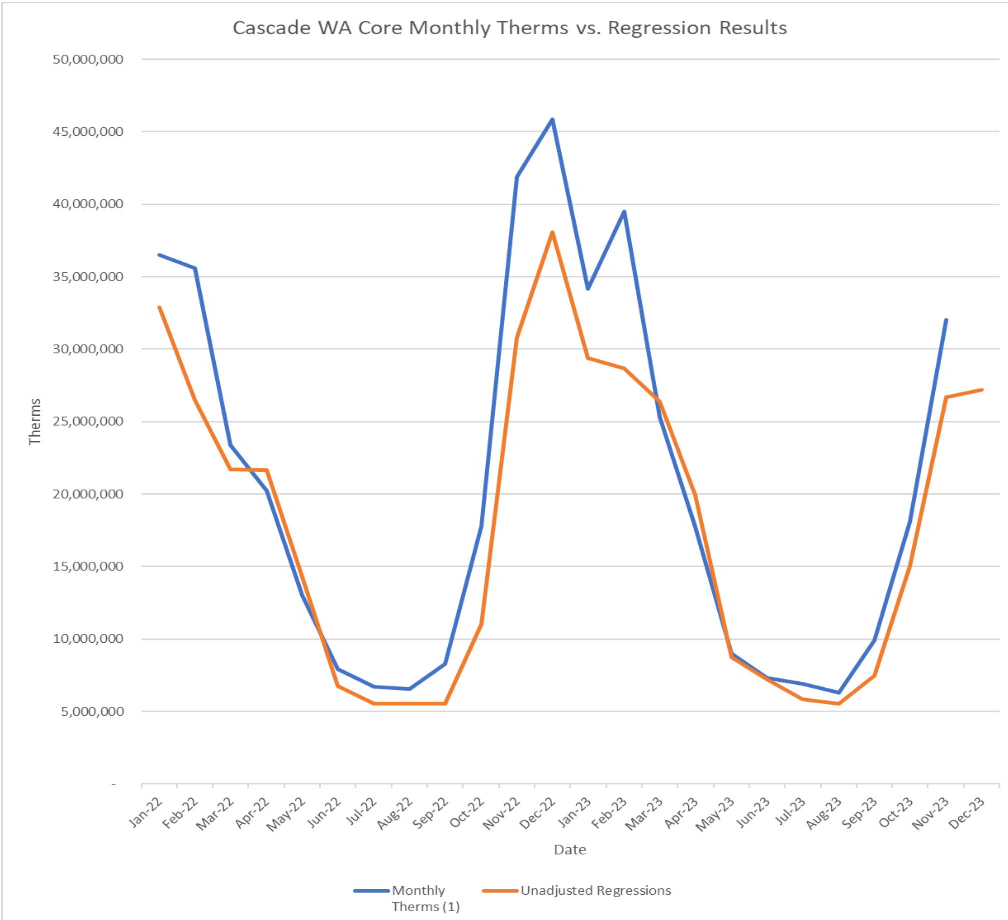
Atrium performed a model validation step to check the accuracy of the daily regression results in their ability to predict load under actual historic weather conditions. To check the appropriateness of the modeling results, total therms were derived from the daily regression coefficients by applying the regression derived use-per-customer ("UPC"), given historical HDD, wind, and day of the week (where applicable), and multiplied the result by monthly customers in our daily AMI data set. This was compared to the summarized actual daily AMI usage data and customer meters that Atrium collected. Based on Figure 3, below, Atrium determined that, the model was reasonably able to predict the Core customers' load response to HDD and wind (and weekend, where applicable) for the given AMI data.

Figure 3: Daily Model Verification – Daily Regressions vs. Summarized Daily Data



In addition, Atrium performed two other tests of model validation for the daily regressions. Though Atrium was satisfied that the daily regression model was reasonably able to predict the total therms for a given day and weather for the data in our Daily AMI sample dataset, Atrium also tested the Daily Regression alignment to core System Sendout and Billing Data, which are generally considered to be the most representative of the Company's load and customer usage. In order to align with monthly Billing and daily System Sendout, the Daily AMI UPC regression results were extrapolated to the total number of customers (as of December 31, 2023) for each weather zone and each core customer class. The results are shown in Figure 4, and Figure 5, below.

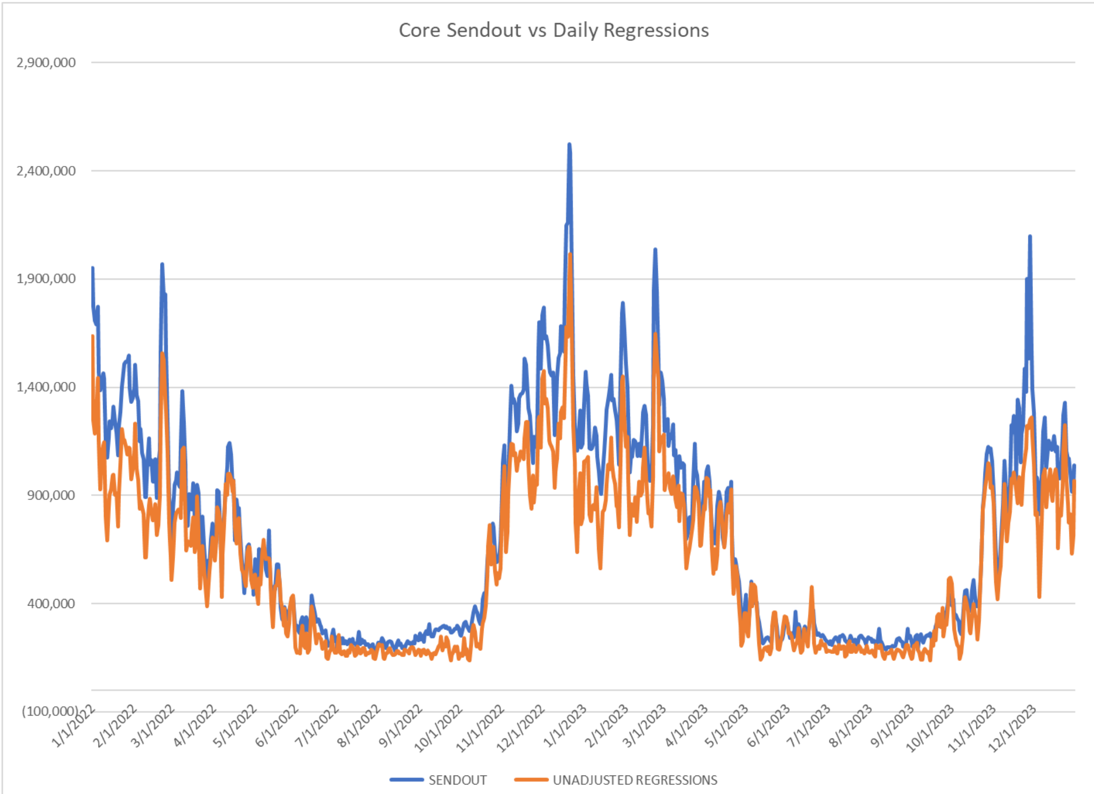
Figure 4: Load Estimated by Daily Regressions Compared to Monthly Billing Data[6]



As Figure 4 shows, the Daily AMI dataset underestimated class load, given actual HDD and Wind (and day of the week, where applicable) when compared to monthly Billing Data. Atrium also observed this when comparing total core load derived for the historical period covered by the daily AMI dataset using daily regression results and core System Sendout. Figure 5, below, shows the marked disparity between the results of the daily regression results and actual core System Sendout. As Figure 6 shows, the load prediction using the daily regression results materially underestimated core System Sendout.

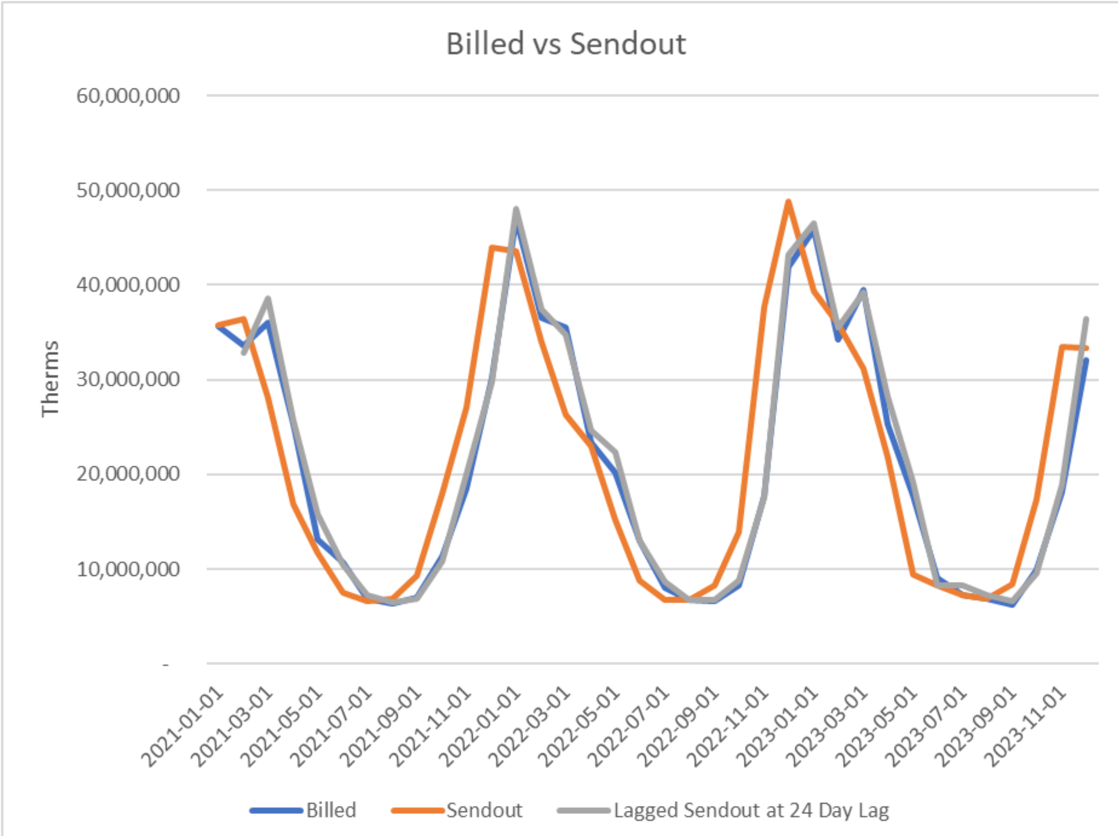
[6] For simplicity, the monthly data was assumed to be lagged by one full month (rather than 24 days) and was moved to the preceding month to align with daily data.

Figure 5: Core Sendout vs. Load Estimated by Daily Regressions



Atrium performed one final model verification step. The *daily* System Sendout was converted to *monthly* System Sendout and compared to the *monthly* Billing Data. Atrium expected the data to be similar, though due to differences between daily usage and monthly billing cycles and meter reading dates, a lag will occur between the System Sendout and Billing Data. Analysis determined the best estimate of this lag was 24 days, based on the closest correlation between Billing Data and System Sendout, given a range of lag periods. Figure 6, below, demonstrates the effect of lagging the System Sendout by 24 days to most closely agree to Billing Data, and more importantly shows that core System Sendout and monthly Billing Data are in agreement once the System Sendout Data is lagged.

Figure 6: Lag Analysis Results



Overall, Atrium's review of the AMI Data demonstrated that the UPC per day derived from the AMI Data closely reflected the daily data in our Daily AMI dataset, but differed significantly from the expectations from the Billed Data. For the smaller customer classes (503 and 504), the variance was relatively uniform across the year. For the larger customer classes (505 and 511), the variance was not constant, demonstrating a greater variance in the winter months compared to the non-winter months, suggesting that the AMI Data coverage for the 505 and 511 classes did not capture the load characteristics of the population. Consequently, Atrium determined that the Daily AMI Data would require adjustments to ensure that the resulting analysis using the AMI Data did not underestimate the expected Design Day contribution from Classes 505 and 511. For this reason, Atrium determined that an analytical process was necessary to calibrate and adjust the AMI Data to more closely agree to the Billing Data and System Sendout for the Core customer classes.

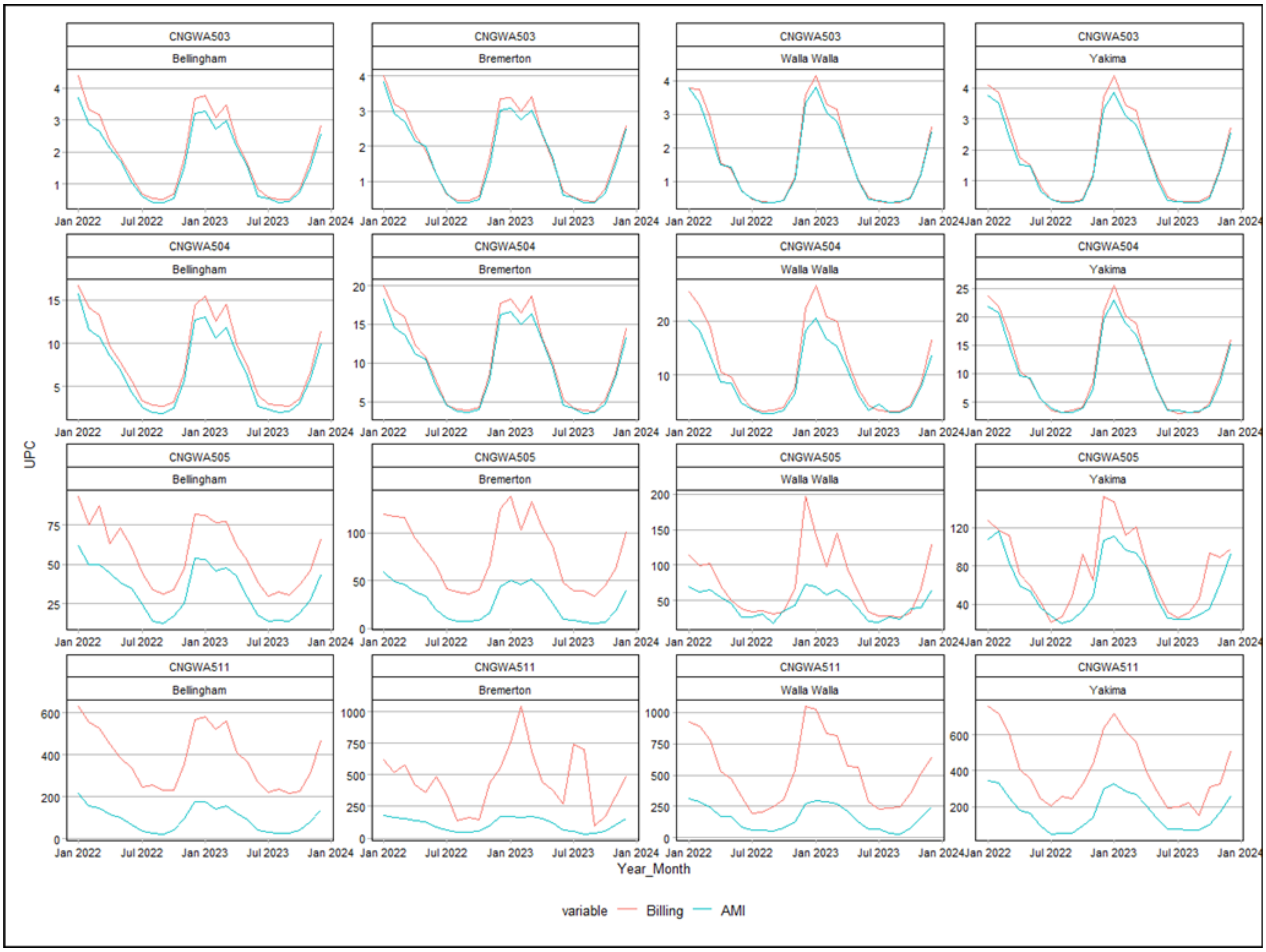
4 Data Calibration

Based on the differences for all customer classes when compared to Billing Data, Atrium deemed it necessary to make a calibration adjustment to the AMI Data prior to utilizing the AMI Data for Design Day and class allocation. However, this should not deter the use of this data for the intended purpose within the load study, rather until a full AMI deployment and validation of the AMI Data transmission and collection process, the WUTC should ensure that both AMI Data and Billing Data are considered to ensure that no undue shifts in cost allocation occur as a result of the migration towards AMI Data.

4.1.1 Possible Causes for Data Differences

Typically, the average usage of customers in the same geographical location and in the same customer rate class can be used to substitute data for a customer which lacks sufficient information, providing that customers are of relatively similar size and weather sensitivity. However, when we substituted average use per customer based on daily AMI Data, we noted material differences that could skew the class allocation results.

Figure 7: Observed Data Differences between AMI Data and Billing Data



Atrium has identified two likely causes for the discrepancies – data transmission issues (all classes) and sampling error (for the large industrial classes 505 and 511). With respect to transmission issues, the AMI data Atrium received to perform its Study was aggregated by town. Within this dataset, we noted several occurrences, of negative therms and/or or zero therms (at the aggregated town level) when the expectation, given HDD 60, would have predicted some heating usage (i.e., Atrium selected a weather threshold of colder than 10 HDD 60 to make this determination). Those identified transmission issues were removed from our data set. However, since data was aggregated by town, we would not be able to identify the occurrence of similar transmission issues that were embedded in the town aggregation. We believe this issue may be throughout the dataset and is one likely cause for the differences we are seeing in the residential (503) and commercial (504) classes, where the variance was relatively uniform across the year. For the large industrial classes, (505 and 511), where the variance was not constant and demonstrated a greater variance in the winter months compared to the non-winter months, the problem is two-fold. First, we believe the transmission issue noted above is also impacting these classes; but, in addition, it is likely that there may be large, highly weather-sensitive customers that are not yet daily metered and therefore not reflected in the daily regressions.

Atrium notes, that this problem was also evident in the 2022 Load Study, noting Table 7 from the 2022 Load Study demonstrated significant variances in Classes 505 and 511 and found these rate classes to have inadequate AMI coverage to provide a representative sample of the population; and while not as pronounced, the smaller classes also showed variances in the underestimated direction.[7]

4.1.2 Data Calibration Process

Monthly Regressions

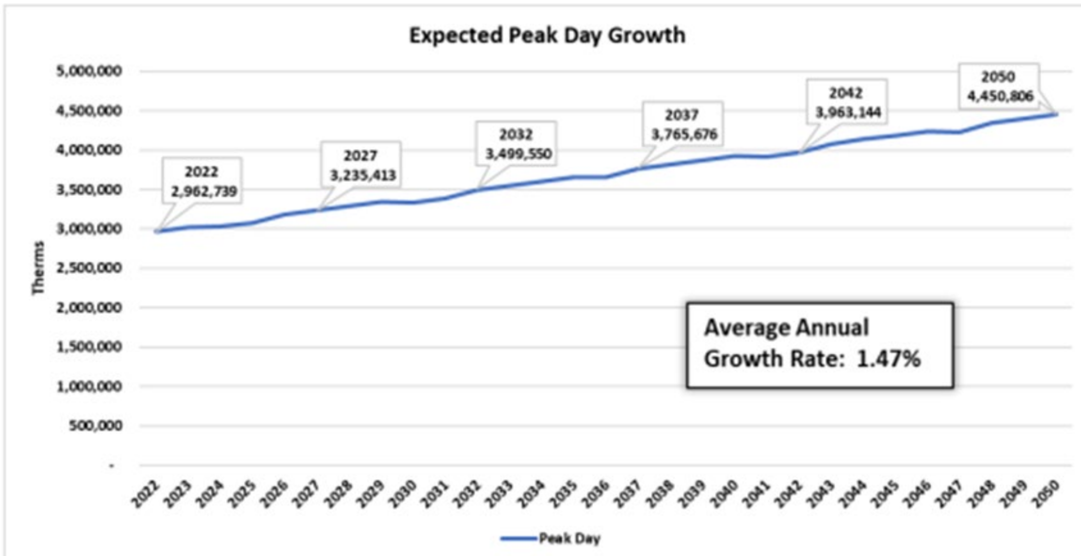
The first step in the data calibration process was to establish a baseline of the expected Design Day system demand at the system level. To establish this baseline, Atrium performed monthly data regressions on Cascade's monthly Billing Data. This data had the advantage of covering all customers within the class and weather zone. In the monthly regressions, total daily therms (by customer class and weather location) were regressed by 24-day lagged HDD60 weather data. The Design Day prediction using the monthly Billing Data was consistent with the 2023 Washington IRP design day load estimates for the Core customer classes, shown in Figure 7 and Table 6, below.

[7] Cascade Load Study, op.cit., at Table 4, pg. 8

Figure 8: Core Peak Day 2022 - 2050

Cascade Natural Gas Corporation
2023 (WA) Integrated Resource Plan

Figure 3-19: Expected System Peak Day Growth (Volumes in Therms)



The projected Design Day results of the monthly data regressions for the Core customer classes are reported in Table 6. As Table 6 shows, the Core Design Day Prediction from the monthly regressions is closely aligned with the IRP Prediction shown in Figure 8, above, of roughly 3 million therms.

Table 6: Design Day Prediction - Monthly

Rate	503	504	505	511	Total
Design Day	1,540,624	1,045,942	99,407	117,850	**2,803,823**
Core %	**54.9%**	**37.3%**	**3.5%**	**4.2%**	**100%**

The resulting coefficients and key statistics for the monthly regressions are listed in Table 7, below. In all cases, the independent variable was HDD 60 (x coefficient) and the dependent variable was therms per day (monthly therms divided by number of days in the month).

Table 7: Monthly Regression Results (January 2021 – December 2023)

Regression Results	Bellingham	Bremerton	Walla Walla	Yakima
Residential (503)				
R^2	0.9847	0.9483	0.9781	0.9863
F	1417	404	981	1586
x coefficient	12,156	7,028	5,283	3,421
x t-stat	37.6	20.1	31.3	39.8
y coefficient	39,687	15,447	12,521	7,276
Commercial (504)				
R^2	0.9780	0.9531	0.9755	0.9786
F	979	448	877	1004
x coefficient	5,668	4,114	3,849	3,985
x t-stat	31.3	21.2	29.6	31.7
y coefficient	26,325	16,844	15,703	18,357
Industrial (505)				
R^2	0.8951	0.9284	0.8372	0.7753
F	188	285	113	76
x coefficient	428	274	178	574
x t-stat	13.7	16.9	10.6	8.7
y coefficient	6,447	1,928	1,195	8,111
Large Volume (511)				
R^2	0.9434	0.3294	0.9621	0.9027
F	367	11	559	204
x coefficient	439	367	427	451
x t-stat	19.1	3.3	23.6	14.3
y coefficient	6,489	5,432	4,313	6,644

Data Calibration

Once the baseline peak day prediction, based on monthly regressions, was established, Atrium made a calibration adjustment for the difference between therms derived through daily regressions and actual therms reflected in the monthly Billing Data. Using the established 24-day lag between calendar and billing data, Atrium calculated monthly calibration factors based on the relationship between the lagged AMI Data and the Billing Data. Application of these factors to the UPC from the daily AMI Data provided for a calibrated data set that addressed the discrepancies discussed regarding the AMI Data.

Adjusted Daily Regressions

Once UPC calculated from the AMI data was adjusted by the calibration factor, the daily regressions were re-run using adjusted UPC as the dependent variable. Because of the billing lag, and with the existing data provided to Atrium for the load study, calibration factors could be calculated for the period January 8, 2022 through December 7, 2023; and accordingly, the adjusted daily regressions were also based on data from this period. The coefficients and key statistics that resulted from the adjusted daily regressions are shown in Table 8, below.

Table 8: Daily Regression Results (Adjusted for Calibration)

				Intercept		HDD		Wind		Weekend Dummy	
Rate	Weather Zone	Adjusted R2	F	Y Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat
CNGWA503	Yakima	0.959	8,142.351	0.218	6.231	0.110	118.224	0.014	2.933		
	Walla Walla	0.924	4,220.887	0.262	6.842	0.111	91.145	0.018	4.435		
	Bremerton	0.909	3,472.352	0.178	4.674	0.149	80.122	0.037	9.204		
	Bellingham	0.956	7,673.357	0.362	17.510	0.129	121.209	0.032	11.958		
CNGWA504	Yakima	0.946	4,069.752	3.266	15.077	0.573	101.598	0.022	0.743	(0.601)	(4.087)
	Walla Walla	0.918	2,602.686	3.148	12.892	0.658	87.487	0.081	3.231	(0.277)	(1.429)
	Bremerton	0.905	2,227.928	2.790	14.528	0.723	78.233	0.178	8.832	(1.097)	(7.293)
	Bellingham	0.949	4,300.343	2.312	24.879	0.503	110.530	0.124	10.851	(0.867)	(9.179)
CNGWA505	Yakima	0.708	563.285	55.731	19.176	2.628	34.761	(0.870)	(2.198)	(26.069)	(13.238)
	Walla Walla	0.770	779.056	35.326	13.316	3.801	46.510	0.372	1.370	(22.750)	(10.805)
	Bremerton	0.834	1,168.206	31.782	17.252	4.698	52.956	1.630	8.413	(27.895)	(19.327)
	Bellingham	0.799	925.495	37.305	39.657	2.095	45.473	0.589	5.090	(22.407)	(23.426)
CNGWA511	Yakima	0.851	1,327.151	235.561	25.544	13.771	57.336	(0.129)	(0.102)	(51.705)	(8.267)
	Walla Walla	0.858	1,407.247	240.630	19.732	24.092	64.134	5.713	4.581	(70.417)	(7.275)
	Bremerton	0.354	128.534	224.118	10.600	18.566	18.235	8.851	3.980	(21.731)	(1.312)
	Bellingham	0.869	1,545.929	208.841	42.268	15.659	64.702	4.629	7.613	(67.872)	(13.510)

The adjusted daily regression results were extrapolated to the total number of customers (as of December 31, 2023) for each weather zone and for each of the Core classes to arrive at a Design Day prediction. A side-by-side comparison of the three Design Day analyses Atrium prepared (daily (unadjusted), daily (adjusted), and monthly) is below, in Table 9. As the Table shows, without adjustment to the daily AMI data, the residential class would have to bear a greater allocation of costs (directly benefitting industrial and large volume customers) than the monthly billing data suggests would be appropriate. As Table 9 shows, the Core Design Day prediction from the adjusted daily regressions, though still below Cascade's IRP prediction of roughly 3 million therms, is more closely aligned with the IRP; and more closely reflects the baseline cost allocation percentages calculated in Atrium's monthly regressions.

Table 9: Summary of Atrium Load Study Analyses

	Atrium Daily Design Day Prediction - Daily (Unadjusted)	*Core %*	Atrium Design Day Prediction - Daily (Adjusted)	*Core %*	Atrium Design Day Prediction - Monthly	*Core %*
CNGWA503	1,350,043	*57.6%*	1,492,164	*54.8%*	1,540,624	*54.9%*
CNGWA504	877,768	*37.5%*	1,011,683	*37.1%*	1,045,942	*37.3%*
CNGWA505	69,647	*3.0%*	100,565	*3.7%*	99,407	*3.5%*
CNGWA511	45,344	*1.9%*	120,491	*4.4%*	117,850	*4.2%*
TOTAL	**2,342,802**	*100.0%*	**2,724,904**	*100.0%*	**2,803,823**	*100.0%*

4.1.3 Verification of Adjusted Daily Regression Results

Atrium compared the load predictions given historic weather, wind, and customer counts derived from the adjusted daily regressions to monthly Billing Data and System Sendout. Those results are depicted graphically below in Figure 9 and Figure 10.

Figure 9: Core Sendout vs. Adjusted Daily Regressions

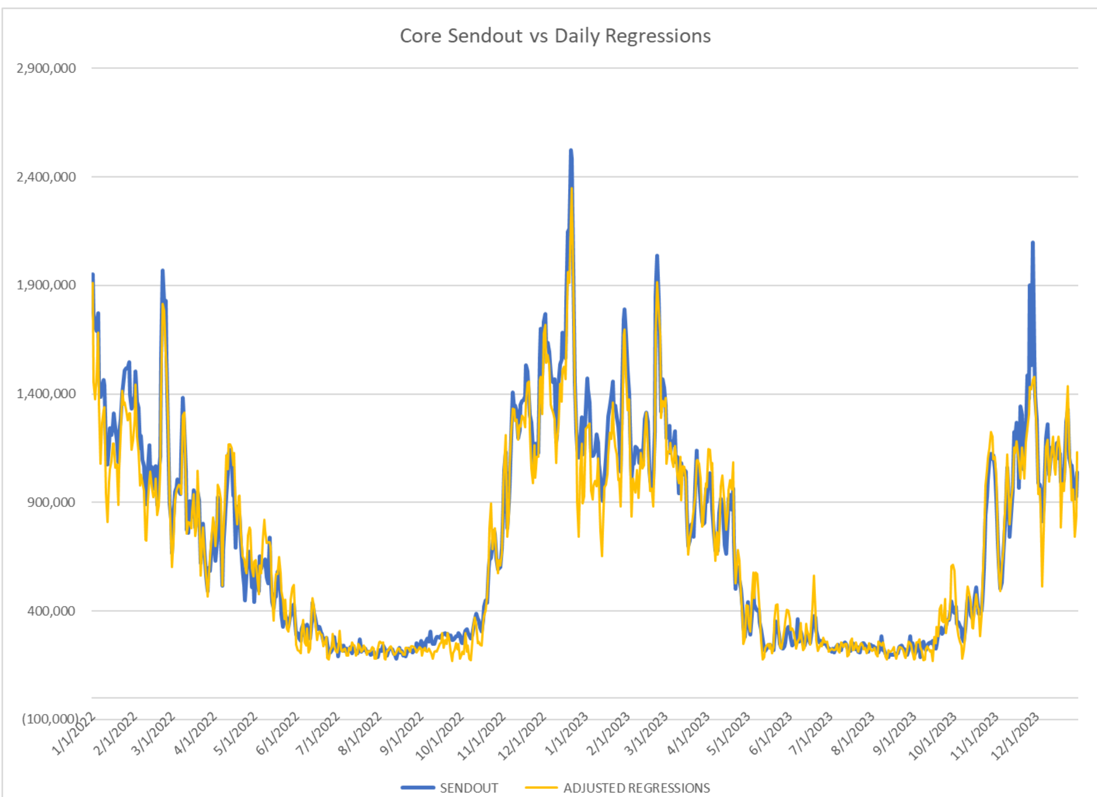
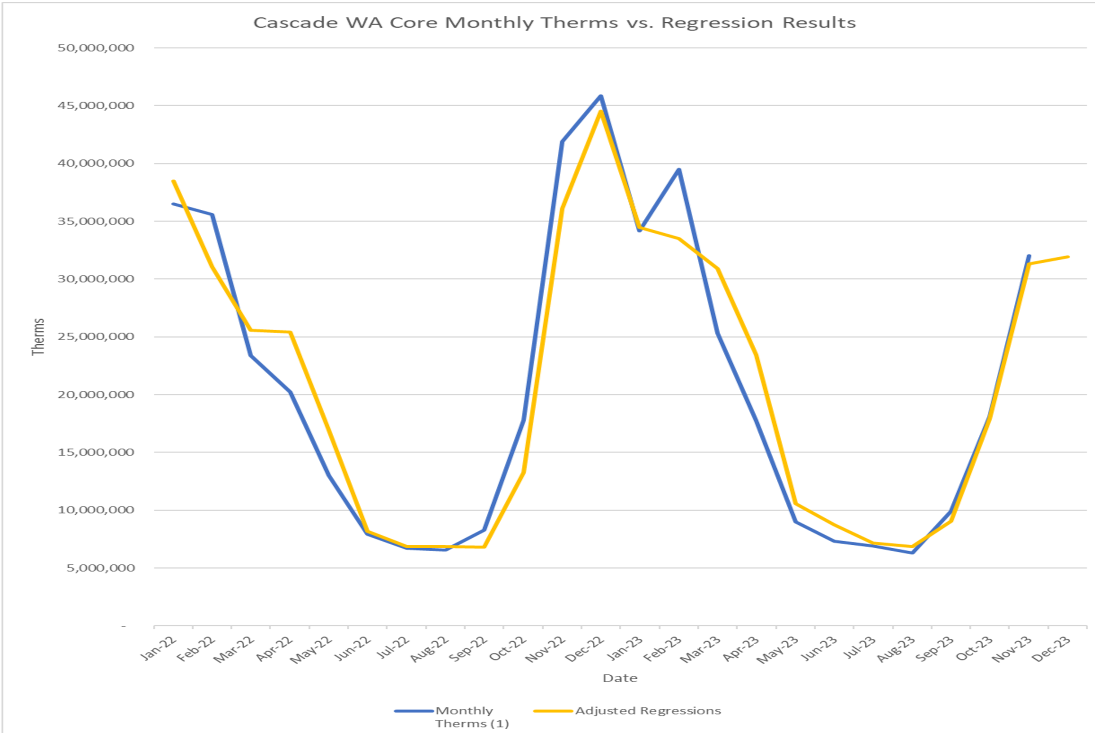


Figure 10: Monthly Billing vs. Adjusted Daily Regressions



5 Design Day Load Study Results

Atrium recommends that the calibrated AMI Data be used to allocate costs of the fixed gas system to the customer classes. The results of the adjusted daily regressions using the calibrated AMI Data are consistent with the Billing Data, but offer additional detail, are more consistent with Design Day planning in the IRP and will allow for further refinements and improvements as future AMI coverage increases. The Company should, however, continue to compare the AMI Data to Billing Data and reconcile any differences; and improve data collection processes in order to make full use of the AMI data as more AMI is deployed. The Design Day Results for the Core customer classes is shown in Table 10, below.

Table 10: Design Day Prediction –Daily (Adjusted)

Rate	503	504	505	511	Total
Design Day	1,492,164	1,011,683	100,565	120,491	**2,724,904**
Core %	**54.8%**	**37.1%**	**3.7%**	**4.4%**	**100%**

ATRIUM ECONOMICS
CENTERED ON ENERGY
www.atriumecon.com