Measuring CFL Markets: A Collaborative Regional Study on the Northwest's Largest Efficiency Resource

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ABSTRACT

This paper presents findings from a detailed Puget Sound region residential CFL market saturation study. This study was the first collaborative research effort of this scale to be conducted by the four largest regional utilities and focused specifically on gathering lighting data from residential customers. Data from this study were used to assess remaining market potential and will aid in refining future program designs and marketing strategies.

Puget Sound regional utilities, like many others, are expecting to achieve a large portion of energy savings through residential lighting focused conservation and efficiency programs. Because the market for CFLs has changed considerably over the last 10 years and because this sector represents a very large share of the energy savings opportunity in the residential sector, the utilities commissioned this study to gather comprehensive current data in order to plan effective residential lighting programs.

A mail-based survey was sent out to over 7,000 randomly selected residential customers, with 1,558 returned. These returned surveys provided a rich dataset to characterize the current status of this market, including number of fixtures by location, CFL placement, customer demographics, and interest in purchasing CFLs. Results indicate that each of the utilities have current CFL saturation levels equal to approximately 20 percent, which are well above national average data available at the time of this study. All households, rooms, fixtures, lighting controls and demographic groups reported a significant amount of remaining achievable and technical potential for CFLs. Bathrooms, among the highest lighting energy use rooms, had the lowest CFL saturation levels (approximately 10 percent). Renters and multifamily residents reported the lowest saturation levels and were least likely to have ever purchased a CFL. And, detached single family homes offered the greatest remaining potential for CFLs because of the large number of sockets present. These results suggest that, even in regions with moderate to higher than average saturation levels, utilities should move forward with aggressive residential CFL programs targeting market segments that offer the greatest potential for savings.

Background

In its fifth and most recent Power Plan (2005), the Northwest Power and Conservation Council identified residential lighting as the number one source of conservation savings for the Pacific Northwest through the year 2025. The region is expected to achieve 530 aMW of cost-effective savings at a total resource cost of 1.7 cents per kWh. As such, residential lighting has become an important end use within the energy efficiency portfolio of Puget Sound utilities.

Relatively little was known about the regional CFL market and potential of efficient residential lighting before this study was conducted. Because the utilities were expecting a large amount of savings from residential lighting, utility staff determined that it was necessary to gather data on the local market to support program planning and implementation efforts. To gather these data, the four largest utilities serving Puget Sound customers sponsored the residential compact fluorescent lighting study referred to in this paper. Collaboratively, representatives from Puget Sound Energy, Seattle City Light, and Snohomish County PUD designed this study to focus on the lighting needs and purchasing habits of residential customers within their collective service areas.

The study, which concluded in June 2007, focused on addressing the following two primary research objectives, both for the Puget Sound region as a whole and for each utility service territory:

1. To quantify the number of standard (one-inch) screw-base sockets and the current placement of CFL bulbs, by room, fixture type, and control type.
2. To quantify the current saturation of CFL bulbs and assess consumer likelihood of installing additional CFL bulbs where they have not already done so.

A secondary data review was also completed during the early stages of this project in order to facilitate the design of the primary research efforts. This review was conducted in late 2006. The primary research was conducted using a paper-based survey mailed to a randomly selected sample of households across the utility service territories. The survey was fielded as a part of a pilot test during January 2007, and was then fully implemented during May and June 2007.

Sample Population

Table 1 summarizes the sample population, and number of surveys returned. Based upon response rates from the pilot test, it was determined that sample sizes of 2,600 for Puget Sound Energy and Seattle City Light and 1,500 for Snohomish County PUD would be required in order to achieve the target number of responses (1200 total, 400 per utility).[1]

Table 1: Sample Population and Survey Statistics

	Puget Sound Energy	Seattle City Light	Snohomish County PUD	Total Sample
Total Sample Mailed	2,725	2,725	1,625	7,075
Responses Returned	565	624	369	1,558
Usable Responses Returned	537	609	342	1,488
Sample Margin of Error	4.2%	4.0%	5.3%	2.5%

[1] The utility representatives hoped to achieve a 95% confidence interval with a 5% margin of error. Receiving 400 surveys per utility was necessary to achieve that goal.

To achieve these numbers, each utility drew simple random samples from their respective billing databases. Note that 125 surveys were sent out for each for a pilot test to determine the projected response rate for each utility, and are included in the "total sample mailed" numbers. The response rates for the three utilities ranged from 21 to 23 percent (average was 22 percent). In total, 1,558 Puget Sound households returned a completed survey of which 1,488 were usable for the analysis. The margins of error for the three individual utility samples ranged from 4.0 to 5.3 percent.

To assess the representativeness of the survey data to the overall population from which they were drawn, demographic data collected from survey respondents were compared to United States census data from 2000 for the counties within the Puget Sound service areas. This analysis found that survey respondents were slightly more likely than the general population to:

- Be older than adults in the general population (by roughly ten years)
- Be more educated: 51 percent of respondents have their Bachelor's or Advanced degrees, whereas only 33 percent in the general population hold these degrees.
- Own rather than rent: household ownership was 62 percent among the census population and 75 percent among survey respondents.

In general, though there were slight to moderate differences observed between the survey respondents and general population data, the sample was deemed to be appropriately representative of the population at large. Any slight or moderate influences demographic differences may have had on survey results are discussed within the findings of the report.

Survey Findings

This section summarizes overall household lighting data and examines important findings concerning sockets, CFL bulbs, saturation levels, and remaining market potential for the Puget Sound Area covered by the service territories of the three participating utilities. The section then explores specific consumer purchasing habits to determine how they may influence utility sponsored CFL programs.

Table 2 summarizes overall averages reported for the number of sockets, CFL bulbs, and CFL saturation levels for survey respondents. Ninety-five percent confidence intervals are included in parentheses below their respective averages.

Table 2: Sockets, CFLs and CFL Saturation: Puget Sound and Utility Samples

Sample	Sample Size	Number of Sockets		Number of CFLs Installed		Average of Household Saturations[2]	
		Avg.	Median	Avg.	Median	Avg.	Median
Puget Sound Energy	537	41.7 (39.5-43.8)	37	6.9 (6.1-7.6)	3	18.6% (16.6%-20.6%)	9.3%
Seattle City Light	609	33.4 (31.6-35.2)	28	5.6 (5.0-6.2)	2	18.2% (16.4%-20.0%)	10.0%
Snohomish County PUD	342	40.9 (38.3-43.5)	36	8.5 (7.3-9.8)	5	23.0% (20.1%-25.9%)	12.3%
Total Sample	1,488	38.1 (36.9-39.3)	33	6.7 (6.3-7.2)	3	19.4% (18.2%-20.7%)	10.4%

[2] Saturation equals number of CFL bulbs divided by number of sockets in each household. Not that this statistic was calculated by averaging all of the household saturation levels reported and is not the saturation level of all sockets in the residential sector of each utility's service territory.

Several differences were observed between the three utilities when looking at the averages for sockets, CFLs and saturation. Seattle City Light customers reported a lower number of sockets on average when compared to the other two utilities, which is likely due to the greater number of smaller homes in the utility's more urban and dense service territory (23% of SCL respondents reported households of 1000 square feet or less compared to just 10% for the other two utilities). Snohomish County PUD customers reported the highest number of CFL bulbs and saturation levels when compared to the other two utilities, which may be due to the fact that Snohomish began their utility sponsored CFL programs before the other utilities in the Puget Sound region.

Sockets

Socket data help generate an overall picture of lighting in the household. It provides information on how lighting is distributed throughout households and what potential remains for CFLs in the residential sector. Across all utilities, respondents reported a mean of 38.1 and a median of 33 sockets per household, with the distribution for individual households shown below in Figure 1. The wide distribution of the number of sockets is likely due to factors such as household size, as shown in Figure 2.

Figure 1: Distribution of Screw-Base Sockets in Households

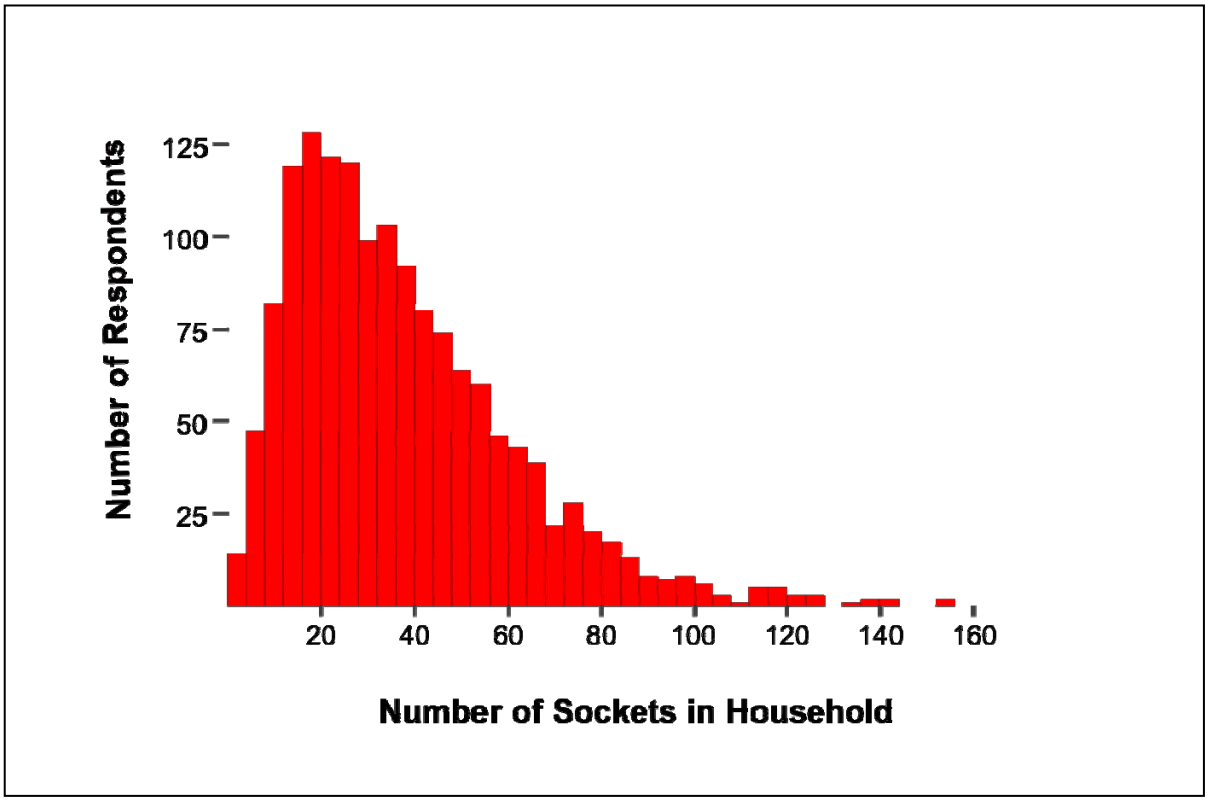
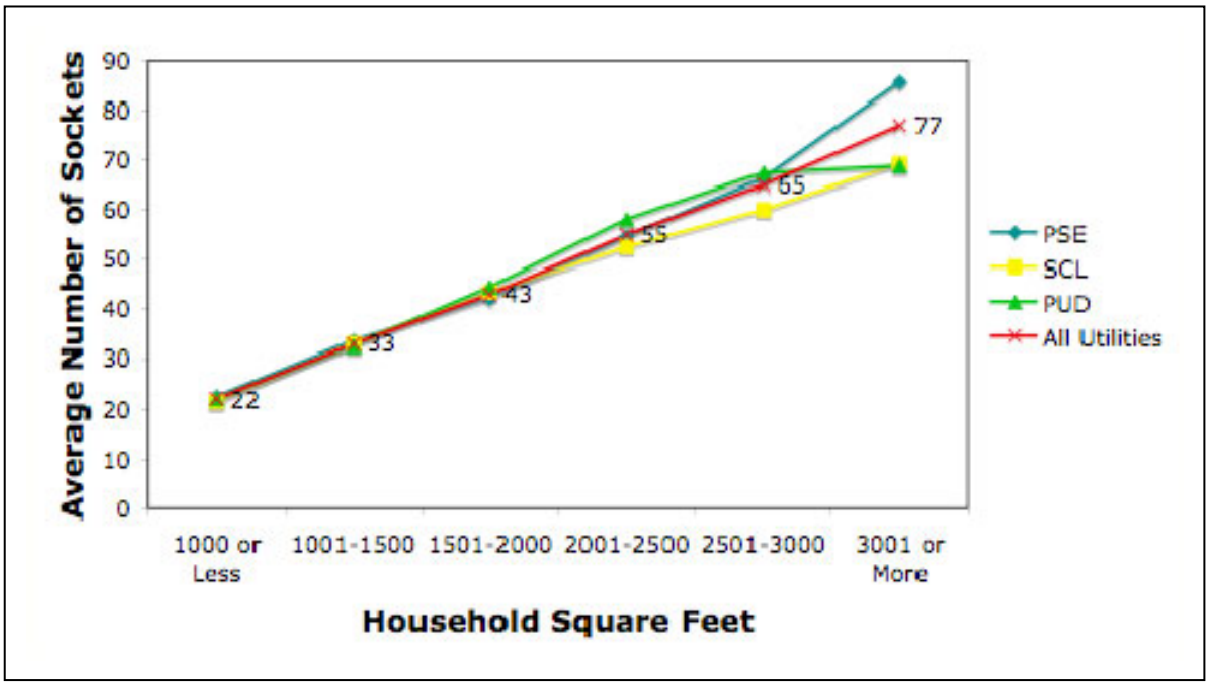


Figure 2: Average Number of Sockets by Household Area: Puget Sound and Utility Samples



Several regression analyses were run to gain further insight into the relationship between household square feet and the number of sockets. The regression through the origin had a very high R^2-value, suggesting that about 77 percent of the variation in the average number of sockets can be explained by household floor area. The coefficient on this regression was statistically significant at the one percent level. The equation for this regression is shown below.

$$Sockets = \underset{(0.000)}{0.020(Household\ Ft^2);} \qquad R^2 = 0.765$$

Socket counts were also collected for the various rooms, lighting fixtures, and control types found throughout the household. Sockets counts were highest for the most common rooms reported in households, such as kitchens, living rooms, master bathrooms and master bedrooms, and were lower for rooms such as home offices and family rooms. Kitchens had the highest reported number of sockets across all surveyed households at a mean of 4.5, while home offices were the lowest with a mean of 1.0. All other rooms fell in the mean range between 2.0 and 4.0 sockets.

Three fixture types were surveyed as a part of this effort: "surface mount or hanging" fixtures, "recessed cans", and "table or floor lamps." The majority of sockets were reported in surface mount or hanging fixtures at 65 percent, with 18 percent reported in recessed cans and 17 percent in table or floor lamps. Eighty percent of all fixtures were controlled by on-off switches, while the remaining 20 percent were controlled by dimmers, sensors, or 3-way switches.

CFLs and Saturation

Puget Sound area households reported an average of 6.7 CFLs and saturation levels of 19.4 percent. The distributions for both CFLs and saturation were relatively wide, suggesting that individual households in the Puget Sound area vary greatly with respect to the prevalence of CFLs.

Figure 3: Distribution of CFLs in Household

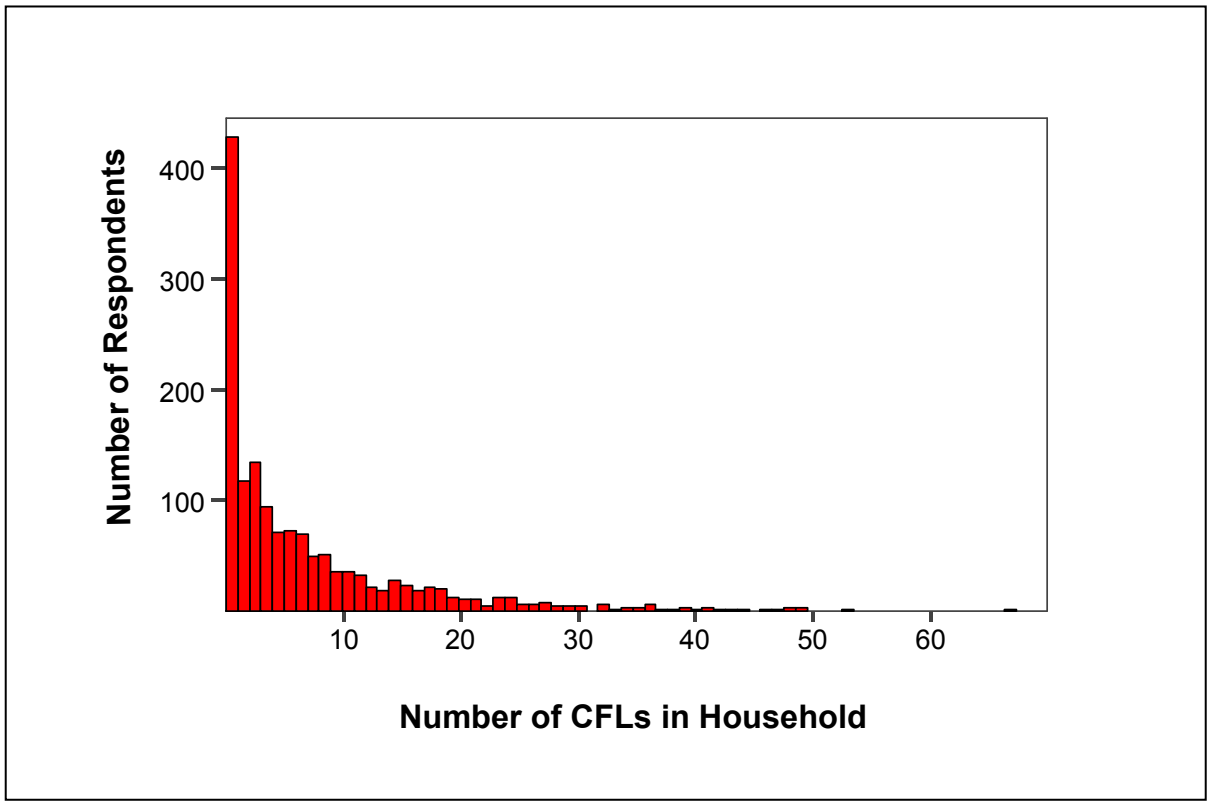
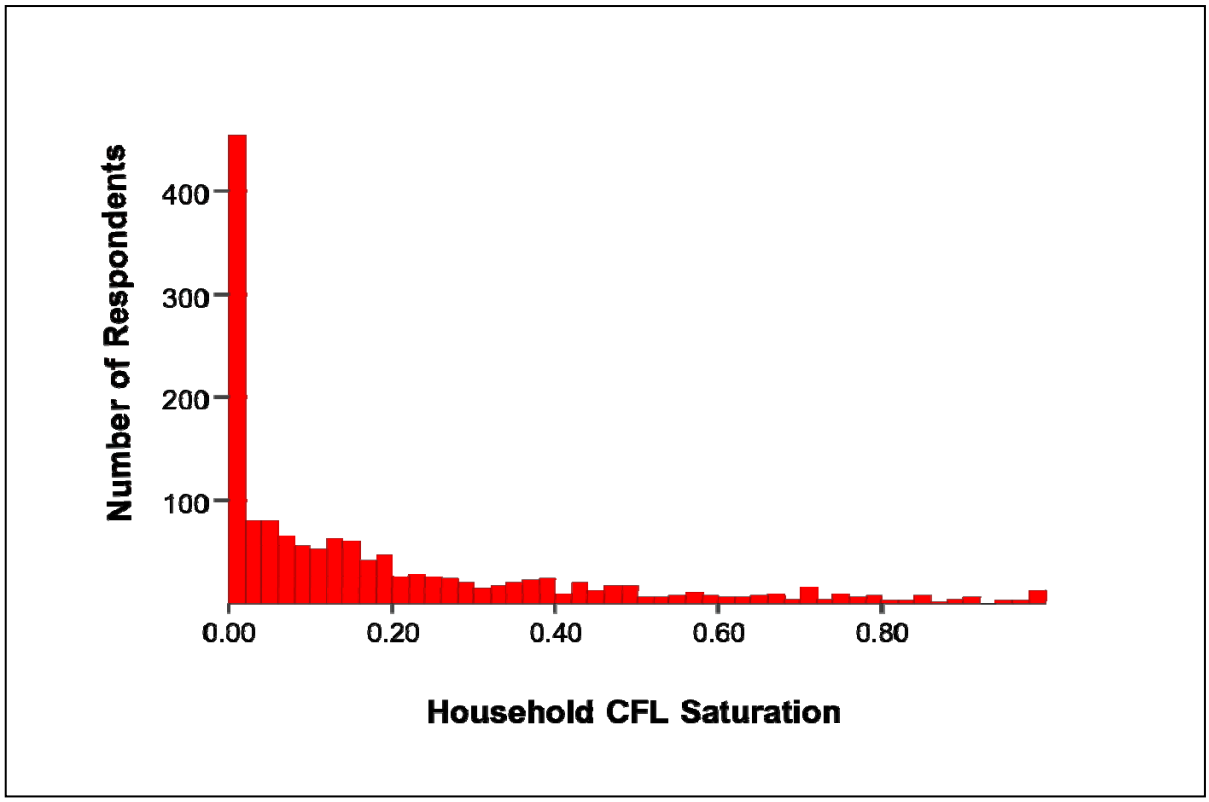


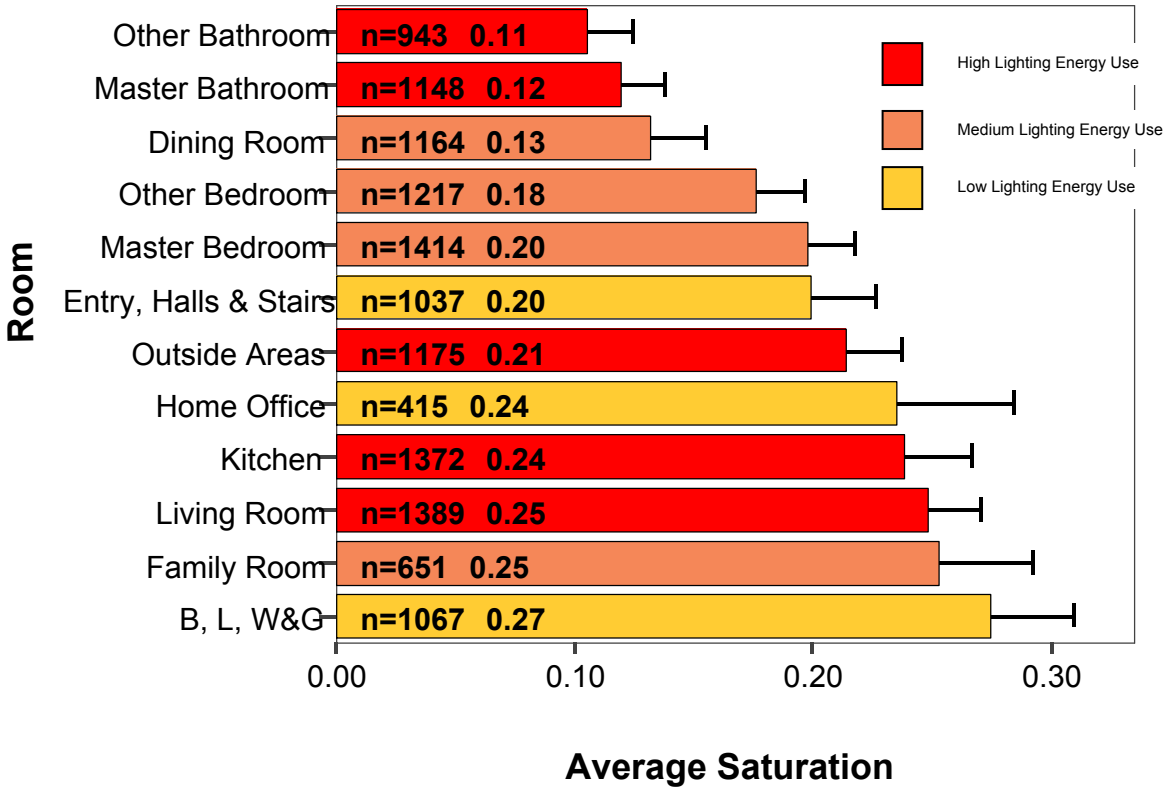
Figure 4: Distribution of CFL Saturation Levels in Households



Both of the distributions show a large spike on the left side of the figure, which represents the significant portion of the population currently reporting zero CFLs installed in their households. Among all respondents, 29 percent reported having zero CFLs currently installed in their households, while 46 percent reported having two or less CFLs installed. Demographic data were examined to see if particular groups were more likely to report having zero CFLs currently installed when compared to others, with housing type and tenure showing the most significant differences. 42 percent of apartment or condo residents reported zero CFLs installed compared to only 23 percent of detached single family residents, and 41 percent of renters reported zero CFLs installed compared to only 24 percent of owners.

Saturation levels for the rooms and fixture types reported in this study show where residential customers in the Puget Sound area are installing CFLs. These data provide useful information on where residential lighting efforts should be focused and where the greatest potential remains for utility programs. As shown in Figure 5, saturation levels fell between or near the range of 20 to 30 percent for almost all rooms in the household. The exception to this range was the dining room and bathrooms, which had reported saturation levels of around 12 percent.

Figure 5: Average Saturation of CFL Bulbs by Room: Households with Room Type[3]



Saturation levels for the three fixture types surveyed were reported at the following levels for the Puget Sound area:

- Table or Floor Lamp: 27 percent
- Recessed Can: 22 percent
- Surface Mount or Hanging: 18 percent

These data suggest that individuals are most likely to put CFLs in table or floor lamps when compared to other fixture types. The number for recessed cans is slightly surprising, as it was originally expected to be the lowest of all fixtures due to the fact that they are best outfitted with reflector style bulbs, a more expensive and harder to find specialty style of CFL. However, the reported saturation of 22 percent suggests that people are having no trouble finding this style of bulb or are using other styles instead.

Remaining Potential

The issue of remaining potential was of particular concern to the utilities involved with this study. Several of the utilities were under the impression that CFL awareness and saturation levels had increased significantly in the last couple of years due to increased publicity and public

[3] Each bar is color-coded into one of three different lighting energy use classifications as determined by a 1996 Tribwell and Lerman study on Pacific Northwest lighting and two studies published in 2005 by RLW Analytics and KEMA.

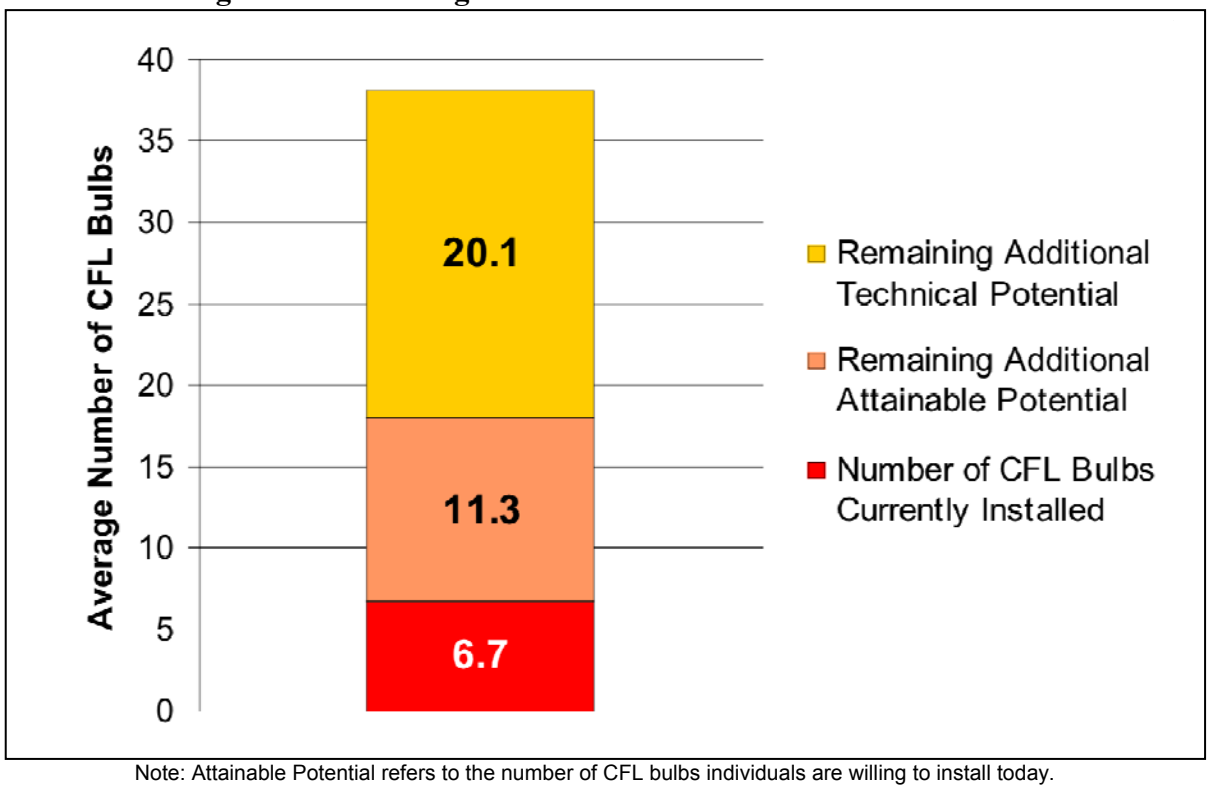
awareness and were concerned that the market was becoming saturated. Though market saturation is an objective for the utilities, it is important to know at what point the market has been effectively transformed so CFL programs can be scaled back.

The remaining potential for CFL bulbs in the Puget Sound Area is defined two ways:

- Attainable Potential – the number of CFL bulbs individuals are *willing* to install today. Attainable potential was determined by asking individuals to estimate the number of CFL bulbs they would install if they had the right type of bulb and didn't have to worry about wasting bulbs currently in place. This measure reflects the current state of awareness, perceptions, and knowledge among consumers.
- Technical Potential – the number of CFL bulbs individuals *could* install today (i.e., if all ordinary size screw-in sockets were filled with CFL bulbs). Technical potential was determined by counting the number of sockets[4] reported that do not currently have a CFL installed. No decrement is made in this category for specialty bulb applications.

Figure 6 shows the average remaining potential for CFLs at the household level in the Puget Sound region. On average, households are currently willing to install an additional 11.3 CFLs on top of the 6.7 already in place. This leaves an additional 20.1 standard screw-base sockets in which households would not install CFLs today.

Figure 6: Remaining CFL Potential at the Household Level[5]



Note: Attainable Potential refers to the number of CFL bulbs individuals are willing to install today.

Remaining potential was also calculated for all rooms types included in this survey. Individuals reported being willing to install one additional CFL in each room, suggesting there is

[4] The survey asked only about ordinary size screw-in sockets that work with traditional CFL bulbs.
[5] Note: Attainable Potential refers to the number of CFL bulbs individuals are willing to install today.

a great amount of remaining potential throughout the household. All fixture types surveyed also had significant remaining technical and attainable potential for CFLs.

Consumer Habits and Purchasing Characteristics

Survey respondents were asked to indicate when they made their most recent CFL purchase. These data were then examined to see if there were any major differences between demographic groups. Again, major differences were observed for housing tenure and type, as shown in Table 3. Renters and respondents living in apartments or condos were significantly more likely to have never purchased a CFL when compared to household owners and those living in detached single family homes.

Table 3: Most Recent CFL Purchase, by Housing Type and Tenure

When did you last buy a CFL?	Single Family, Detached	Apartment or Condo	Own or Buying	Rent or Leasing
Recently	16%	6%	14%	7%
Within the past several months	31%	24%	30%	22%
Within the past year	20%	15%	19%	18%
More than a year ago	16%	15%	165	15%
Never bought a CFL bulb	18%	40%	19%	38%
All Respondents	65%	22%	75%	25%

Utilities were also interested in gathering current data on CFL storage rates for their residential customers. Respondents reported storing an average of 37 percent of the bulbs from their most recent purchase for later use. This number suggests that consumers may now be storing more bulbs than in the past, as a 2005 estimate by Snohomish County PUD indicated residential customers were storing an average of 25 percent of the CFLs they purchased.[6]

Discussion and Recommendations

Following are key recommendations based on the findings from this research for future utility planning and marketing efforts aimed at increasing CFL bulbs in the residential sector. These recommendations focus on targeting groups that are more likely to have zero CFL bulbs and increasing the number of CFL bulbs in market segments identified as having the greatest amount of potential. Taken together, these recommendations provide an approach on how to target areas of the market that are currently underserved and that hold the greatest potential for additional energy savings. Such an approach will help utilities more effectively meet their specific lighting and energy conservation goals and further increase the saturation[7] of compact fluorescent lighting in the Puget Sound Area.

[6] Pg. 8, Snohomish County PUD. Screw-Base Compact Fluorescent Lighting: Progress and Evaluation of the PUD's Retail CFL Program. (Snohomish County Public Utility District, 2006).
[7] Saturation is defined as "the percentage of lighting sockets in the average home that are filled with CFLs."

Key Finding #1: Opportunity Exists for More CFL Installations

Data indicate that opportunities to install CFL bulbs exist in every area of the home and in each type of lighting fixture assessed through this survey. Additionally, CFL rebate and coupon programs are likely to increase customer willingness to purchase CFL bulbs.

Recommendation #1: encourage installation of additional CFL bulbs throughout the house. Data indicate that a significant amount of potential still exists across all rooms, fixtures, and segments of the population. Utilities should develop programs and marketing campaigns that encourage individuals to install additional CFL bulbs beyond those they already have in place or in new locations in the household. For example, utilities could develop a campaign encouraging their customers to install two or three additional bulbs in their homes and indicate the substantial environmental and economic benefits this would have for their service territory. Such a strategy would take advantage of the large amount of remaining potential reported by customers who indicated they already have CFL bulbs in place.

Recommendation #2: continue to facilitate consumer purchases through utility CFL rebate and coupon programs. Of survey respondents, 70 percent indicated that they would be more likely to purchase CFL bulbs with a rebate or coupon. Utilities should continue their efforts in this area and, as will be discussed below, with a specific emphasis on traditionally low saturation groups such as renters and apartment or condo dwellers.

Key Finding #2: CFL Programs Should Be Targeted

There were some key differences observed between homeowners and renters and type of home, between different types of rooms and when looking at type of control for specific fixtures, all of which should be addressed when developing programs.

Recommendation #3: develop a strategy that focuses on encouraging individuals in the multifamily sector to try CFL bulbs for the first time. Both renters and apartment or condo dwellers were identified as the only two groups being significantly more likely than the rest of the population to have zero CFL bulbs in place. Utilities should consider developing a program that focuses on providing this market sector with incentives and education about energy efficient lighting as a way to increase the number of CFL bulbs installed.

Recommendation #4: promote the use of CFL bulbs in low saturation rooms. Strikingly, while bathrooms and dining rooms are two of the highest energy usage areas in the home, these rooms were reported to have the lowest CFL saturation levels in the household. Marketing efforts focusing on education that specialty bulbs are available for these rooms may help increase saturation in these areas.

Recommendation #5: promote and provide information on all specialty bulbs currently available and continue efforts to promote development of specialty bulbs not yet available in the market. Data suggest that specialty bulbs may be required for around 20 percent[8] to 35

[8] If only sockets with dimmer, sensor, or 3-way controls are classified as those requiring specialty bulbs, the percentage of sockets requiring specialty bulbs is around 20%.

percent[9] or more of all fixtures in the average household in the Puget Sound area in order to work properly with lighting controls (i.e., dimmers, three-way switches, and sensors) or appropriately fill recessed cans. This number may be even higher when you take into account bulbs that are required for specific fixtures, such as candelabra bulbs for chandeliers and globe bulbs for bathroom vanities. This study found that there is tremendous opportunity to install more CFL bulbs in recessed cans, specifically encouraging the use of indoor reflector bulbs. In other type of fixtures that do not require specialty bulbs, some individuals may still be unwilling to install a standard twist or quad CFL and may instead prefer a less obvious CFL bulb (i.e., a specialty bulb). For these reasons, reflector bulbs for recessed cans should also be a key focus in any programmatic effort.

Utilities should promote messages through marketing materials and at local stores that inform customers about the availability of specialty bulb options and encourage individuals to consider them in their lighting purchases. As an example, bill inserts or point-of-purchase pamphlets may include images of globe style CFL bulbs installed in a bathroom vanity fixture or CFL bulbs in a pendant style fixture in the dining room.

However, there currently are several specialty bulbs that are needed but are not yet available in the market. Specifically, there are currently few reliable products available to replace incandescent bulbs on standard dimmers, in chandeliers, and in other applications where point-source light is desirable. In these cases, utilities should continue or step up efforts to more vigorously work with all channels to offer, distribute and manufacture the needed CFL bulbs. Utilities have had tremendous and demonstrated influence in other arenas (e.g., appliance standards) and have the ability, especially when they join forces with each other, to make more specialty bulbs available and thereby reduce energy usage in key areas of the home and fixtures.

References

Energy Market Innovations, Inc. *Puget Sound Area Residential Compact Fluorescent Lighting Market Saturation Study.* (Puget Sound Energy, Seattle City Light, Snohomish County PUD, 2007).

Northwest Power and Conservation Council. *The Fifth Northwest Electric Power and Conservation Plan* (Northwest Power and Conservation Council, Portland, Oregon, 2005).

[9] If sockets with dimmer, sensor or 3-way controls *and* all sockets in recessed cans are classified as those requiring specialty bulbs, the percentage of sockets requiring specialty bulbs is around 35%.