

# **Seattle's Conservation Kit Program— Transforming the Residential Use of Compact Fluorescent Lighting**

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## **ABSTRACT**

A decade after electric utilities nationwide began the effort to transform the residential lighting market, the average household in Seattle owned only one compact fluorescent (CF) bulb. With an urgent need to reduce utility loads in 2001, Seattle City Light (a municipal utility) offered Conservation Kits with two newer-generation CF bulbs to every residential customer. Kit distribution to solicited respondents was followed later in 2001-2002 by mailing two retail discount coupons to all households. The two lighting initiatives are referred to as the Conservation Kit and Retail Coupon Programs. This paper reports on the process and impact evaluation of the Conservation Kit Program operated during 2001. The evaluation estimates energy savings from and the cost-effectiveness of Kit measures, as implemented in existing residential buildings throughout the utility service area. It assesses the program's effectiveness at meeting six strategic objectives. The study also documents progress toward CF lighting market transformation in the urban residential sector.

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## ABSTRACT

A decade after electric utilities nationwide began the effort to transform the residential lighting market, the average household in Seattle owned only one compact fluorescent (CF) bulb. With an urgent need to reduce utility loads in 2001, Seattle City Light (a municipal utility) offered Conservation Kits with two newer-generation CF bulbs to every residential customer. Kit distribution to solicited respondents was followed later in 2001-2002 by mailing two retail discount coupons to all households. The two lighting initiatives are referred to as the Conservation Kit and Retail Coupon Programs. This paper reports on the process and impact evaluation of the Conservation Kit Program operated during 2001. The evaluation estimates energy savings from and the cost-effectiveness of Kit measures, as implemented in existing residential buildings throughout the utility service area. It assesses the program's effectiveness at meeting six strategic objectives. The study also documents progress toward CF lighting market transformation in the urban residential sector.

## Program Design Issues

**Planning Background.** Seattle City Light has been an actor in fluorescent lighting transformation for over two decades, beginning with programs in the commercial sector.<sup>1</sup> In the residential sector, the utility lighting efforts had concentrated on existing and new construction multifamily buildings,<sup>2</sup> until the advent five years ago of regional-based retail programs sponsored by the Northwest Energy Efficiency Alliance (NEEA).<sup>3</sup> Seattle City Light conducted research in the mid-1990s on compact fluorescent (CF) lighting products for the residential sector, in cooperation with other regional utilities (Brattesani & Ducey 1994).<sup>4</sup> That research recommended developing retail programs, finding ways to lower bulb costs, improving the quality and variety of products offered in retail stores, and helping customers make a gradual transition to CF lighting. The regional programs accomplished the first three goals, but still, voluntary adoption of CF products was slow.

**Program Rationale.** Program developers in Seattle City Light's Community Conservation group came to recognize that a new initiative would be required. While early adopters may have acquired a CF bulb during the 1990s out of curiosity, repeat sales were slow to pick up. The early selection of CF products was limited, users perceived them as not fitting many fixtures, and lighting quality did not fully meet user expectations. Since their first introduction, many of these limitations have been ameliorated by a proliferation of product designs and improved lighting quality. Utility planners considered how to overcome the remaining market transformation barriers, to move customers to try the

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<sup>1</sup> Lighting Survey and Incentive programs (1979-1983), Energy Management Surveys (1984-1992), Commercial Incentives Pilot program (1987-1991), and Energy Smart Design (1991-present), now Energy Smart Services.

<sup>2</sup> Multifamily Conservation programs, including the Common-Area Lighting program (1986-present), and Built Smart programs, including the Affordable Housing program (1983-present).

<sup>3</sup> LightWise (1997-1998) and Energy Star® Lighting and Coupons (1999-2001), offered in cooperation with local electric utilities by the Northwest Energy Efficiency Alliance.

<sup>4</sup> The research and demonstration project also involved regional utilities such as Puget Power, Snohomish County PUD, Tacoma City Light, and the Electric League of the Pacific Northwest

bulbs again or, indeed, for the first time. In mid-2000 the Community Conservation group began planning ways to reintroduce compact fluorescent lighting to residential customers and advance the overarching goal of market transformation.

**Program Goals.** To clarify program goals, planners studied six service delivery options. Meanwhile, changes in the West Coast energy market beginning in June 2000 added urgency to the planning process. By October 2000 the program design jelled and implementation preparations began in earnest. The program goals and strategic objectives were stated as follows.

**Goal 1.** To improve public relations between Seattle City Light and utility customers, allowing every residential customer to have an opportunity to take advantage of this program (including apartment dwellers and condo/townhome owners).

**Goal 2.** To increase customer awareness of and future retail demand for CF lighting products.

**Goal 3.** To support the retail sector component of market transformation.

**Goal 4.** To utilize collaboration opportunities, leverage other resources, and use a delivery method that minimizes staffing intensity.

**Goal 5.** To acquire cost-effective conservation energy savings in 2001, providing economic benefits that reduce the impact of the proposed power cost adjustment on customers and help reduce Seattle City Light's purchased power bill.

**Planning Options and Adopted Program Design.** The original planning options paper identified six potential program delivery methods. Two options would offer unsolicited delivery of a free CF bulb to residential customers, either through the mail or door-to-door. Two other options would solicit customer requests for a pair of free CF bulbs, either by a mail-back response card or through neighborhood community centers. And finally, two options were proposed to utilize the retail market through a retail coupon redeemable at participating retailers, with or without a buy-down of wholesale prices. The adopted program design solicited active customer participation, requiring their response to get the products, followed by passive coupon mailings to all residents. Program developers judged that these steps would best further the objective to encourage future purchases, increase long-term use of CF lighting by residential customers, and promote market transformation (Fevold & Morita 2000).

The first and major phase of the adopted program, involved mailing CF bulbs in a Kit to residents who respond to the initial mailed solicitation. The Kit also contained an efficient bathroom faucet aerator supplied by the City water utility, Seattle Public Utilities (SPU), along with a diagnostic water flow-rate measurement bag. Planners assumed a 30% solicitation response rate, based on past experience of another West Coast utility in a give-away program and their assumption for planning a similar program for Oregon residential customers (PacifiCorp 2000). Planning projections were that 90% of Kit recipients would install bulbs and 75% would install the faucet aerator. The Kit option required the use of a fulfillment company to mail solicitation letters and Kits during spring 2001. Seattle City Light supplemented the Kit Program by delivering CF bulbs to a few key community groups and events during 2001. The Retail Coupon Program began in fall 2001 and continued into early 2002.

## **Evaluation Design & Methods**

Impact and process evaluation activities were launched by Seattle City Light in mid-2001, starting with a survey of program participants and nonparticipants.

**Survey Objectives.** Six months after Kit distribution, Seattle City Light conducted survey research to provide the basis for estimating market trends in CF product use and to quantify water and energy savings resulting from the program. Specific objectives for the survey were to assess Kit bulb installation rates, satisfaction with and barriers to requesting the Kit or using Kit products, prior use of and satisfaction with CF bulbs, and differences between participants (Kit requestors) and nonparticipants (non-requestors). The survey assessed impacts of the Kit faucet aerator and water flow-rate bag, as well

as spillover effects from the Kit Program on retail activity (through subsequent purchases during 2001 of CF bulbs and showerheads). A long-term survey was scheduled to follow in 2002. This two-survey method had been used with success for a similar mass distribution showerhead program mounted by Seattle City Light in 1992 (Brattesani & Okumo Tachibana 1993 and 1994).

**Survey Design.** The mailed survey was fielded by the utility. Proportional stratified 1% random samples were drawn from a program database of all residential customers. Survey instruments were mailed in fall-winter 2001; 40% of subjects returned completed questionnaires, for respondent samples of 629 participants and 581 nonparticipants. This number included a second group of nonparticipants sent a revised questionnaire due to low initial survey response. Results provided a 4% level of precision on proportions near 50%, with a 95% confidence interval. Group differences were analyzed using chi-square statistics for frequency data.

**Survey Implementation.** The short-term survey was scheduled to go into the field immediately after Labor Day. Mail-out was held back to avoid initiating the survey during the week of September 11, 2001. Subsequent anthrax threats to the US postal system caused apprehension that residents would reject survey-related mail. This was a difficult time to ask customers to respond, given their other concerns, so extra efforts were made to elicit their interest in the survey. These efforts included design features (compact layout); posting directly from Seattle City Light in envelopes with the utility return address; multiple follow-ups via a reminder postcard and booklet re-mailings; and alerting customers to the CF bulb \$6 retail coupon offer enclosed with fall 2001 utility bills. Fortunately, the original instrument design using red, white, and blue added subliminal appeal. One program delivery and survey problem resulted from legal requirements related to customer confidentiality. This caused users of the database to generate multiple Kit and survey mailings to some property managers rather than to service addresses; this could have been avoided with more implementation time and better database grooming.

**Use of Survey Results for Impact Estimates.** The responses to specific survey questions enabled the calculation of annualized megawatt-hour (MWh) energy savings, annualized gallons of reduced water and waste-water (sewer) flows, and levelized cost in mills per MWh (or, cents per kWh) of program energy savings. Statements of average megawatt (aMW) utility load reduction in 2002 all include a 5.2% credit for savings from avoided transmission and distribution (T&D) line losses. A variety of sources contributed deemed values and parameters for use in calculations of Conservation Kit Program impacts. These included Seattle City Light's recent residential customer characteristics survey (Geist 2000), a light metering study by Tacoma City Light (Tribwell & Lerman 1996), and technical potential analyses by the Northwest Power Planning Council for Seattle City Light's service area (Eckman 2000 and 2001), along with prior and current water metering studies (SBW & Hopkins 1994; SBW & Hickman 1994; DeOrea et al. 2002).

## Evaluation Results

**Program and Survey Response.** In spring 2001, Seattle City Light sent solicitation letters to 314,064 residential customers, offering a free Conservation Kit upon return of a reply postcard. Requested Kits were then sent to 178,481 of these customers (57%). By year-end, due to the utility programs, Seattle area residents installed over half a million new CF bulbs. The survey research shows that, although Seattle households had only one CF bulb installed at the beginning of 2001, by year-end over half had nearly *four* bulbs installed. Because these participating customers perceived the potential for locating *seven to eight* CF bulbs in each home, these households moved from a baseline saturation of 12% to a year-end level of 44%.

**Kit Bulb Technical Potential.** The technical potential for lighting energy savings, had *all* customers requested the Kit and installed *both* CF bulbs contained in it, was 34,233 MWh (Table 1).

This level of energy savings would have reduced Seattle City Light’s average system load by 4.111 aMW. The technical potential for lighting energy savings from *participating* customers, had they installed both CF bulbs, was 19,454 MWh, which would have reduced the average system load by 2.336 aMW.

**Table 1.** Technical Potential and Actual Energy Savings from CF Bulbs Distributed by the Conservation Kit Program

Lighting Measure Impacts	Count	Annual MWh	2002 aMW
Customers sent solicitation	314,064	34,233*	4.111*
Requested Kits delivered	178,481	19,454*	2.336*
Immediate Kit Effect: Kit bulbs installed immediately	285,570	15,564	1.869
Delayed Kit Effect: Kit bulbs installed in 6-8 months	49,758	2,712	0.326
Gross Cumulative Effect from Kit Bulbs	335,328	18,275	2.195
Free Rider Effect on Immediate Installations	(-35,696)	(-1,945)	(-0.234)
<b>Net Effect from Kit Bulbs</b>	<b>299,632</b>	<b>16,330</b>	<b>1.961</b>

\* Technical potential from 100% response and 100% installation

**Kit Bulb Impact.** The actual annualized program *gross* impact was 18,275 MWh from cumulative bulb installations by year-end 2001, or 94% of the technical potential for participating customers (Table 1)—a spectacular result. Of this amount, 85% were acquired immediately and 15% resulted from installations delayed over the six to eight months following Kit delivery. Free riders, who by self-report on the survey would have installed CF bulbs during this period on their own without using the Kit, comprised about 11% of the observed savings.<sup>5</sup> The *free-rider adjusted effect* of the program is equivalent to 91 kWh per delivered Kit. This estimate of free-ridership reduces the *net* savings directly attributable to the Conservation Kit bulbs to 16,330 MWh, with a system load impact of 1.961 aMW.

**Kit Bulb Spillover.** Besides direct energy savings from the Kit CF bulbs, there was a measurable spillover effect from the Conservation Kit and Retail Coupon programs.<sup>6</sup> Based on participant self-reports, nearly 90% of subsequent CF bulb purchases during the remainder of the year were influenced (‘a lot’ or ‘a little’) by use of the Kit products. This *spillover effect* of the program resulted in up to 9,070 MWh in additional annualized energy savings (Table 2).

**Kit Water Impact.** The Conservation Kit also contained efficiency measures that produce electricity savings by reducing hot water usage. Half of program participants installed the Kit faucet aerator and 1% acquired and installed a new efficient showerhead based on testing with the Kit water flow-rate bag. These actions resulted in additional annualized energy savings of 2,675 MWh. Faucet aerators produced an average 11 kWh and showerheads produced 4 kWh per delivered Kit.

<sup>5</sup> Respondents were asked how likely it was that they would have purchased a CF bulb during the Kit distribution period, spring 2001; 21% replied that they were very likely to do this on their own. This estimate of *free ridership* reduced the participant installation rate by 0.2 bulbs, from 1.6 to 1.4 Kit bulbs per home.

<sup>6</sup> Rosenberg (1996) has defined *spillover* as “any reduction in energy consumption or demand that is due to a DSM program, other than reductions due to measures or actions taken by participants as a part of the program.” Including those purchases influenced even ‘a little’ by the Kit may result in a generous estimate of the program spillover effect.

**Table 2.** Annualized Net Impacts from Lighting and Hot Water Efficiency Measures Delivered or Influenced by the Conservation Kit and Coupon Programs

Lighting & Water Measure Impacts	Count	Annual MWh	2002 aMW
Net Effect from Kit Bulb (Table 1)	299,632	16,330	1.961
Adjusted Spillover Effect: Subsequent Participant purchases attributable to influence of Kit	166,418	9,070	1.089
<b>Total Program CF Bulb Impact</b>	<b>466,050</b>	<b>25,400</b>	<b>3.050</b>
Kit Faucet aerators installed	89,241	2,001	0.240
Showerheads installed: Based on use of water flow-rate bag	2,499	674	0.081
<b>Total Water Measure Effect</b>	<b>—</b>	<b>2,675</b>	<b>0.321</b>
<b>Overall Net Impact of Programs</b>	<b>—</b>	<b>28,075</b>	<b>3.372</b>

**Kit Total Impact.** By year-end 2001 the combined impact of the Conservation Kit and Retail Coupon programs generated 28,075 MWh in net annualized electricity savings and drove the overall net impact up to 3.372 aMW—one percent of the residential system load. The overall amount saved per average Kit was 106 kWh. This corresponds favorably to the planning projection of 110 kWh (comprised of 95 kWh from lighting measures and 15 kWh from water measures).

**Table 3.** Combined Impact of Conservation Kit with Other Direct Distributions of CF bulbs to the Seattle City Light Community During 2001

Lighting & Water Measure Impacts	Delivered	Installed	Annual MWh	2002 aMW
Block Watch CF Bulb Distribution: to “Night Out” event participants for porch lights	17,000	12,750	1,403	0.168
Office of Housing CF Bulb Distribution: to past participants in the Low-Income MF Pgm	32,606	24,455	1,333	0.160
Mariner’s Game CF Bulb Distribution	10,000	1,500	82	0.010
<b>Other Distribution Impact</b>	<b>59,606</b>	<b>38,705</b>	<b>2,818</b>	<b>0.338</b>
<b>Overall Net Impact of Bulbs (Table 2)</b>	<b>—</b>	<b>466,050</b>	<b>28,075</b>	<b>3.372</b>
<b>Combined Plan Impacts</b>	<b>—</b>	<b>504,755</b>	<b>30,893</b>	<b>3.710</b>

**Supplemental Impacts.** What is more, Seattle City Light conducted three other supplemental activities during 2001 to introduce CF bulbs into the hands of residential customers, which are accounted for under the Conservation Kit Program. The utility distributed free CF bulbs at community events and through community-based infrastructures. The most significant impacts resulted from the installations estimated to result from distribution of nearly 60,000 CF bulbs to Block Watch participants, past participants in the Low-Income Multifamily Program, and attendees at a local Mariner’s baseball game. It is calculated that about 65% of those bulbs (38,705) were installed in the service area during 2001.<sup>7</sup> The result was in another 2,818 MWh of net annualized energy savings and 0.338 aMW of system load reduction (Table 3).

<sup>7</sup> No current measurements were made of these supplemental efforts. Instead, deemed installation rates were adopted from measurements made in the early 1990s for unsolicited showerheads (65%; Brattesani and Tachibana 1994), and

**Combined Plan Impacts.** The combined impact during 2001 of the Conservation Kit and Retail Coupon Programs with the supplementation distributions was to generate 30,893 MWh in annualized net energy savings and reduce Seattle City Light's system load by 3.710 aMW. In the process, *Seattle residents installed over half a million new CF bulbs.* This result precedes the impact of 2002 redemptions on bulb and lamp rebates from the Retail Coupon Program, which were modest in number.

## **Evaluation of Impacts by Objective**

Seattle City Light has been a leader at taking the long-term, comprehensive view to designing, operating, and evaluating conservation programs. Programs serve public purposes and often reflect the municipal partnership among various utilities. Over time a three-dimensional matrix has emerged that frames this comprehensive approach. The utility offers many programs and efficiency services organized under umbrella identities that make conservation support appear relatively seamless to area citizens and businesses. These umbrellas are organized first by customer sub-sectors, second by end-uses, and third by the organizing principles of public purposes and environmental resources (energy, water, waste, air quality, land use).

The Conservation Kit and Retail Coupon programs were designed within this 3-D framework. Goals were established to ensure a well-rounded program. These goals likewise focus the evaluation objectives on the subsector, end-uses, and public purposes served by the program. The subsector is all residential customers in the service area who may be reached by mail, within the legal constraints on use of utility bill mailing addresses. The end-uses include lighting (energy), domestic water heat (energy), interior sink and shower water (including unheated), wastewater (sewage flow), air quality (avoided carbon-dioxide emissions), and land use (avoided mercury disposal). The public purposes for the programs were to ensure equal opportunity, increase customer awareness, foster future demand, support the retail sector, leverage resources through collaboration, ensure staff efficiency, acquire the conservation energy resource, and generate economic benefits.

### **Goal 1. Equal Opportunity**

#### **Did the Kit program allow every residential customer to have an opportunity to take advantage of this program (including apartment dwellers and condo/townhome owners)?**

Virtually all 314,064 residential customers of Seattle City Light had the opportunity to participate in the Conservation Kit Program, having received the mailed solicitation letter. However, about half of nonparticipants responding to a follow-up survey did not notice the announcement letter for the Kit offer. Nonparticipants matched participants on most characteristics; those who did not notice the offer remain receptive to future market transformation efforts. This will have implications for future residential lighting promotions by Seattle City Light.

**Most Kit Solicitations Delivered.** Among Conservation Kit participants, fewer than 1% of survey questionnaires mailed in September 2001 were undeliverable by the Postal Service. This population appears to have resided in stable numbers at the same location sent the Kit solicitation letter six months earlier. Among nonparticipants, the first sample approached for the September survey resulted in 7% undeliverable mail; the second sample approached two months later in November yielded 13% undeliverable mail. Compared to participants, this population had fewer "good addresses" in the customer database extract by fall 2001, indicating more mobility than among participants. The

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currently observed for solicited CF bulbs (over 90%; Tachibana and Brattesani 2003), averaged to 75% for this application and adjusted for the proportion of bulb hand-outs going to residents within Seattle City Light's service area.

6% increase in undeliverable nonparticipant mail between September and November suggests, by back projection, that it is likely most, if not all, Kit solicitation letters did reach their intended destinations among nonparticipants, but that the impending move-out reduced the recipient's awareness of, or interest in responding to, the Kit Program solicitation.

**Many Nonparticipants Did Not Notice Solicitation.** From these inferences, it appears that virtually all of the 314,064 residential customers of Seattle City Light did have the opportunity to participate in the program, having received the mailed solicitation announcing the free offer. However, it is also clear that about half of nonparticipants did not notice the Kit announcement. We called this group the nonparticipant Passive Group, as they felt they did not receive the Kit offer, did not recognize it as an offer, or did not act upon the offer. (By contrast, those in the other half who mentioned a reason for not participating beyond missing the notice are called the nonparticipant Choice Group, because they chose not to send for CF bulbs at the time of the offer.) Of interest, a large proportion of the nonparticipant Passive Group asked in hand-written comments on their questionnaires whether they could still receive the Kit. They appeared genuinely interested in trying the CF bulbs. In all, the great majority of nonparticipants (77%) did not participate at least in part due to some stumbling block related to the program solicitation, their own response, or delivery of the product.

**Demographic Factors Not Significant.** Because so many nonparticipants said they did not recall the Kit offer, demographic analyses compared the Passive group with the Choice group. The Choice Group was significantly different from the Passive group only in number of household members. Choice Group respondents were more likely to have four living in their home, whereas those in the Passive group were more likely to have five or more. No other demographic variables differentiated these two nonparticipant subgroups.

**Nonparticipants Open to Opportunity.** The unsolicited requests for the Kit from nonparticipants who did not recall the offer suggest a tremendous opportunity to introduce more utility customers to CF bulbs. Whether they did not receive the offer, did not notice it, or did not consider it important at the time cannot be determined by the survey data. It is possible that busy residents needed additional offers or reminders to kindle enough interest to send for the Kit. Taken as a rule of thumb in advertising, an audience needs multiple exposures to an ad before buying a new product. The survey itself may have been the crucial influential promotion that prompted requests for the Kit. Regardless of the explanation for failing to request the Kit, many nonparticipants have now heard enough about CF bulbs to raise their awareness, and are willing to try them. The utility has an opportunity to target another round of this or a similar program to the nonparticipant population. Those who made a conscious decision not to participate, in contrast, are the least likely converts to CF lighting. In particular, those who said their lights were on dimmers or in recessed fixtures, approximately 16% of nonparticipants, might be excluded from the group of potential CF bulb customers until CF bulb technology cost-effectively addresses those applications.

## **Goal 2.A. Customer Awareness**

### **Did the Kit program increase customer awareness of CF lighting?**

The Conservation Kit program was effective both at increasing customer awareness and at bolstering future demand among residential customers for compact fluorescent bulbs. The large proportion of residents who said they used a CF bulb for the first time when they received the City's Kit indicates that the Conservation Kit Program was a vital force in increasing awareness of and transforming the Seattle market for CF bulbs. This program offered a relatively expensive item free of charge. The demographic findings suggest that the direct distribution program was a particularly effective method of introducing a product to a market segment that would be reluctant to purchase

CF bulbs on their own but stand to benefit most by the resulting energy savings. The Conservation Kit overcame some prior negative impressions of the technology, increased customer satisfaction with CF lighting, and effectively met the utility's goal to reintroduce the bulbs directly to customers and stimulate the market for CF products. The direct distribution method increased customer trust and interest in the product, and made an important contribution to transformation of the residential market for CF lighting.

**Kit Generated New Users.** The Conservation Kit Program introduced a large proportion of utility customers to CF bulbs. Two-thirds (66%) of program participants tried a compact fluorescent (CF) light bulb in their homes for the first time when they received the City's Kit. Across all households in the service area, 57% were program participants; hence, the Conservation Kits were responsible for transforming 38% of all the households in Seattle City Light's service area to CF bulb *New Users*.

**Early Buyers are Baseline for Awareness.** Those who had tried CF bulbs before receiving the Kit offer are called *Early Buyers*. A third of all respondents were Early Buyers; they were found in the same proportion among both program participants and nonparticipants. One-third (33%) of all Seattle City Light customers were Early Buyers, another 38% became New Users due to the program, and 29% remained non-users of CF lighting at the time of this survey. Early Buyers were more often homeowners, residents of single-family homes, male respondents, those who have larger households, and those with household incomes of \$60,000 or more.<sup>8</sup>

**New Users are Different from Baseline.** In contrast, New Users were more likely than Early Buyers to be renters, apartment dwellers, female respondents, have fewer members of their households, and have lower household incomes, less than \$60,000. The smaller the household, the more likely the Kit participant was a New User (and had not used CF bulbs before the Kit program). The demographic profile of new CF bulb users makes sense in that those who live in one-person households and have lower incomes would be less likely to have spent money to try (relatively expensive) CF bulbs. Apartment dwellers overlap with renters, and are also more likely to have lower incomes than homeowners. They may be reluctant to spend extra money on household lighting that would remain with the apartment after they move. Of interest is that women were more likely to be new CF bulb users than men were. Lower income customers are less likely on their own to use unfamiliar, higher-cost products (this group includes many women). However, the program was successful at encouraging people with these demographic features to use the Kit CF bulbs and consider purchasing more.

**Satisfaction Rise Indicates New Awareness.** Participants also indicated high levels of satisfaction with Kit bulbs compared to bulbs previously purchased and used in the home. The greater satisfaction with the Kit bulbs suggests that program participants noticed the design and technological improvements characteristic of the newer bulbs. The findings also suggest that customers will be more likely to use CF bulbs if the first bulbs they try have the latest technology. Among the 66% of participants trying a CF bulb for the first time, the Kit program increased their opportunity to become aware of the benefits of CF lighting.

## **Goal 2.B. Future Demand**

### **Did the Kit program increase future demand for CF lighting?**

Some free-rider effects (mentioned earlier) and significantly greater spillover effects were seen from respondent choices and attributions in the survey responses. Self-reports on subsequent bulb purchases match regional sales figures (NEEA 2002) attributed to the utility's service area. Program participants linked their purchasing behavior to the Kit program.

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<sup>8</sup> Here, as with all reported survey results, effects are significant in the  $p < .000$  to  $p < .05$  range.

**Kit Use Led to Retail Purchasing.** Nearly one-third (30%) of program participants bought additional CF bulbs after receiving their Kits. Participants who had purchased more installed an average of 4.0 additional bulbs. Calculated for the entire participant sample, participants installed an average of 1.04 additional purchased bulbs per household, after implementing Kit measures. That is, subsequent purchases alone doubled the number of CF bulbs that participants used as a group before receiving the Kit offer. These increases represent a change in the buying habits of participants, as they have begun to purchase CF bulbs on their own. By contrast, a small fraction (8%) of nonparticipants reported purchasing CF bulbs between the time of the Kit offer and the time of the survey. These nonparticipants had installed an average of 3.1 additional bulbs during that time period. Calculated for the entire nonparticipant sample, nonparticipants installed an average of 0.25 additional purchased bulbs per household.

**Purchasing Attributed to Kit Influence.** Participants say that the Kit program had a favorable impact on their subsequent bulb purchases. More than half of the participants who bought more bulbs said the program influenced their purchase “a lot,” and more than three-quarters said the program influenced them at least “a little” to buy more bulbs. Attributing savings from these “spillover effect” bulbs to the Kit program results in an estimated 9,070 MWh of energy savings, in addition to the 16,330 MWh net effect from Kit bulbs, for a total Kit program impact of 25,400 MWh from compact fluorescent bulbs. Individuals generally are reluctant to admit their behavior was influenced by outside forces such as advertising, for example. That participants linked their behavior to the Kit program is another indication of the effectiveness of the program and its method of giving residents a sample product to test and use. Once they could try the products in their homes, participants were more willing to buy more.

**Future Purchasing More Likely Due to Kit.** A further indication of the program’s impact is that participants were more sure than were nonparticipants that they would purchase more bulbs in the future. Over one-third of program participants, compared to one-quarter of nonparticipants, said they were “very likely” to purchase one or more CF bulbs in the next six-to-eight months. In contrast, only a small fraction (6%) of participants compared to 18% of nonparticipants said they were “not at all likely” to buy a CF bulb. Additional utility promotions of CF bulbs during 2001, such as the distribution of bulbs through community outreach programs, overlapped the Kit program and survey period. The slight overlap of the Kit program with the discount coupon mailing from Seattle City Light may have augmented the subsequent purchases. Given the continued promotion of CF bulbs and lamps, evidence of increased demand and further CF bulb installations would be measurable by the end of 2002, at the time scheduled for the long-term evaluation survey.

### **Goal 3. Retail Sector Support**

**Did the Conservation Kit program use the retail sector to move the home lighting market from incandescent to fluorescent products?**

**Kit Increased Retail Sales.** Certainly the Conservation Kit and Retail Coupon programs were jointly responsible for a considerable increase in CF bulb purchasing during 2001. The Northwest Energy Efficiency Alliance attributes 227,249 in general CF bulb sales during the year to the Seattle City Light service area (which comprises 5.5% of the Pacific Northwest region). Survey respondents corroborate this level of sales.

**Table 4.** Retail Purchase of CF Bulbs by Program Participants and Nonparticipants Subsequent to the Conservation Kit Offer

Lighting Measure Impacts	Count	Annual MWh	2002 aMW
Nonparticipant CF Bulb Purchases: After spring 2001, by survey report	33,896	1,847	0.222
Participant CF Bulb Purchases: After receiving Kit, by survey report	185,620	10,116	1.215
Total CF Bulb Purchases: Customer reports during intervening period of Summer-Fall 2001	219,516	11,963	1.437
<b>Seattle Area CF Bulb Retail Sales: during all of 2001 in PNW region (NEEA 2002)</b>	<b>227,249</b>	<b>14,998</b>	<b>1.801</b>

Based on their own reports via the survey, Seattle City Light residential customers purchased 219,516 CF bulbs during summer-fall 2001, or 97% of those accounted for by regional sales figures (Table 4). For comparison, CF bulb sales in 2000 were only a fraction of this level (about 21,000, or 9% of 2001 sales). Hence the cumulative impacts of the West Coast energy crisis and regional drought, combined with the efforts of Seattle City Light’s Conservation Kit and Retail Coupon programs as well as NEEA’s Energy Star® promotions, were to multiply retail sales by a factor of 10. The Kit program influenced the retail sector indirectly, by introducing CF bulbs to many customers for the first time, and reintroducing the technology to early adopters. The Coupon program followed on, by using the retail sector directly to encourage bulb purchases through a wide variety of stores and outlets.

**Goal 4.A. Collaboration**

**Did the Conservation Kit program collaborate with and leverage the resources of other agencies?**

To deliver the Conservation Kit and Retail Coupon Programs, Seattle City Light collaborated with two major partners, the Northwest Energy Efficiency Alliance (NEEA) and Seattle Public Utilities (SPU).

**NEEA Supported Retail Coupon Program.** In 2001 and 2002, Seattle City Light worked with NEEA and the Bonneville Power Administration to deliver the Retail Coupon program, in which a number of other urban-area utilities also participated. With NEEA, Seattle City Light recruited many retail stores to honor the coupons for bulbs and lamps, to boost in-store stocks of CF lighting products, and to host point-of-purchase displays. Seattle City Light personnel also staffed booths at retail outlets to provide educational services and promote the program directly to shoppers. Moreover, the CF bulbs purchased by Seattle City Light for the Conservation Kit program carried the Energy Star® designation, in keeping with the branding efforts of NEEA to further promote market transformation and customer education about quality lighting products.

**SPU Water Utility Contributed Measures.** An important partner with Seattle City Light on many programs in the past, the SPU Resource Conservation unit joined with City Light to offer customers a free bathroom aerator and flow-rate measurement bag in the Kit. These measures provided additional energy savings from hot water, as well as cold-water savings. This collaboration did not make the program any less costly to SCL, but it did demonstrate effective collaboration on behalf of customers by the two City utilities. The water measures included in the Conservation Kit were planned to save residential households 400 gallons in annual water and wastewater flows and 35 kWh in energy consumption. The actual results, based on engineering calculations and parameters from recent SPU research (DeOrea et al. 2002), were annual savings of 442 gallons and 15 kWh per Kit participant

household. Table 5 estimates the total water and sewer impacts from Kit water measures. These are significant to Seattle City Light for their contribution to Kit electricity savings and customer goodwill.

**Table 5.** Water and Wastewater Impacts of the Conservation Kit Program

<b>Water Measure Impacts on Water &amp; Wastewater (sewer) Flows</b>	<b>Count</b>	<b>Annual Gallons Water</b>	<b>Annual Gallons Sewer</b>
<b>HOT &amp; COLD WATER</b>			
Kit Faucet aerators installed	89,241	71,839,005	71,839,005
Showerheads installed: Based on use of water flow bag	2,499	7,040,933	7,040,933
<b>Total Flow Reductions</b>	<b>91,740</b>	<b>78,879,938</b>	<b>78,879,938</b>
<b>ELECTRICALLY HEATED WATER ONLY</b>			
Kit Faucet aerators installed	89,241	32,405,638	32,405,638
Showerheads installed: Based on use of water flow bag	2,499	3,176,073	3,176,073
<b>Total Flow Reductions</b>	<b>91,740</b>	<b>35,581,711</b>	<b>35,581,711</b>

**Water Measures Generated Savings.** The water measures included the Conservation Kits resulted in considerable utility bill savings for participating customers. The average Seattle Public Utilities residential customer in 2001 paid a rate of 0.41¢ per gallon for potable water and another 0.60¢ per gallon for wastewater (sewer) service. At these rates, the water savings attributable to Conservation Kit aerators and showerheads installed as the result of flow-rate bag testing would have yielded annualized residential customer bill savings of \$796,688: \$323,408 for potable water and \$473,280 for waste-water. This amounts to about \$4.46 per delivered Conservation Kit. Participants who installed the Kit aerator saved 805 gallons and \$8.13 per year on water and sewer costs, at 2001 rates, while participants who purchased and installed an efficient showerhead, as a result of testing with the Kit flow-rate bag, saved another \$11.55 per year. The result of collaboration between Seattle City Light and Seattle Public Utilities was a combined annualized reduction in utility bills to customers of \$2,674,468 at 2001 rates.

**Goal 4.B. Staffing Efficiency**

**Did the Conservation Kit program use a delivery method that minimized staffing intensity?**

**Fulfillment Contract Kept Staffing Low.** By hiring a fulfillment house to mail the solicitation letter, field responses, and mail Conservation Kits to participating customers, Seattle City Light minimized the number of utility staff and work-hours needed to deliver the program. By mailing the Retail Coupons with electric bills during a regular billing cycle, the utility also minimized distribution mailing costs. As a result, 76% of program funds were able to go directly to acquiring CF bulb and faucet aerator stocks, at \$13.10 per Kit. Seattle City Light administration (staff labor and expenses) was held to only 58¢ per Kit, or 3% of the overall program cost. This is important during times when a utility cannot ‘staff up’ and must make do with existing resources. The remaining 20% of total program costs went for fulfillment house labor and mailing expenses. Seattle City Light’s administrative cost of \$103,749 includes \$98,538 for staff labor, which represents 1.6 full-time equivalent employees for the year. For a program that yielded 2.6 aMW in direct net energy savings and 1.1 aMW in spillover effects,

this is an incredibly low utility staffing intensity. This measure does not incorporate staffing of the delivery contractor.

### **Goal 5.A. Energy Savings**

#### **Did the Kit program help residential customers get started on reaching their 10% energy savings goal for 2001?**

In 2001, Seattle City Light asked customers to provide immediate help by cutting back on energy use. Local television meteorologists were enlisted in a special campaign urging citizens to “Save 10% At Home and At Work.” Residential customers responded by reducing their 2001 energy consumption to 3,050,903 MWh from the 2000 level of 3,317,251 MWh—a drop of 266,348 MWh.<sup>9</sup> The average residential customer cut annual energy use from 10,473 kWh to 9,454 kWh per household—down by 10% (SCL 2002).

**Kit Contributed to Curtailment Campaign.** The Conservation Kit program made a contribution to this campaign. The early impact of the Kit among participants was 17,565 MWh in savings from the immediate installation of CF bulbs and faucet aerators. Later in the year another 13,502 MWh of savings came on line as participants installed acquired showerheads, most of the remaining Kit bulbs, and additional bulbs purchased at retail outlets. As a result of the Conservation Kit distribution and their own subsequent actions, participating residential customers reduced their annualized electricity consumption through home CF lighting by as much as 31,067 MWh. This reduction comprised about 12% of the observed 10% reduction in energy use, or 1% of total residential sector energy consumption in 2000. If all residential customers had participated, the total sector energy use would have been reduced by 2%—simply by changing a few light bulbs in each home. This level of gross energy savings reduced Seattle City Light’s average system load by 3.731 aMW. More than half (57%) of these savings were acquired early in 2001. Because the Kits were distributed in spring 2001, they do appear to have helped residential customers get a start on reaching their 10% savings goal for the year. Progress toward the utility’s load curtailment goal was also likely aided by the Retail Coupon distributed in September-October 2001 with customer electric bills, which further encouraged retail purchases of qualifying CF bulbs.

### **Goal 5.B. Cost-Effectiveness**

#### **Did the Kit program acquire conservation energy savings cost-effectively?**

The Conservation Kit produced significant economic benefits to the utility and to participating customers. On an annualized basis, the Kit reduced wholesale power purchases by over \$2.1 million. Meanwhile, participating residential customers lowered their own electric bills by \$1.9 million and water/wastewater bills by \$0.8 million, for a combined annualized reduction in City utility bills to customers of \$2.7 million at 2001 rates. As shown below, the Kit program acquired conservation energy savings cost-effectively, well below the cost of energy production, and did so beginning early in the year.

**Summary of Kit Expenditures.** The Conservation Kit Program expended \$2,865,735 for CF bulb stocks (measures), the fulfillment house contractor (delivery), and Seattle City Light labor and expenses (administration). Per Kit, these costs amounted to \$12.01 for measures, \$3.47 for delivery, and \$0.58 for administration. Seattle Public Utilities expended \$194,544, or an average of \$1.09 per Kit, for

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<sup>9</sup> Heating degree-days were virtually identical in the two years: 4,970 (2000) and 4,993 (2001); these values match the thirty-year average for 1970-1999.

faucet aerator stocks and water flow-rate bags (measures). This brought the total Kit cost to \$17.15 each. The cost of the program evaluation would add about 1.5% to the total program cost.

**Description of Levelized Cost.** The Utility levelized program cost is calculated as program expenditures divided by the present value of lifetime energy savings. The present value of energy savings applies a three-percent discount per year to the future stream of savings, to represent Seattle City Light's borrowing rate of interest. This discount is applied over the 7.2-year average life of compact fluorescent bulbs (weighted by installed location<sup>10</sup> and expected operating hours), the 5-year life of efficient faucet aerators, and the 15-year life of efficient showerheads. To judge cost-effectiveness, the levelized cost is compared to the avoided cost of buying energy in other markets.

**Parameters for Levelized Cost Calculation.** The levelized cost of the Conservation Kit program used the following parameters. Total utility cost was \$3,060,279, comprised of \$2,337,564 for the purchase of measures (bulbs, aerators and bags), \$618,966 for Kit delivery, and \$103,749 for program administration. The cost to customers of purchasing bulbs in retail stores during 2001 is assumed to be \$10 per bulb; replacement showerheads also cost about \$10. The annual energy savings per participant are 142 kWh. The net energy savings attributable to the program as a whole were 28,075 MWh, providing 3.37 megawatts of average load reduction. The weighted-average lifetime of all Kit measures (lighting and water) is 7.3 years. The present value of these savings is 1,014 kWh per participant over the life of the measures, or 181,025 MWh for the program overall.

**Levelized Costs Improve on Planned Values.** The levelized cost to Seattle City Light of the Conservation Kit program was 17.7 mills (1.77¢) per kWh. Including energy savings from the water measures, the program cost the combined City utilities 16.9 mills. The Kit Program was planned to deliver the energy resource at 29.9 mills to Seattle City Light and 26.4 mills to the combined City utilities. The program was successful at meeting and significantly exceeding this objective. Incorporating the cost to customers of Kit-attributable spillover purchases, the participant cost was 28.7 mills for bulbs acquired due to the Kit's influence, and the total Service Area cost was 26.1 mills. These costs are very competitive with the costs of energy alternatives, whether internal to the Utility (owned generation) or from external markets. Clearly the Kit program acquired energy savings below Seattle City Light's 69 mill (6.9¢) per kWh cost of delivering energy in 2001, including deferred power costs.<sup>11</sup> For comparison, during 2001 the average residential rate was 6.2¢ (SCL 2002). From these findings we may conclude that the program did, indeed, acquire cost-effective conservation energy savings.

### **Goal 5.C. Immediate Economic Benefits**

#### **Did the Kit program help reduce energy bills for Seattle City Light residential customers, and help reduce the utility's purchased power bill?**

**Participants Benefit from Lower Bills.** The average Seattle City Light residential customer paid a rate of 6.21¢ per kilowatt-hour in 2001. At this rate, the direct energy savings attributable to Conservation Kit CF bulbs (18,275 MWh) yielded annualized residential customer bill savings of

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<sup>10</sup> The Kit survey reported the following actual percentages installed by location—*In single-family electric space heat households*: 17% porch (exterior), 7% entry-hall, 14% kitchen, 34% living-dining room; 4% bathroom, 10% bedroom, 7% laundry-utility; 7% den-office; —*In non-electric space heat households*: 18% porch (exterior), 6% entry-hall, 12% kitchen, 26% living-dining room; 6% bathroom, 11% bedroom, 9% laundry-utility; 12% den-office; —*In multifamily electric households*: 5% porch (exterior); 8% entry-hall, 16% kitchen, 40% living-dining room, 10% bathroom, 15% bedroom, 1% laundry-utility; 5% den-office.

<sup>11</sup> The utility's annual report shows \$36.04 as *Net power cost per MWh delivered* (p.36), and a footnote indicates the average price of power per MWh delivered would have been \$69.41 without the deferral of wholesale power purchase costs from 2001 to future years.

\$1,134,878. Additional CF bulbs purchased and installed by participants and nonparticipants subsequent to the Conservation Kit offer (11,963 MWh) yielded additional annualized residential customer bill savings of \$742,902. The cumulative impact of Kit and purchased CF bulbs for Participating customers was a reduction in an individual annual household energy bill of \$10.

**Utility Benefits from Lower Wholesale Purchases.** At an average \$69.41 per MWh cost of delivering energy in 2001, the direct energy savings due to Conservation Kit CF bulbs (18,275 MWh) yielded avoided annual wholesale power purchases of \$1,268,468. Additional CF bulbs purchased and installed by participants and nonparticipants subsequent to the Conservation Kit offer (11,963 MWh) yielded additional annualized wholesale purchase power savings of \$830,352.

## Assessment and Discussion

**The Market Transformation Question.** The overarching question is, at the end of 2001 had Seattle moved further along the path to market transformation in residential use of compact fluorescent lighting? As the survey research confirmed, before receiving the Kit solicitation participants, like most U.S. households, owned 1.03 CF bulbs on average, and nonparticipants owned 0.94. By fall 2001 participants had installed 1.60 Kit bulbs.<sup>12</sup> In addition, participants went on to buy and install another 1.04 bulbs, while nonparticipants had purchased about 0.25. The result is a scenario where participants, who formerly averaged *one* CF bulb per home, now had an estimated *four* bulbs installed. Most participants (85%) at the time of the survey felt there were still more locations in the home suitable for a CF bulb. Averaged across all participants, this group indicated the potential to install 4.6 more bulbs per household. Meanwhile most nonparticipants (72%) also felt they still had places where they could install a CF bulb, with the number of locations averaging 6.2 per household across the whole group. Summing these values, participants (8.27) and nonparticipants (7.39) were congruent in their perceptions of the combined total of lighting locations appropriate for a CF bulb. Where the product is the unit of measurement, it appears that by early 2002 participating Seattle residents had moved about halfway to their perceived *saturation capacity*<sup>13</sup>.

**Progress Toward Market Transformation.** To judge progress toward *market transformation*,<sup>14</sup> the perceived saturation capacity should be compared to an independent measure of the technical potential for lighting products. An independent metering study of residential lighting in the Pacific Northwest during 1993-1995 found that the typical single-family home had about 15 light fixtures (Tribwell & Lerman 1996). Extrapolating from this study by application sites, a typical multifamily unit might be expected to have about 11 light fixtures, and the residential sector overall would have about 14. Since survey respondents perceived 8 fixtures per home where a CF bulb could be installed, from the metering study one may infer that they perceived CF lighting to be inappropriate for about 6 more fixtures. Reasons could include lights on dimmers, on daylight or motion sensors, in recessed cans, already linear fluorescent, or used for too few hours to seem a reasonable application. Indeed, 18% of nonparticipants cited these factors for not requesting the Conservation Kit in the first place. As an index of progress toward market transformation among participants, they have installed about 44% of their perceived maximum saturation capacity, compared to 12% before the Kit Program began. This finding describes a market segment that was in the early stages of CF bulb usage before the program, and saw a

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<sup>12</sup> Participants expected to install 0.28 more of the remained unused Kit bulbs in the half year after the survey.

<sup>13</sup> *Saturation capacity* refers here to the total number of CF bulbs that could be used in a household, if one were used in all places that could be fitted with one, according to the perceptions of survey respondents.

<sup>14</sup> *Market transformation* refers here to the change in product usage over time, in this case the change from incandescent to compact fluorescent bulbs. Elsewhere, Rosenberg (1996) has defined market transformation as what occurs “when a DSM program induces a lasting change in the structure of an energy product or service market or the behavior of market actors that results in greater adoption and penetration of energy-efficient technologies.”

dramatic increase in bulb usage in a relatively short time. Still, participants are less than halfway to perceived saturation capacity, and perhaps a bit over one-fourth of the way to penetrating the technical potential for residential lighting applications. It is too early still to tell if the response to Seattle's 2001 programs will have a lasting effect on market behaviors. The 5-7 year measure life for CF bulbs should slow recidivism to incandescent bulbs. The evaluation was designed to incorporate a second survey to follow up on longer-term market impacts. Unfortunately, however, the second survey was subsequently abandoned due to budget constraints.

**Residents Shift from Early Adoption to Early Majority.** Program participants during 2001 moved from the stage of partial Early Adoption well into the Early Majority stage (Rogers 1995).<sup>15</sup> Seattle City Light served as a 'change agent' during 2001, communicating professional advice to customers on complex conservation issues, and concentrating the market demand upon manufacturers and suppliers on behalf of residential customers. The Conservation Kit Program, combined with Retail Coupon promotions and auxiliary efforts, made great strides toward adding pressure and draw to the diffusion of CF bulbs into the retail market. Among the Kit nonparticipants, a tremendous opportunity remains for the Seattle City Light to introduce more residents to current CF lighting technology.

## Conclusion

During 2001 Seattle City Light mounted a Conservation Kit program that acquired 3.7 aMW of annualized load reduction at a levelized cost to the utility of 17.7 mills, with a cost to participating customers of 28.7 mills for spillover purchases. The program exceeded planning expectations for cost-effectiveness, and acquired the resource at one-fourth of the utility's 2001 cost to deliver energy. Meanwhile the program was effective at meeting objectives for ensuring equal opportunity, increasing customer awareness, fostering future demand, supporting the retail sector, leveraging resources through collaboration, ensuring staff efficiency, acquiring the conservation energy resource, and generating economic benefits. Not only did the Conservation Kit Program meet its stated planning objectives, but it also met the utility's overarching goal to advance market transformation for compact fluorescent lighting in the residential sector of Seattle City Light's service area.

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<sup>15</sup> Rogers (1995) laid out five stages in an idealized model for diffusion of innovation. In his definition, *Early Adopters* (among the first 16% to accept an innovation) are an "integrated part of the social system, and are the system's opinion leaders, in that they are respected in determining the suitability of innovations." The next group in the diffusion process, the *Early Majority* (the next 34%), "are deliberate in their willingness to adopt new innovations, but interconnect through personal networks, so their decision process is longer than that of Early Adopters." The final two groups in the process are the *Late Majority* (also 34%), "decision makers who are skeptical and may adopt innovations out of economic necessity," and *Laggards* (the final 16%), who "use the past as a point of reference, and possess no opinion leadership."

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