# Residential New Construction (Single and Multi-Family)Billing Analysis

*Market Research Report*

PREPARED BY

**RLW Analytics**

REPORT #E08-185
OCTOBER 11, 2007

NORTHWEST
ENERGY
EFFICIENCY
ALLIANCE

www.nwalliance.org

529 SW Third Avenue, Suite 600
Portland, Oregon 97204
(tel) 503-827-8416 (fax) 503-827-8437

**SINGLE AND MULTI-FAMILY RESIDENTIAL NEW CONSTRUCTION BILLING ANALYSIS**

One of the objectives of the 2006 Residential New Construction Characteristics and Practices Study was to characterize the overall energy usage of these buildings. This short report discusses the methodology used to collect and analyze the data to estimate annual energy usage. Billing data reflected in this report represents data captured over a 16-month period of continuous occupancy from January 2006 through March 2007 that was then normalized for typical weather conditions. The report describes total building energy use by state and by heating system type. It also presents consumption differences between housing units with cooling and those without.

**Caveats.**

There was significant attrition of the original field audit sample resulting from the process of collecting and cleaning the billing data. The sample for electric energy use dropped from an audit total of 804 single and multi-family units to 458 with useable data. The attrition on the sample of gas heated homes was similar with the added problem of having no data at all for the Portland or Boise metropolitan areas. The report includes a discussion of the reasons for the attrition and the potential for associated bias. It also provides a relative precision estimate for each reported mean value. Given these relatively high attrition rates, the results reported provide more of an indicative view of the new construction market rather than a definitive view of energy usage.

In addition to the data attrition issues, since the data was collected on total utility bills any comparisons between groups distinguished by fuel type has to be considered in light of the fact that there may be correlation between end-uses and fuel types. For example, while the report includes information that allows for comparison between homes heated with electricity and homes heated with gas, since water heating fuel type is heavily correlated with space heating type any energy usage differences between these groups is more likely a representation of both space *and* water heating differences.

Similarly, while it is possible to compare total electric energy usage between homes with cooling and without, there is an embedded correlation with space heating fuel type that makes it difficult to interpret the results.

**Key Findings**

Given the previous caveats, the report includes some key findings as follows:

- The average new single family home uses 11,142 kWh of electricity per year.
- Electrically heated homes use almost 7,600 more kWh than the average home consuming a total of 18,703 kWh per year.
- The average gas heated home uses about 1,000 kWh less than the average consuming a total of 10,127 kWh and 699 therms per year.
- Roughly three-quarters of the homes in this sample had space cooling systems and used on average 660 kWh per year more than their uncooled counterparts.
- The average new multifamily unit uses about 1,750 kWh less than its single family counterpart consuming 9,392 kWh per year.

- The average new home in the sample is 2,417 $ft^{2;}$ the average new multi-family unit is less than half the size at 1,148 $ft^2$
- On a normalized basis, the average single family home uses 4.8 $kWh/ft^2$-year;
- Single family homes with electric heat had a normalized usage of 7.6 $kWh/ft^2$ while homes with gas heat used 4.4 $kWh/ft^2$ indicating that electric space heating usage in new homes is roughly 3.2 $kWh/ft^{2.}$
- Single family homes with cooling used roughly 0.3 kWh/ft2 more energy than their non-cooled counterparts.
- Multi-family housing units used a normalized annual electric usage of 8.2 $kWh/ft^2$.

# RESIDENTIAL NEW CONSTRUCTION CHARACTERISTICS AND PRACTICES STUDY

## *Task 5.8: Billing Data Collection and Analysis Memo*

**October 11, 2007**

**Prepared for:**

Northwest Energy Efficiency Alliance

Prepared by:

RLW ANALYTICS

1055 Broadway, Suite G

Sonoma, CA 95476

# Table of Contents

# Task 5.8: Billing Analysis

Billing analyses were conducted to estimate weather normalized annual energy consumption (NAC) for each home surveyed for the Northwest Energy Efficiency Alliance's Residential New Construction Baseline Study (RNC). This chapter discusses the methodology used to calculate these estimates, and reports the results for homes in the study.

During the initial on-site surveys, study participants were asked to sign billing data release forms. RLW submitted these billing release forms to the respective utilities requesting 15 months of post occupancy billing information[1] if available.

The billing data returned from the utilities were screened for quality and completeness, and were formatted for weather normalization analysis using the Princeton Scorekeeping Method (PRISM). The PRISM results include weather normalized annual consumption, the expected annual gas and electric consumption in a "typical" weather year, and categorizes the NAC by heating usage (cool temperature dependent usage), cooling usage (warm temperature dependent usage), and base usage (non-temperature dependent usage).

Homes were divided into single-family and multifamily housing and energy usage was examined for both heating and cooling loads. Findings are presented by state for both single-family and multifamily homes.

## *Sample*

The final single-family and multifamily audit sample for the RNC study was 804 unique homes, 604 single-family (SF) and 200 multifamily (MF) units. RLW obtained 642 billing release forms. Table 1 shows that 458 sites had useable electric data and 167 had useable gas data after RLW cleaned the data to ensure that billing histories had a complete 12 months of data within the billing period.

| | SF and MF | | Single-Family | | Multifamily | |
|---|---|---|---|---|---|---|
| | Electric | Gas | Electric | Gas | Electric | Gas |
| Final audit sample | 804 | | 604 | | 200 | |
| Billing release forms | 642 | 373 | 481 | 335 | 161 | 38 |
| Any data returned | 534 | 179 | 449 | 163 | 85 | 16 |
| Useable data (1/06-12/06) | 458 | 167 | 393 | 153 | 65 | 14 |

**Table 1: Final Sample Counts**

The tables below show the quantity of electric and gas account numbers held by each utility as well as the number of accounts the utilities returned data for. The column titled "% Reported" calculates the percentage of each utility's accounts that was returned to us. The column "% of Total Accounts" calculates what percent of the total number of sites each utility was responsible for.

[1] Billing data requested were for the period of January 2006 through March 2007.

| Utilities | Electric Account Numbers | Electric Accounts Reported | Gas Account Numbers | Gas Accounts Reported | % Reported | % of Total Accounts |
|---|---|---|---|---|---|---|
| AAPP Propane | 0 | 0 | 1 | 0 | 0.0% | 0.1% |
| Amerigas | 0 | 0 | 1 | 1 | 100.0% | 0.1% |
| Avista Utilites | 13 | 10 | 35 | 29 | 81.3% | 4.9% |
| Benton County PUD | 6 | 6 | 0 | 0 | 100.0% | 0.6% |
| Blachly-Lane Electric Cooperative | 2 | 0 | 0 | 0 | 0.0% | 0.2% |
| Cascade Natural Gas | 0 | 0 | 48 | 9 | 18.8% | 4.9% |
| Central Electric Cooperative | 9 | 0 | 0 | 0 | 0.0% | 0.9% |
| Central Lincoln PUD | 2 | 2 | 0 | 0 | 100.0% | 0.2% |
| Chelan County PUD | 1 | 1 | 0 | 0 | 100.0% | 0.1% |
| City of Centralia Utilities | 2 | 2 | 0 | 0 | 100.0% | 0.2% |
| City of Richland | 2 | 2 | 0 | 0 | 100.0% | 0.2% |
| Clark Public Utilities | 19 | 19 | 0 | 0 | 100.0% | 1.9% |
| Corey Oil and Propane Co. | 0 | 0 | 2 | 2 | 100.0% | 0.2% |
| Cowlitz County PUD | 2 | 2 | 0 | 0 | 100.0% | 0.2% |
| Eugene Water & Electric Board | 21 | 12 | 0 | 0 | 57.1% | 2.1% |
| Farmer Supply | 0 | 0 | 1 | 1 | 100.0% | 0.1% |
| Ferrel Gas | 0 | 0 | 3 | 0 | 0.0% | 0.3% |
| Franklin County PUD | 4 | 4 | 0 | 0 | 100.0% | 0.4% |
| Idaho Falls Power | 1 | 1 | 0 | 0 | 100.0% | 0.1% |
| Idaho Power Company | 162 | 160 | 0 | 0 | 98.8% | 16.4% |
| Inland Power & Light Company | 1 | 1 | 0 | 0 | 100.0% | 0.1% |
| Intermountain Gas Company | 0 | 0 | 42 | 0 | 0.0% | 4.3% |
| Kootenai Electric Cooperative | 7 | 1 | 0 | 0 | 14.3% | 0.7% |
| Lane Electric Cooperative | 3 | 1 | 0 | 0 | 33.3% | 0.3% |
| Legacy | 0 | 0 | 1 | 1 | 100.0% | 0.1% |
| Lewis County PUD | 7 | 6 | 0 | 0 | 85.7% | 0.7% |
| Luke's Propane | 0 | 0 | 1 | 0 | 0.0% | 0.1% |
| Mason County PUN No. 3 | 3 | 0 | 0 | 0 | 0.0% | 0.3% |
| MCGG | 0 | 0 | 1 | 0 | 0.0% | 0.1% |
| McMinnville Water & Light | 1 | 1 | 0 | 0 | 100.0% | 0.1% |
| Midstate Electric Cooperative | 2 | 0 | 0 | 0 | 0.0% | 0.2% |
| Monmouth Power & Light | 3 | 2 | 0 | 0 | 66.7% | 0.3% |
| Montana Dakota Utilities | 0 | 0 | 3 | 3 | 100.0% | 0.3% |
| Northwest Natural | 0 | 0 | 115 | 0 | 0.0% | 11.7% |
| Northwestern Energy | 18 | 15 | 14 | 12 | 84.4% | 3.2% |
| Pacific Power & Light | 1 | 0 | 0 | 0 | 0.0% | 0.1% |
| PacifiCorp | 56 | 26 | 2 | 0 | 44.8% | 5.9% |
| Portland General Electric | 83 | 52 | 0 | 0 | 62.7% | 8.4% |
| Propane | 0 | 0 | 2 | 0 | 0.0% | 0.2% |
| Puget Sound Energy | 72 | 65 | 106 | 104 | 94.9% | 18.1% |
| Ravalli County Electric Coop | 1 | 0 | 1 | 0 | 0.0% | 0.2% |
| Salem Electric | 4 | 3 | 0 | 0 | 75.0% | 0.4% |
| Seattle City Light | 17 | 0 | 0 | 0 | 0.0% | 1.7% |
| Snohomish County PUD | 24 | 2 | 0 | 0 | 8.3% | 2.4% |
| Springfield Utility Board | 1 | 1 | 0 | 0 | 100.0% | 0.1% |
| Suburban Propane | 0 | 0 | 2 | 1 | 50.0% | 0.2% |
| Tacoma Power | 47 | 45 | 0 | 0 | 95.7% | 4.8% |
| Umatilla Electric Cooperative | 4 | 4 | 0 | 0 | 0.0% | 0.4% |
| WA Water Power | 3 | 3 | 0 | 0 | 0.0% | 0.3% |
| **SF Total** | **604** | **449** | **381** | **163** | **62.1%** | **100.0%** |

**Table 2: Single-family Accounts by Type per Utility Reported**

| Utilities | Electric Account Numbers | Electric Accounts Reported | Gas Account Numbers | Gas Accounts Reported | % Reported | % of Total Accounts |
|---|---|---|---|---|---|---|
| Avista Utilites | 19 | 9 | 12 | 3 | 38.7% | 11.6% |
| Cascade Natural Gas | 0 | 0 | 10 | 0 | 0.0% | 3.7% |
| City of Centralia Utilities | 2 | 2 | 0 | 0 | 100.0% | 0.7% |
| City of Richland | 2 | 0 | 0 | 0 | 0.0% | 0.7% |
| Clark Public Utilities | 5 | 5 | 0 | 0 | 100.0% | 1.9% |
| Eugene Water & Electric Board | 1 | 1 | 0 | 0 | 100.0% | 0.4% |
| Fall River Rural Electric Cooperative | 2 | 0 | 0 | 0 | 0.0% | 0.7% |
| Franklin County PUD | 6 | 0 | 0 | 0 | 0.0% | 2.2% |
| Idaho Power Company | 15 | 12 | 0 | 0 | 80.0% | 5.6% |
| Intermountain Gas Company | 0 | 0 | 12 | 0 | 0.0% | 4.5% |
| Lower Valley Energy | 2 | 0 | 0 | 0 | 0.0% | 0.7% |
| Mason County PUN No. 3 | 3 | 0 | 0 | 0 | 0.0% | 1.1% |
| McMinnville Water & Light | 4 | 1 | 0 | 0 | 25.0% | 1.5% |
| Midstate Electric Cooperative | 2 | 0 | 0 | 0 | 0.0% | 0.7% |
| Montana Dakota Utilities | 0 | 0 | 2 | 2 | 100.0% | 0.7% |
| Northwest Natural | 0 | 0 | 13 | 0 | 0.0% | 4.9% |
| Northwestern Energy | 10 | 5 | 4 | 2 | 50.0% | 5.2% |
| PacifiCorp | 18 | 11 | 0 | 0 | 61.1% | 6.7% |
| Portland General Electric | 31 | 15 | 0 | 0 | 48.4% | 11.6% |
| Puget Sound Energy | 25 | 16 | 13 | 9 | 65.8% | 14.2% |
| Rocky Mountain Power | 2 | 2 | 0 | 0 | 100.0% | 0.7% |
| Seattle City Light | 33 | 0 | 0 | 0 | 0.0% | 12.4% |
| Skamania County PUD | 1 | 0 | 0 | 0 | 0.0% | 0.4% |
| Snohomish County PUD | 7 | 3 | 0 | 0 | 42.9% | 2.6% |
| Tacoma Power | 8 | 3 | 0 | 0 | 37.5% | 3.0% |
| Vera Water and Power | 2 | 0 | 0 | 0 | 0.0% | 0.7% |
| WA Natural Gas | 0 | 0 | 1 | 0 | 0.0% | 0.4% |
| **MF Total** | **200** | **85** | **67** | **16** | **37.8%** | **100.0%** |

**Table 3: Multifamily Accounts by Type per Utility Reported**

The final SF audit sample consisted of 604 sites, but the final number of sites with usable electric billing data in the analysis is only 393. Since we do not have billing histories for the sites that we did not receive data for, we can not quantify the bias that may be introduced from the low rate of billing data returned. However, the staff in charge of collecting the billing data did not note any differences in return rate between urban and rural or small and large service providers, nor any other systematic trends in the service providers that returned data. RLW re-weighted the sites with billing data to project to the total sites in the population at the county level, to best represent the regional population using the available data.

The single-family results section begins with a presentation of the sample sizes used in the billing analysis by state. Particular attention should be paid to the low kWh sample points in Oregon and Washington, relative to the audit sample as shown in Table 4 (40% and 66% respectively), and the results should be used with the knowledge that the billing data do not include all of the randomly selected sites in the baseline study.

| *State* | *SF kWh* |
|---|---|
| Idaho | 87% |
| Montana | 83% |
| Oregon | 40% |
| Washington | 66% |
| Overall | 65% |

**Table 4: SF Sites in kWh Billing Analysis as a % of Total SF Audit Sites**

The single-family gas data received as a percent of the total gas accounts was 40%, therefore the results should only be used as indicative, but not definitive, of the single-family gas usage. One key area that we received little data for includes SF therm data in Portland. The multifamily projects had an overall 32% reporting rate for electric accounts and 21% for gas, therefore again these results should only be used as indicative, but not definitive, of multifamily usage.

## *Data Sources*

The data used by RLW to conduct this evaluation came from two sources. For the billing analysis, billing data were acquired from each participating utility. Data were requested for all eight hundred and four participant homes who participated in the 2006 study. Billing data were requested for the period of January 2006 to March 2007, where available, using meter numbers, account numbers, addresses, and customer names.

In order to perform the weather normalization, daily temperatures were obtained from the Western Regional Climate Center (WRCC) for the same time period. The climate center archives weather measurements from hundreds of weather stations throughout the western United States. Houses were linked by zip code to the nearest weather stations in order to perform the weather normalization.

## *Methodology*

### ***Data Collection***

*Release Forms*

During the onsite survey, RLW auditors gathered customer account and meter numbers. Customers were asked to sign billing data release forms which gave RLW permission to obtain historical usage for the customers account. This information was placed in a master database and requests were compiled for each utility. Existing utility contacts were leveraged whenever possible. Utilities were given a template listing each customer and their contact information needed for the study. They were asked to return usage data, in kWh or therms, for each month from 1/1/06 through 3/31/07.

*Weather Data*

Weather data were obtained from the Western Regional Climate Center. RLW identified all zip codes for the sample sites the study. The list of zip codes was overlaid on a map of the WRCC weather stations to identify the nearest matching weather stations. In many cases, the available weather station data were insufficient to perform the analysis. In order to remedy this problem, RLW established the practice of requesting 2 or 3 nearby weather stations in order to ensure usable data were obtained to provide coverage for all zip codes. The zip code/weather

station map was reviewed to make sure primary and secondary weather stations were requested for each zip code.

## ***Analysis***

### *The Objective of the Analysis*

The primary goal of the analysis is to estimate an NAC, which uses actual weather data to adjust a home's energy consumption to a typical year's weather data. This provides an estimate of energy consumption for heating, cooling, and base loads. Weather has a large impact on the energy consumption of a home. Hotter than average summers and colder than average winters result in increased annual energy consumption in most cases. Likewise, cooler than average summers and warmer than average winters result in reduced energy usage. NAC is useful for comparisons across different years and planning estimates.

The commonly accepted method for calculating NAC is the Princeton Scorekeeping Method (PRISM), which RLW used for this analysis. The PRISM algorithm develops a mathematical model that represents the temperature to energy consumption relationship. This normalization analysis recognizes the fact that each home reacts differently to varying heating and cooling degree days, and each customer has unique space conditioning operating characteristics. Homes with more efficient heating or cooling appliances and equipment, radiant barrier insulation, and efficient windows will consume less energy. A well designed house with good windows and better insulation will require much less heating or cooling.

### *Princeton Scorekeeping Method (PRISM)*

RLW considered other approaches to weather normalization, such as non-PRISM CDD and HDD analysis or model-based normalization, but based on our experience, a PRISM approach produces the most accurate results for the lowest possible cost. RLW did not use the PRISM software, rather a comprehensive approach that we have used over the past 15 years that incorporates the PRISM model.

The systematic data preparation approach is predicated on the premise that every possible *valid* data point should be incorporated into the analysis. The systematic data preparation approach recognizes that the cavalier elimination of data points can result in the undermining the veracity of the estimates of energy savings, and the ability to extrapolate the results to the general population of participants. However, the systematic data preparation approach also recognizes that not identifying, and excluding from the analysis those customers that are anomalies could also undermine the veracity of the estimates. RLW cleaned the data and screened out the sites without data in the appropriate date range, which constituted the large majority of the dropped sites.

This simplest model where the specification is such that energy consumption depends on either heating or cooling degree days only is shown in Equation 1.

$$U_i = \alpha + \beta * DD_i(\tau) + e$$

Where;

$U_i$ = average daily consumption in interval i.
$DD_i(\tau)$ = average degree days in interval i, based on reference temperature $\tau$
$\alpha,\beta$ = parameters to be estimated to minimize e.
e = a random error term.

**Equation 1: The PRISM Heating Only Model**

The PRISM model reflects that a customer's energy usage is equal to some base level $\alpha$, and a linear function between a reference temperature $\tau$, and the outside temperature. The constant proportionality, $\beta$, represents a customer's effective heat-loss or heat-gain rate.

As mentioned, PRISM recognizes that each customer has unique space conditioning operating characteristics. To capture these unique space conditioning characteristics, PRISM examines a range of heating and cooling reference temperatures. The model chosen to represent a customer's energy use is the model that best linearizes the relationship between usage and degree days. For each customer, an optimal model based on a unique temperature reference temperature ($\tau$) is identified by the minimum MSE of the regression.

Once the optimal parameters have been established, normalized annual consumption is estimated using Equation 2.

$$NAC=365*\alpha+\beta*DD_o(\tau)$$

Where:

$DD_o$ is the number of degree days expected in a typical year.

**Equation 2: The Determination of Normalized Annual Consumption (NAC) [2]**

When this model is applied to a home's heating characteristics, it is referred to as the *heating only model* (HOM). When this model is applied to a home's cooling characteristics, it is referred to as the *cooling only model* (COM). Each of these models run separately on homes that have heating usage in therms and cooling usage in kWh. However, the Pacific Northwest has a high percentage of homes that are heated with electricity. When both heating and cooling usage are in kWh PRISIM has to be adjusted to account for this.

[2] For a more comprehensive technical discussion of PRISM, see Impact Evaluation Of Demand-Side Management Programs, Volume 1: A Guide to Current Practice, EPRI Report CU-7178,V1, page 5-6.

The adaptation of the PRISM methodology considers a *heating and cooling model* (HCM), along with the standard PRISM *heating only* or *cooling only models*. The expansion of the standard PRISM approach to consider heating, and cooling loads is calculated using Equation 3.

$$U_i = \beta_0 + \beta_1 * HDD_i(\tau_1) + \beta_2 * CDD_i(\tau_2) + e_i$$

Where:

| | | |
|---|---|---|
| $U_i$ | = | The electric usage during cycle i. |
| $HDD_i(\tau_1)$ | = | The heating degree days based on reference temperature $\tau_1$, during cycle i. |
| $CDD_i(\tau_2)$ | = | The cooling degree days based on reference temperature $\tau_2$, during cycle i. |
| $\beta_i$ | = | The coefficients to be estimated to minimize the error term. |
| $e_i$ | = | The error in predicting U. |

**Equation 3: The PRISM Heating and Cooling Model**

As with the standard PRISM procedure, the optimal heating and cooling model is determined by calculating the regression models assuming various reference temperature values ($\tau_1$ and $\tau_2$). Expected annual degree days are applied to the optimal model to calculate a normalized annual consumption (NAC). The results of the model can be interpreted as:

- $\beta_o$ is an estimate of the average base load for a cycle;
- $\beta_1$ represents the heating slope, or the increase in electric usage for each incremental increase in heating degree days; and,
- $\beta_2$ represents the cooling slope, or the increase in electric usage for each incremental increase in cooling degree days.

Generally there are four builder affected end uses for the new homes, heating, cooling, lighting and water-heating. Heating uses mostly gas, cooling and lighting always use electric energy, and water heating may use either gas or electricity. The billing information contains separate data from electric and gas usages.

The standard PRISM approach uses usage and degree day data on a billing cycle basis. However, by doing that, the dependent variable has an inherent variability associated with the varying lengths of billing cycles. By bringing in the *average daily* usage as the dependent variable, the effects of the varying lengths of the billing cycle are mitigated for the estimation of the heating and cooling slopes ($\beta$). This is a result of the number of degree days being directly correlated to the number of days in the cycle. However, the estimate of base load ($\beta_o$) reflects the average base load per cycle and does not account for the days in the cycle. In effect, this estimate infers the base load will be $\beta_o$, regardless of the length of the cycle. Since base load usage is a function of time, this result may introduce a slight bias into the calculation. To eliminate this bias, the augmented PRISM approach uses usage per day per square foot of floor area as the dependent variable, and expresses the degree days on a per day basis.

# *Challenges*

As anticipated, this evaluation was difficult to perform for a variety of reasons. Coordinating data requests from a multitude of utility partners, reviewing data submittals, cleaning data, and organizing data presented unique challenges. This section highlights the complexities that are involved when working with numerous utilities, billing systems, and customers.

### ***Finding a Utility Contact***

The first difficulty in performing the weather normalization was establishing contact with the over 60 utilities. RLW had contact information for a subset of the utilities. Often the contact we had was not the appropriate person to provide the billing data requested. We found that most utility staff were unaware of the study and busy with pressing tasks, resulting in the need for a lot of follow up calls, and ultimately a lower number of billing datasets received.

### ***Obtaining and Formatting the Billing Data***

Each utility has their own software for billing customers. Apparently some of these programs are not very well equipped to produce billing data. As a result some utilities had difficulties providing the data requested for this analysis. Some utilities were unable to fulfill our data request at all because of the time involved in compiling this data.

Billing data collection was further complicated by the fact that many of the utilities in the Pacific Northwest are very small utilities or public utility districts (PUD). It can be difficult for these smaller utilities to find the resources to gather the data. It was not uncommon for utilities that did respond to the request to take a month or longer to return data.

The most time consuming task was compiling the data from each utility. Nearly every utility has unique billing software. As a result, the data received by RLW was in different formats for each utility. It required a considerable amount of time to reorganize this data into a uniform format for analysis. Additionally, utilities bill on different cycles. Some utilities bill from the first day of each month for all customers, some have a different day for each customer, and some utilities bill on a bi-monthly basis.

### ***Obtaining Usable Weather Data***

The WRCC has hundreds of weather stations throughout the northwest. Many of these stations have been in place for long periods of time. It is common for a station to stop collecting data on specified intervals and begin logging data intermittently; some stations stop collecting data completely. In order to obtain data for 84 stations RLW requested 185 stations, of those 110 were unusable due to missing data. RLW made an additional data requests for 9 more stations to reach the total of 84.

# *Results*

In reviewing these results the reader is reminded of the following facts:

- Sample points with returned data are low in Oregon and Washington, relative to the audit sample (40% and 66% respectively), and do not include all of the randomly selected sites in the baseline study
- The percentage of single-family gas data received was only 40% overall and of particular note, the Portland and Boise metro gas data was completely missing. Therefore the results should only be used as indicative, but not definitive, of the single-family gas usage.

- This billing analysis does not account for factors such as an abundance of billing data from one geographic area, data dominated by one type of heat source, or customer demographics.

### ***Single-Family Results***

Table 5, Table 6, and Table 7 presents the sample size, the average annual electric and gas usage for single-family (SF) accounts with billing data, and the relative precisions. The average usage is presented by state and overall. The average usage is also presented for the following groups of customers:

- **All Single-Family** – All SF customers with electric or gas billing histories,
- **SF Electric Heat** – All SF customers with *electric* heat (with or without cooling),
- **SF Gas Heat** – All SF customers with *gas* heat (with or without cooling),
- **SF Cooled** – All SF customers *with* air conditioning (with gas or electric heat), and
- **SF Non-Cooled** – All SF customers *without* air conditioning (with gas or electric heat).

Table 5 contains the sample sizes for the data presented above. Note that RLW attempted to collect data for all sites in the original sample, but we were not able to obtain data from some utilities, resulting in the reduced sample sizes.

| State | *All Single-Family* | | *SF Electric Heat* | | *SF Gas Heat* | | *SF Cooled* | | *SF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual Electric Usage Sample n | Annual Gas Usage Sample n | Annual Electric Usage Sample n | Annual Gas Usage Sample n | Annual Electric Usage Sample n | Annual Gas Usage Sample n | Annual Electric Usage Sample n | Annual Gas Usage Sample n | Annual Electric Usage Sample n | Annual Gas Usage Sample n |
| Idaho | 156 | 3 | 3 | - | 153 | 3 | 153 | 1 | 3 | 2 |
| Montana | 15 | 15 | - | - | 15 | 15 | 10 | 10 | 5 | 5 |
| Oregon | 70 | 21 | 15 | - | 55 | 21 | 58 | 13 | 12 | 8 |
| Washington | 124 | 114 | 17 | - | 106 | 114 | 55 | 20 | 69 | 94 |
| Overall | 365 | 153 | 35 | - | 329 | 153 | 276 | 44 | 89 | 109 |

**Table 5: Sample Sizes**

The average annual kWh usage for all sites that we received billing data for was 11,142 kWh. The average kWh for sites with electric heat and gas heat was 18,703 kWh and 10,127 kWh respectively. Not surprisingly, the sites with electric heat have higher electric usage than those with gas heat. What may surprise the reader is the cooled vs. non-cooled sites. Overall, the cooled sites have an annual kWh usage of 11,319 while the non-cooled sites have a usage of 10,659. When reviewing these numbers it is important to consider the sample size and the relative precisions associated with the usages. Additionally, we did not receive billing data for any sites in Montana with electric heat. We also did not receive any gas usage billing data for any sites with electric heat.

| State | *All Single-Family* | | *SF Electric Heat* | | *SF Gas Heat* | | *SF Cooled* | | *SF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms |
| Idaho | 10,199 | 496 | 20,150 | - | 9,904 | 496 | 9,929 | 354 | 16,105 | 567 |
| Montana | 8,416 | 69 | - | - | 8,416 | 69 | 9,063 | 71 | 7,226 | 64 |
| Oregon | 12,108 | 758 | 16,828 | - | 11,087 | 758 | 12,134 | 847 | 11,983 | 646 |
| Washington | 11,626 | 818 | 19,998 | - | 10,032 | 818 | 12,648 | 736 | 10,465 | 839 |
| Overall | 11,142 | 699 | 18,703 | - | 10,127 | 699 | 11,319 | 582 | 10,659 | 756 |

**Table 6: Average Annual kWh and Therms by State, Heat Fuel, and Cooling Presence**

| State | *All Single-Family* | | *SF Electric Heat* | | *SF Gas Heat* | | *SF Cooled* | | *SF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms |
| Idaho | 6% | 19% | 38% | - | 6% | 19% | 6% | 0% | 38% | 2% |
| Montana | 11% | 9% | - | - | 11% | 9% | 11% | 12% | 23% | 11% |
| Oregon | 10% | 16% | 17% | - | 11% | 16% | 11% | 22% | 27% | 11% |
| Washington | 10% | 5% | 21% | - | 10% | 5% | 17% | 14% | 10% | 5% |
| Overall | 5% | 7% | 13% | - | 5% | 7% | 6% | 18% | 9% | 7% |

**Table 7: Relative Precisions**

Table 8 presents the distribution of electric energy usage by base usage, heating usage, and cooling usage. Base usage is the component of NAC that is neither heating-degree day nor cooling degree day dependent. Heating usage is the component of usage that is heating degree day dependent. It may include usage from any energy consuming activities that

increase during cooler weather, such as increased cooking or electric blanket usage, and is not necessarily energy consumed entirely by the heating system. Similarly, cooling usage may include loads that increase with temperature, such as greater refrigerator or freezer loads, or fans, and not necessarily the cooling system itself

Again, the distributions are presented by group of customer (heating fuel and conditioned) in order to show how electricity usage varies by the home characteristics.

For example, in homes with electric heat, the proportion of total electric usage that is attributable to heat is much higher than the proportion in the overall SF sample. Using the overall region as an example for this comparison, for the full sample of homes with both electric and gas heat, the proportion of heating kWh of the total kWh is 7%. For homes with electric heating, the proportion of heating kWh of the total kWh is 36%.

| State | *SF Electric Heat* | | | *SF Gas Heat* | | *SF Cooled* | | | *SF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Base kWh | Heat kWh | Cool kWh | Base kWh | Cool kWh | Base kWh | Heat kWh | Cool kWh | Base kWh | Heat kWh |
| Idaho | 69% | 26% | 5% | 93% | 7% | 92% | 1% | 7% | 90% | 10% |
| Montana | - | - | - | 87% | 13% | 87% | 0% | 13% | - | - |
| Oregon | 59% | 35% | 6% | 92% | 8% | 71% | 26% | 3% | 65% | 35% |
| Washington | 61% | 38% | 1% | 93% | 7% | 65% | 32% | 3% | 60% | 40% |
| Overall | 61% | 36% | 3% | 93% | 7% | 87% | 6% | 7% | 64% | 36% |

**Table 8: Proportion of Total Annual kWh Usage by Base, Heating, and Cooling Usage**

Table 10Table 9 presents the distribution of therm usage by base usage, and heating usage, and for homes with gas heating.

| State | *Single-Family Gas Heat* | | |
|---|---|---|---|
| | Base Therms | Heat Therms | n |
| Idaho | 59% | 41% | 3 |
| Montana | 33% | 67% | 15 |
| Oregon | 31% | 69% | 21 |
| Washington | 30% | 70% | 114 |
| Overall | 31% | 69% | 153 |

**Table 9: Proportion of Total Therm Usage by Base and Heating Usage**

Table 10 presents the average Energy Use Index (EUI) by state, heating fuel type, and cooling presence, where EUI is measured as kWh per SF for electric usage and therms per SF for gas usage. The average electric EUI for SF homes in the region is 5.8 kWh/sf. The average electric EUI is much higher for homes with electric heat 7.6 kWh/sf. The average electric EUI for gas heated homes is lower than the average of all homes at 4.4 kWh/sf. The average electric EUI for cooled homes is higher than the average home at 4.9 kWh/sf, but lower than electrically heated homes since the region under study is a heating dominated climate. It is important to note that end uses in electrically heated homes often include electric water heating as well; therefore, some of the difference in normalized electric usage can be attributed to water heating.

| State | *All Single-Family* | | *SF Electric Heat* | | *SF Gas Heat* | | *SF Cool* | *SF No Cool* |
|---|---|---|---|---|---|---|---|---|
| | kWh per sqft | Therms per sqft | kWh per sqft | Therms per sqft | kWh per sqft | Therms per sqft | kWh per sqft | kWh per sqft |
| Idaho | 4.9 | 0.2 | 10.2 | - | 4.7 | 0.2 | 4.7 | 8.5 |
| Montana | 3.2 | 0.0 | - | - | 3.2 | 0.0 | 3.4 | 2.8 |
| Oregon | 5.0 | 0.3 | 6.7 | - | 4.6 | 0.3 | 4.9 | 5.7 |
| Washington | 4.9 | 0.3 | 8.0 | - | 4.3 | 0.3 | 5.4 | 4.4 |
| Overall | 4.8 | 0.3 | 7.6 | - | 4.4 | 0.3 | 4.9 | 4.6 |

**Table 10: Average Energy Use Index by State, Heat Fuel, and Cooling Presence**

Table 11 presents the average size of the homes included in the analysis for each group of customers by state since the sizes of the homes within each group vary, resulting in differences in the EUI.

| State | *All Single-Family* | | *SF Electric Heat* | | *SF Gas Heat* | | *SF Cool* | *SF No Cool* |
|---|---|---|---|---|---|---|---|---|
| | kWh | Therms | kWh | Therms | kWh | Therms | kWh | kWh |
| Idaho | 2,091 | 2,028 | 1,983 | - | 2,094 | 2,028 | 2,100 | 1,885 |
| Montana | 2,614 | 2,614 | - | - | 2,614 | 2,614 | 2,632 | 2,580 |
| Oregon | 2,420 | 2,214 | 2,511 | - | 2,400 | 2,214 | 2,484 | 2,117 |
| Washington | 2,364 | 2,445 | 2,511 | - | 2,338 | 2,445 | 2,342 | 2,389 |
| Overall | 2,326 | 2,417 | 2,477 | - | 2,307 | 2,417 | 2,322 | 2,338 |

**Table 11: Average Square Footage by State, Heat Fuel, and Cooling Presence**

## ***Multifamily Results***

Table 12 presents the average normalized annual electric and gas usage for multifamily (MF) accounts with billing data. The average usage is presented at the regional level due to the low sample sizes. The average square footage for the MF units is 1,148 sf.

The average annual kWh for all of the multifamily sites we received billing data for was 9,392 kWh, with a relative precision of 7% for kWh and 20% for Therms. Noticeably we received no gas usage for MF sites in Idaho and Oregon.

| State | *All Multifamily* | | *MF Electric Heat* | | *MF Gas Heat* | | *MF Cooled* | | *MF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms | Annual kWh | Annual Therms |
| Overall | 9,392 | 383 | 10,757 | - | 7,152 | 383 | 7,589 | 274 | 10,834 | 419 |
| n | 59 | 14 | 36 | - | 23 | 14 | 35 | 6 | 24 | 8 |
| RP | 7% | 20% | 8% | - | 10% | 20% | 8% | 41% | 10% | 24% |

**Table 12: Average Annual kWh and Therms**

Table 13 presents the distribution of electric usage by base usage, heating usage, and cooling usage. Base usage is all usage that is non-weather dependent such as lighting, plug loads, and appliances.

| State | *MF Electric Heat* | | | *MF Gas Heat* | | *MF Cooled* | | | *MF Non-Cooled* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Base kWh | Heat kWh | Cool kWh | Base kWh | Cool kWh | Base kWh | Heat kWh | Cool kWh | Base kWh | Heat kWh |
| Overall | 62% | 37% | 1% | 93% | 7% | 77% | 18% | 5% | 63% | 37% |

**Table 13: Proportion of Total Annual kWh Usage by Base, Heating, and Cooling Usage**

This concludes the billing analysis results memo for NEEA's 2006 Residential New Construction Baseline Study.

# *Billing Release Form*

## Utility Customer Authorization to Release Electric and/or Gas Usage Information

| **SECTION A -** ***This section is to be completed by the utility customer. Residential utility customers please leave business name blank. Please print or type.*** | | | |
|---|---|---|---|
| Name: | | Phone Number: | (  )  - |
| Billing Address: | | Housing Type: SF SF-A MF | |

**INFORMATION TO BE RELEASED** – *Usage records for the following facilities may be released to the Northwest Energy Efficiency Alliance. Additional requests may be listed on an attachment provided the attachment indicates that it is an addendum to this agreement. Data will be provided for multiple meters at a single premise provided they are on the above noted customer's utility account(s). A multi-family premise may require releases from individual tenants.*

| **Premise Address** (address at the meter location, not the billing address) | City, State, Zip | Gas and/or Electric Utility | Utility Name or Numeral *(see back)* | Account Number | Meter Number |
|---|---|---|---|---|---|
| | | Gas ☐ Elec. ☐ | | | |
| | | Gas ☐ Elec. ☐ | | | |

*The undersigned utility customer requests and authorizes the above mentioned utility(ies), hereafter referred to as the utility company, to release the information listed above to the party named in Section B of this form. The utility customer also hereby releases the utility company from any and all liability arising from or connected with providing this information to RLW Analytics, Inc. This authorization to release customer data expires one year from the signature date below.*

| **Customer Signature:** | | **Date**: | |
|---|---|---|---|

| **SECTION B –** ***This section is to be completed by the organization that is to receive the information. Please print or type.*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Name: | | | | E-Mail address: | | | |
| Agency or Organization: | | | | Phone Number: | (  )  - | | |
| Street Address: | | City: | | State: | | Zip: | |
| *Signature of the agency or organization representative to whom this information is to be released.* | | | | | | Date | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Alder Mutual Light Company | 34 | City of Rupert | 67 | Idaho County Light & Power Coop | 100 | PacifiCorp |
| 2 | Asotin County PUD | 35 | City of Soda Springs | 68 | Idaho Falls Power | 101 | Parkland Light & Water Company |
| 3 | Avista Utilities | 36 | City of Sumas | 69 | Idaho Power Company | 102 | Pend Oreille County PUD |
| 4 | Benton County PUD | 37 | City of Weiser | 70 | Inland Power & Light Company | 103 | Peninsula Light Company |
| 5 | Benton Rural Electric Association | 38 | Clark Public Utilities | 71 | Kittitas County PUD | 104 | Port Angeles City Light |
| 6 | Big Bend Electric Cooperative | 39 | Clatskanie PUD | 72 | Klickitat County PUD | 105 | Portland General Electric |
| 7 | Blachly-Lane Electric Cooperative | 40 | Clearwater Power Company | 73 | Kootenai Electric Cooperative | 106 | Puget Sound Energy |
| 8 | Blaine City Light | 41 | Columbia Basin Electric Cooperative | 74 | Lakeview Light & Power | 107 | Raft River Rural Elec Coop |
| 9 | Bonners Ferry Electric Department | 42 | Columbia Power Cooperative Assoc. | 75 | Lane Electric Cooperative | 108 | Ravalli County Electric Coop |
| 10 | Bonneville Power Admin | 43 | Columbia River PUD | 76 | Lewis County PUD | 109 | Riverside Electric Company |
| 11 | Burley Electric Department | 44 | Columbia Rural Electric Association | 77 | Lincoln Electric Cooperative | 110 | Ruston Electric Utility |
| 12 | Canby Utility Board | 45 | Consumers Power, Inc | 78 | Lost River Electric Cooperative | 111 | Salem Electric |
| 13 | Cashmere Light Department | 46 | Coos-Curry Electric Cooperative | 79 | Lower Valley Energy | 112 | Salmon River Electric Cooperative |
| 14 | Central Electric Cooperative | 47 | Cowlitz County PUD | 80 | Mason County PUD No. 1 | 113 | Seattle City Light |
| 15 | Central Lincoln PUD | 48 | Douglas County PUD | 81 | Mason County PUD No. 3 | 114 | Skamania County PUD |
| 16 | Challam County PUD | 49 | Douglas Electric Cooperative | 82 | McCleary Light & Power | 115 | Snohomish County PUD |
| 17 | Chelan County PUD | 50 | East End Mutual Electric Company | 83 | McMinnville Water & Light | 116 | South Side Electric Lines, Inc |
| 18 | City of Albion | 51 | Eatonville Power | 84 | Midstate Electric Cooperative | 117 | Springfield Utility Board |
| 19 | City of Ashland | 52 | Elmhurst Mutual Power & Light | 85 | Milton-Freewater Light & Power | 118 | Surprise Valley Electrification Corp. |
| 20 | City of Bandon | 53 | Emerald PUD | 86 | Mission Valley Power | 119 | Tacoma Power |
| 21 | City of Cascade Locks | 54 | Eugene Water & Electric Board | 87 | Missoula Electric Cooperative | 120 | Tanner Electric Cooperative |
| 22 | City of Centralia Utilities | 55 | Fall River Rural Electric Cooperative | 88 | Modern Electric Water Company | 121 | Tillamook PUD |
| 23 | City of Cheney Light Department | 56 | Farmer's Electric Company | 89 | Monmouth Power & Light | 122 | Town of Steilacoom |
| 24 | City of Chewelah Light Department | 57 | Ferry County PUD | 90 | Nespelem Valley Electric Coop | 123 | Troy Power & Light |
| 25 | City of Coulee Dam Light Department | 58 | Flathead Electric Cooperative | 91 | Northern Lights, Inc | 124 | Umatilla Electric Cooperative |
| 26 | City of Declo | 59 | Forest Grove Light and Power | 92 | Northern Wasco County PUD | 125 | Umpqua Indian Utility Coop |
| 27 | City of Drain Light and Power | 60 | Franklin County PUD | 93 | NorthWestern Energy | 126 | United Electric Cooperative |
| 28 | City of Ellensburg | 61 | Glacier Electric Cooperative | 94 | Ohop Mutual Light Company | 127 | Vera Water and Power |
| 29 | City of Heyburn | 62 | Grant County PUD | 95 | Okanogan County Electric Coop | 128 | Vigilante Electric Cooperative |
| 30 | City of Milton | 63 | Grays Harbor County PUD | 96 | Okanogan County PUD | 129 | Wahkiakum County PUD |
| 31 | City of Minidoka | 64 | Harney Electric Cooperative | 97 | Orcas Power & Light Cooperative | 130 | Wasco Electric Cooperative, Inc. |
| 32 | City of Plummer | 65 | Hermiston Energy Services | 98 | Oregon Trail Electric Cooperative | 131 | Wells Rural Electric Company |
| 33 | City of Richland | 66 | Hood River Electric Cooperative | 99 | Pacific County PUD No. 2 | 132 | West Oregon Electric Coop |
| | | | | | | 133 | Whatcom County PUD |