Process and Impact Evaluation of the Low Income Appliance Replacement Program
FINAL

Submitted to:
Efficiency Maine

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ES Executive Summary

This report presents the results of the process evaluation and impact evaluation of the Efficiency Maine Low Income Appliance Replacement Program (LIARP). The goals of the process evaluation are to provide Efficiency Maine with feedback on the design and implementation of the program as well as recommendations for improvement and future plans. The goal of the impact evaluation is to provide Efficiency Maine (EM) with estimates of the impacts of the LIARP, including gross energy and demand savings, net energy and demand savings, in-service rates, hours of use, wattage reduction, and participant spillover for both refrigerators and compact fluorescent light bulbs (CFLs). The evaluation integrates data and findings from a variety of evaluation activities, including the following:

- Interviews with program staff from Efficiency Maine, the Maine State Housing Authority (MSHA), and the Community Action Program (CAP) agencies
- Telephone surveys with 142 program participants
- On-site surveys using refrigerator loggers and lighting loggers at the homes of 40 participating customers.[1]
- Engineering estimates of energy and demand savings attributable to the program based on data collected through the on-site surveys.
- A comparison of key results from a selection of past studies.

ES.1 Process Evaluation Findings

This section provides a summary of the key findings of the process evaluation.

Program staff and CAP staff report that the LIARP is well-designed and simple to administer, and operates smoothly and effectively. They believe a major strength of the program is its streamlined administration due to the simple application process and piggybacking with other low-income programs; this design reduces administrative costs and provides the convenience of a "one-stop shop" for low-income residents seeking assistance. In addition, nearly all program participants are satisfied or very satisfied with the program, the audit, program services, and the products received.

Participation. Program staff believe that customers choose to participate because they "need to replace their refrigerator but can't afford it, and have no other option" and also want to reduce their electricity bills. The results of the participant survey support this contention, as respondents most frequently choose to participate because their refrigerator was not working well (41%) or in order to receive a new refrigerator (41%). Concerns about energy or electricity are cited less frequently (18% and 12%, respectively) as was the benefit of free CFLs (10%). In terms of

[1] All of the lighting data were collected with Dent Instruments Time of Use (TOU) Lighting Loggers while the refrigerator logger data were collected with Wattsup Pro power monitors. The lighting loggers use a photocell and an internal time clock to measure when the lights go on and off. The logger software exports interval data in a text format that provides the percent "on time" during each interval in the metering period. The refrigerator power monitors were plug-in style monitors that gather true power at specified time intervals.

barriers to participation, the major obstacle consists of eligibility issues; that is, customers may not be eligible for the Low Income Home Energy Assistance Program (LIHEAP) program, own their refrigerator, or have the electricity bill in their name. Ineligible customers are often renters. In a few instances, eligible customers have chosen not to replace their refrigerator because they prefer a model with different features and are not willing to pay for the upgrade.

Participant Feedback. CAP staff members report that the vast majority of clients are appreciative and satisfied with the refrigerators and CFLs distributed by the program; the program receives "99% good responses". CAP respondents report that they receive few complaints about the refrigerators; if so, it is usually because of the lack of choice in features, the dimensions of the newer models, the size, or because an occasional refrigerator fails due to a poor gasket.

Participants are very satisfied with the program, with nearly all survey respondents satisfied or very satisfied with all aspects of the program. (Table ES-1)

Table ES-1: Summary of Program Satisfaction

Program characteristics	Combined Percent Satisfied and Very Satisfied	Number of Respondents
Energy audit	97%	142
Information received during energy audit	94%	142
Time it took to receive the initial energy audit	98%	142
New refrigerator	94%	117
Time it took to receive the new refrigerator	99%	117
Quality of service from the company that delivered the refrigerator	98%	117
CFL Bulbs	95%	140
Electricity savings	99%	85
Overall satisfaction with the program	100%	142

Program Effects. Program and CAP staff believe that most participants see reductions in their electricity bills, on average $10-$30 per month. The results of the participant survey support this belief, as 60% of survey respondents report that their electricity bill has decreased since participating in the program, with 46% indicating an amount of up to $30 per month. In addition, nearly two-thirds of respondents (64%) report that the information from the energy audit has changed their energy use behavior. These respondents report that the most common change is turning off lights (42% of all respondents), followed by using CFLs (15%), and setting the heating thermostat lower (11%).

Program Design. Because the auditor is required to be in the home for two hours to test the refrigerator, the program requires the auditor to conduct a blower door test to collect air infiltration information for weatherization program planning. However, several of the CAP respondents question the value of conducting blower door tests, because the LIARP does not

conduct air sealing, the conditions in the home may change over time, and the test may disturb materials in the home, such as vermiculite.

Refrigerator Criteria. Most CAP respondents believe that the current criteria for testing refrigerators are fair and reasonable. Others believe that the pre-1995 model criteria should be updated as the program matures, in order to maintain a ten-year gap (i.e. 1997 models for the 2007 program year). Several respondents suggest allowing auditors to recommend replacement based on the condition of the model rather than solely relying on metering; one suggests that the program use the Association of Home Appliance Manufacturers (AHAM) book instead of metering.

Compact Fluorescent Lights. The MSHA has worked with the CAPs to implement a consistent approach regarding the criteria to replace bulbs. Interviews with CAP staff members found that auditors typically rely on their own judgment in deciding how many CFL bulbs to provide the home, usually based on the room location and estimated hours of use. While most CAP agencies remove the old bulbs and install the CFLs into light sockets, at least one agency leaves the CFLs for the client to install, unless they are elderly. Fifty-five percent of the participant survey respondents report that all or most CFL bulbs were installed by the auditor while 41% report that none of the bulbs were installed by the auditor. According to these respondents, some CAP agencies are more likely to install all CFLs, while other CAP agencies are more likely to install none of the CFLs.

Additional Measures. While one program staffer believes that the program has already targeted the major electric end uses, others mention that hot water heaters, clothes washers, clothes dryers, and heat pumps are potential measure for consideration. Several CAP respondents also suggest water heaters for inclusion in the LIARP (and mentioned the ongoing pilot program) though some are concerned about the length of the payback period, the difficulty of metering, and the complexity and cost of hiring a plumber and/or electrician to install. Another staffer suggests that the LIARP should embrace a whole-house approach, in order to more effectively integrate with other programs.

Program Delivery. Most CAP staff believe that the LIARP has provided a consistent volume of projects from year to year, and most believe that they are on target to meet their 2007 goals. However, several CAP agencies believe they may be exhausting the pool of low-income households for replacing refrigerators—either the refrigerators do not qualify or have already been replaced.

Statewide Purchasing. Several CAP staff members, particularly those from rural areas, express concerns about the upcoming shift to a single vendor to provide statewide delivery of refrigerators. While this strategy will reduce purchasing costs, these staff members are concerned about a lower quality of service, a reduced selection of models, longer delivery times, and the loss of local control.

CAP Agency Fees. Some CAP agencies complain about the size of the program fee, the fact that it has not increased since program inception, and that it is not fair to rural agencies. One respondent says "the fee structure is still the same after three or four years. In rural areas, greater distance for travel incurs greater expenses and more labor. One size does not fit all."

Program Administration Structure. Regarding a partnership with housing authorities, one staffer believes that housing authorities would offer access to a broader range of low-income customers beyond the single-family homeowners that typically participate in the LIARP. However, the housing authorities usually own the refrigerator and pay the electric bills for their tenants, presenting an obstacle to LIARP eligibility.

Quality Control. MSHA conducts onsite inspections at about 5% of homes served by LIARP, though the goal is 10%, and they will target CAP agencies that have problems with following program guidelines. According to program staff, the participants are "usually ecstatic" and there are very few complaints. In addition, the DOE Weatherization program requires post-inspections of every job by the CAP agencies; thus all piggybacked LIARP jobs are inspected.

Budget Expansion by 25%. If the program budget were expanded by 25%, several staff members suggest that the program should simply serve more households. However, several CAP respondents are concerned about the relatively small number of clients who are eligible for refrigerator replacement under current program guidelines. One CAP staffer suggests that the program broaden its income base to reach customers who are not eligible for LIHEAP.

Program staff recommend including electric water heaters as eligible measures, either by fuel switching or upgrading to a newer electric unit, depending on the availability of fuel in the home. About one-half of the CAP respondents also suggest this option, due to the high saturation of electric water heaters. However, several are concerned about the high cost of replacement (est. $600-$800) and working with electricians or plumbers for the installation. Several CAP respondents mention that many clients have electric stoves or ovens, so the program should consider adding those measures as well.

Budget Expansion by 50%. If the program budget were increased by 50%, program staff believe that the program should add several new eligible measures, such as heat pumps, clothes washers, and room air conditioners. In fact, one program staffer questions whether the pool of low-income customers is large enough to support that level of spending, and that the program would need to expand measures. Two CAP staff recommend that the program should "keep whole house usage in mind" and "move beyond appliances and do more weatherization." Several CAP respondents suggest expanding the income eligibility criteria to include the "working poor who fall into coverage gaps."

Program Strengths. Program staff believe that a major benefit of the LIARP is the streamlined administration that uses a single LIHEAP application to deliver the LIARP and other low-income programs. This design results in low administrative costs due to piggybacking with other low-income programs, while providing the convenience of a "one-stop shop" for low-income residents in providing comprehensive services.

Program Weaknesses. One program staffer believes that communication could be improved and that there is "less information available than on other [Efficiency Maine] programs." In addition, several CAP staff members question the role of MSHA as the "middleman"; they believe that there should be more communication between themselves and the MSHA, and the program should be more flexible in administration. Recent changes to improve communication include the establishment of quarterly meetings between the MSHA and EM, plus monthly (rather than quarterly) tracking reports.

Other Appliances. The participant survey collected data on other appliances in respondents' homes. The most common fuel for hot water heaters is electricity (53%); for those respondents with electric water heaters in their homes, 39% of these units are over ten years old. Forty-eight percent of respondents have room air conditioners in their homes, with an average of 1.5 units in each of these homes; however, only 4% of these units are over ten years old. In addition, 20% of respondents have dehumidifiers in their homes and 26% of these units are over ten years in age. Lastly, 39% of respondents use nightlights at home, with an average of 1.7 nightlights per home.

Demographics. As expected, program participants are more likely to own their own home and earn lower incomes, compared to the population of Maine as a whole. Eighty nine percent of the survey respondents are homeowners, compared to 73% statewide; 73% of respondents live in single family homes and 25% live in mobile homes. Eighty five percent of respondents report having household incomes of less than $20,000, compared to 15% of the general population.

In addition, program participants tend to be older, female, less educated, and live in smaller households than the general population. Eighty-one percent of respondents are older than 55 years of age, compared to 36% of the general population. Program participants are much more likely to be female as 83% of respondents are female, compared to about one-half of the statewide population. Twelve percent of respondents have a college degree or beyond, compared to 26% of the general population. Lastly, over one-half of all respondents (55%) live in single person households compared to 27% of the general population.

ES.2 Impact Evaluation Findings

This section provides a summary of the key findings of the impact evaluation.

Overall Program Energy Savings. Table ES-2 displays the estimated gross first-year energy savings (4,874 MWh) and gross lifetime energy savings (33,409 MWh) for the 2006 program year. After adjusting for participant spillover for CFL purchases, the table also presents estimates of the net first-year energy savings (4,938 MWh) and net lifetime energy savings (33,969 MWh) for the 2006 program. The gross first-year energy savings per refrigerator is estimated to be 1,361 kWh[2]; the gross first-year energy savings per CFL, based on the on-sites, is estimated to be 35.7 kWh. Refer to Section 5 for details of the calculations of energy savings.

Table ES-2: Gross and Net Energy Savings, 2006 Program Year

Parameter	Refrigerators	CFLs	Total
Number of Units	2,799	29,804	
Gross First-Year Energy Savings per Unit (kWh)	1,361	35.7	
Gross First-Year Energy Savings Total (MWh)	3,809	1,065	4,874
Assumed Lifetime (years)	20.0	8.8	
Gross Lifetime Energy Savings per Unit (kWh)	8,600	313	
Gross Lifetime Energy Savings (MWh)	24,071	9,337	33,409
Net-to-Gross ratio (1 + SO – FR)	100%	106%	
Net First-Year Energy Savings (MWh)	3,809	1,129	4,938
Net Lifetime Energy Savings per Unit (kWh)	8,600	332	
Net Lifetime Energy Savings (MWh)	24,071	9,898	33,969

[2] This figure is calculated by adjusting the 1,299 annual kWh figure from the tracking database (Table 1-3) by the 104.8% realization rate (Table 4-1) estimated for refrigerators.

Overall Program Demand Savings. Table ES-3 displays the potential gross demand savings (1,700 kW) and seasonal gross peak demand savings (895 kW winter, 685kW summer) for the 2006 program year. After adjusting for participant spillover of CFL purchases, the table also presents estimates of the net potential demand savings and net seasonal peak demand savings. Refer to Section 5 for details of the calculations of demand savings.

Table ES-3: Gross and Net Demand Savings, 2006 Program Year

	Refrigerators	CFLs	Total
Number of Units	2,799	29,804	
Potential Gross Demand Savings (kW)	533	1,167	1,700
Winter Peak Gross Demand Savings (kW)	502	392	895
Summer Peak Gross Demand Savings (kW)	514	172	685
Net-to-Gross ratio	1.0	1.06	
Potential Net Demand Savings (kW)	533	1,237	1,771
Winter Peak Net Demand Savings (kW)	502	416	918
Summer Peak Net Demand Savings (kW)	514	182	696

Refrigerator Replacement. According to respondents from the telephone survey, the refrigerators replaced by the program tended to be very old, as more than 90% of the replaced refrigerators were over ten years in age. Given that the program requires refrigerators to be manufactured prior to 1995, these results seem reasonable. When asked what they would have done with their refrigerator if the program had not been available, 70% of respondents replied that they would have continued to use the old refrigerator. Fourteen percent of respondents who received a refrigerator report that they would have purchased a new refrigerator; 4% would have purchased one within the next six months.

Refrigerator On-site Results. Table ES-4 displays the average annual energy consumption for the replaced refrigerators and the newly installed refrigerators as well as the annual energy savings, from the results of (a) the on-site metering and (b) the program tracking data for participants who volunteered for the telephone survey and for which we received program data.

The results indicate that the newly installed refrigerators have lower consumption (about 15%) than anticipated, similar to the findings of another study.[3] This results in estimated annual energy savings of 1,457 kWh, about 5% greater than the 1,390 kWh derived from the tracking data for the same units. Both of these figures exceed the 1,299 kWh estimate of energy savings from the tracking data for all 245 participants for whom we received program data.

[3] 2004 ACEEE Summer Study conference proceedings, "Statewide Refrigerator Monitoring and Verification Study and Results", Teague and Blasnik, pp. 11:188 – 11:198

Table ES-4: Estimated Refrigerator Energy Consumption and Savings

Source	No. of Units	Old Unit Usage from Tracking Data (avg kWh)	New Unit Usage from Tracking Data (avg kWh)	New Unit Usage from Metering (avg kWh)	Annual Savings from Tracking Data (avg kWh)	Annual Savings from Metering (avg kWh)
On-site Study	31	1,824	435	368	1,390	1,457
Program Tracking Data	245	1,734	434	n/a	1,299	n/a

Comparison of Refrigerator Savings to Other Studies. Two prior studies provide meter-based estimates of refrigerator energy consumption and savings; the first study was done for the Massachusetts sponsors[4] regarding refrigerators eligible for replacement through a home energy audit program and the second study was completed for Southern California Edison.[5] Table ES-5 shows that the estimate of annual energy savings for the LIARP is slightly greater than the Massachusetts estimate and substantially lower than the California estimate.

Table ES-5: Refrigerator Annual Energy Savings Comparison

Source	Estimated Annual Energy Savings (kWh)
Maine LIARP	1,457
Massachusetts, 2004	*1,383*
Southern California Edison, 2004	*1,946*

CFL Installations. The telephone survey found that the program distributed an average of 8.5 CFLs per respondent. Nearly all of these CFLs, 90%, remain installed at the time of the phone interview, and nearly all installed CFLs, 96%, replaced incandescent bulbs (Table ES-5). CFLs are most often installed in living rooms, followed by kitchens, bedrooms and bathrooms.

Table ES-6: CFL Bulb Disposition

Statistic	Provided	Installed	Removed	Not Yet Installed	Plan to Install within Next Year	Cumulative Installations within Next Year
n	1,208	1,085	42	81	53	1,138
Percent	100%	90%	3%	7%	4%	94%

[4] Blasnik, Michael "Measurement and Verification of Residential Refrigerator Energy Use: Final Report 2003-2004 Metering Study." Submitted to NSTAR Electric, National Grid, and Northeast Utilities on July 29, 2004.
[5] KEMA- Xenergy (2004) "Final Report: Measurement and Evaluation Study of 2002 Statewide Residential Appliance Recycling Program." Submitted to Southern California Edison on February 13, 2004.

CFL Wattage reduction. According to the program tracking data for telephone survey respondents, the average wattage of replaced bulbs is 63.8 watts, the average wattage of installed CFLs is 16.1 watts, and, therefore, the CFLs provided by the program are estimated to displace an average of 47.7 watts per installed bulb. Overall, each respondent had an average of 545.6 watts replaced by CFLs throughout the entire home, an average of 137.8 watts of CFLs installed throughout the entire home, and an average of 407.8 watts displaced per home.

CFL Hours of Use. Telephone survey respondents were asked to compare their usage of program CFLs to the bulbs they replaced, and to estimate the average daily use of the program CFLs. Respondents report that the majority of CFLs (66%) are being used "to the same extent" as the bulbs they replaced, while 23% are being used more than the bulbs they replaced and 7% are being used less. Survey respondents report average daily use per bulb of 2.6 hours in the summer and 3.8 hours in the winter. The estimated average daily usage of all installed bulbs in each home is 20.2 hours per day in summer and 29.5 hours per day in winter.

CFL On-site Results. Table ES-7 displays the impact parameters estimated from the on-site logging of CFLs compared to the results of the telephone surveys and the program tracking data for participants who volunteered for the survey and for which we received program data. Consistent with other studies, the on-site inspections yield reduced estimates of in-service rates and hours of use. However, the wattage reduction estimates are very similar for all three sources. Overall, the gross energy savings per CFL estimated from the on-sites is substantially less than the savings estimated through the telephone surveys (71%) or the tracking data (60%). Spillover is estimated to be 6.4% from the telephone surveys, and freeridership is assumed to equal zero.

Table ES-7: Comparison of On-site vs. Telephone Survey Impact Parameters

Source	No. Resp-ondents	No. CFL Bulbs	In-Service Rate	Average Wattage Reduction (Watts)	Average Daily Hours of Use	Gross Annual Energy Savings per CFL (kWh)	Participant Spillover rate
On-Site Results	40	328	83.5%	46.9	2.5	35.7	n/a*
Telephone Survey Results	142	1,208	90%	47.7	3.2	50.1	6.4%
Program Tracking Data	245	1,753	100%	47.4	3.4	59.4	0%

*Spillover was not assessed during the onsite visits.

Comparison of CFL Impact Parameters to Other Studies. Table ES-8 compares the CFL impact parameters calculated from the current study to those produced in the other studies. The in-service rate estimated for the program (83.5%) is significantly higher than the results of the three comparison studies, which range from 58% to 66%. This is likely due to the fact that a program auditor installed the CFLs in the home; in the comparison studies, two of which are based on retail coupon programs, the customer themselves would install the bulbs. At 46.9 watts, the wattage reduction for the LIARP is similar to the estimates from the comparison studies, which range from 45.5 to 48.7 watts. In addition, the daily hours of use estimate of 2.5

hours is similar to but slightly less than the estimates from the other studies, which range from 2.7 to 3.2 hours. This result seems reasonable, given that the LIARP provides participants with a substantial number of CFLs (an average of 8.5 for each telephone survey respondent); some of these CFLs are likely to be installed in low-usage locations.

At 6.4%, the spillover rate is lower than the 22%-30% estimates from the Maine lighting program and the MA/RI/VT study. However, this result also seems reasonable due to the substantial number of CFLs provided to participants; most would not need to purchase more CFLs for their home. In addition, the LIARP serves low-income customers, who may be less able to afford purchasing CFLs than the typical customer who participates in a retail coupon program.

Table ES-8: CFL Impact Parameter Comparison

Study	In-Service Rate	Average Wattage Reduction (Watts)	Average Daily Hours of Use	Gross Annual Energy Savings per CFL (kWh)	Participant Spillover rate	Source[a]
Maine LIARP Results	83.5%	46.9	2.5	35.7	6%	Onsite Inspections
Maine RLP Study	*66%*	*45.5*	*3.2*	*35.1*	*30%*	*Onsite Inspections*
MA/RI/VT Study	*62%*	*48.7*	*2.7*	*29.8*	*22%*	*Onsite Inspections*
We Energies Low-Income	*58%*	*46.4*	*n/a*	*n/a*	*n/a*	*Telephone Surveys*

[a] This column indicates the source for estimates of in-service rate, wattage reduction, and hours of use. Spillover is usually estimated from telephone surveys.

ES.3 Recommendations

Based on the findings of the process evaluation and impact evaluation, this section presents recommendations to consider for the LIARP.

Continue utilizing the MSHA and CAP Agencies to deliver the LIARP. There are several compelling reasons to continue the current program administration structure with MSHA managing the CAP agencies. First, and foremost, is the relationship that CAP agencies have established with low-income customers through their administration of other low-income programs, including LIHEAP and Weatherization. Thus, the CAP agencies serve as a "one-stop shop" for multiple low-income programs, which streamlines LIARP administration, reduces administrative costs, and simplifies participation for clients. In addition, program staff and CAP staff believe that the program operates smoothly and effectively. Lastly, nearly all program participants are satisfied with the current program, its services and products.

Consider alternative strategies to reach low-income customers who are not being served by the LIARP. Given that additional low-income funds will become available in the future, EM should continue spending a portion of these additional low-income funds on other low-income

programs, such as the RIFME pilot program. These programs should target the low-income, multi-family renters that are not being served through the LIARP, which primarily serves single-family homeowners because they are more likely to meet the program requirements of owning their refrigerator and paying their electric bill.

Consider modifying the current LIARP management structure. In the current program management structure, EM oversees the MSHA, which then manages the CAP agencies that implement the LIARP. This vertical management structure appears to inhibit regular communication and information sharing between EM and the CAP agencies, as noted by several program and CAP staff members. Thus, we suggest modifying the program management structure to become a partnership between EM, MSHA, and the CAP agencies, which should facilitate more open communication among all organizations. Consider the following strategies to achieve such a partnership:

- Invite the CAP program managers, at least once per year, to the quarterly meetings held between MSHA and EM in order to discuss program plans, changes, and issues.
- EM staff should regularly attend MSHA inspections, program audits, and CAP staff trainings, at least once annually for each CAP agency.
- MSHA should share with EM the data collected from the field inspections, which will provide another source of information on the program.

Ensure that all CAP Agencies are consistently following program guidelines. The interviews with program staff and CAP staff reveal that all CAP agencies do not consistently follow program guidelines, particularly regarding the installation of CFL bulbs and the removal of old incandescent bulbs. Several CAP agencies believe that there is a limit for the number of CFLs that can be provided to each home, or that the program requires a minimum daily usage of two hours. One CAP agency reports that their auditors do not typically remove the incandescent bulbs from the fixtures and install the CFL bulbs. In addition, 41% of participant survey respondents report that the auditor did not install any of the CFLs in lamps or fixtures in their home; this figure is substantially greater for several agencies. While this figure may be inflated because it is based on respondent self-reports, it still indicates that not all CFLs are being installed by program auditors.

In order to discourage the re-installation of incandescent bulbs, the program should consider requiring all incandescent bulbs be removed from the home by the auditor, which would be consistent with the programs removal of old refrigerators. While the operation of a consistent statewide program implemented by multiple agencies is a challenge, MSHA should continue to reinforce program guidelines with CAP agencies so that the program offers consistent services to all participants.

Consider expanding the income eligibility requirements. Because of program eligibility criteria that require clients to own their refrigerator and pay their electricity bills, the LIARP primarily serves elderly, single-family homeowners. Accordingly, the participant telephone survey finds that 89% of respondents own their home, 98% live in single-family houses or mobile homes, and 58% are 65 years or older; these figures are substantially higher than the general population in Maine.

Several CAP agencies expect to exhaust the pool of households that qualify for refrigerator replacement, and others note that auditors are encountering homes where CFLs are already installed.[6] In light of this information, the program should consider expanding the income limits for eligible customers. The program currently serves any customer who is approved for the LIHEAP program; however, there are "working poor" who may need program assistance but are not LIHEAP eligible. The CAP agencies may be able to identify these clients using their existing client information; alternatively, if EM has access to electric utility billing data, they may be able to identify customers who have enrolled in billing assistance programs, such as the Central Maine Power Electricity Lifeline program. These approaches may present cost-effective strategies for targeting new customers under an expanded eligibility program; however, because this outreach may entail larger administrative costs, the program may need to assess its effect on program cost effectiveness.

Consider expanding the types of measures eligible for the program. Several program staff and CAP staff members suggest that the program can broaden its reach by including additional electric measures in the program. According to the telephone survey of program participants, 53% have electric water heaters, with 44% of these units being older than ten years. This indicates that about 23% of eligible low-income customers have an older electric water heater that may benefit from replacement. In addition, the LIARP is currently operating a pilot program regarding electric water heaters which should provide insight into the viability of this measure. However, note that several CAP staff expressed concern regarding the cost-effectiveness of hiring plumbers and/or electricians to replace electric water heaters.

In addition to water heaters, other measures that may warrant consideration include clothes washers and room air conditioners. However, while the participant survey found that 48% of respondents had a room air conditioner, over 90% of these units are less than ten years old. This indicates that few eligible homes likely have room air conditioners that may be candidates for replacement.

Consider re-structuring the administrative fees. Many of the CAP agencies note that the administrative fees have not increased since the program began. While some complaints regarding costs may be expected, it does appear that rural CAP agencies have a valid point, in light of higher gas prices, to request a travel surcharge for visits located more than a certain number of miles from the office (one CAP staffer suggest 50 miles). In addition, the LIARP might consider an annual "cost of living" increase in order to cover higher labor costs faced by CAP agencies.

Explain the purpose of the blower door test to CAP agencies. Several of the CAP staff members question the value of conducting blower door tests, because the LIARP does not conduct air sealing, the conditions in the home may change over time, and the test may disturb materials in the home, such as vermiculite. The purpose of the test, which we understand to be for weatherization program planning, should be explained to CAP agencies since the test results

[6] Consider conducting further research regarding the saturation of older refrigerators to determine if, in fact, some regions of Maine may exhaust their pool of eligible LIARP customers. This could be done as part of a statewide appliance saturation study, in order to provide information on other appliances as well.

are not directly utilized by the LIARP. Because the auditor is already onsite for two hours to meter the refrigerator, the blower door test has little impact on program costs; however, the LIARP should ensure that the results are being effectively utilized in order to justify this continued effort.

Consider adjusting the program testing requirements for refrigerators. With several years of refrigerator testing experience, the program could consider changes to the current refrigerator metering process. Suggestions from program staff and CAP staff members include the following:

- Consider updating the refrigerator age requirements to maintain a ten-year gap between the current program year and the age requirement for refrigerator models. For example, in 2008 the requirement would be refrigerators manufactured prior to 1998. This would expand the pool of refrigerator models eligible for replacement.
- Consider providing auditors with a checklist that allows them to consistently characterize the condition (regarding hinges, gaskets, leaks, etc) of refrigerators that do not meet program criteria for energy savings, but may soon meet the criteria or fail if the condition continues to deteriorate. While the existing waiver process serves as an avenue for replacing units that do not meet program guidelines, this approach should result in fewer waivers if criteria are specified for auditors in advance. A sliding scale could be designed, where a unit with nearly 750 kWh savings may need to meet fewer criteria than a unit with substantially less than 750 kWh savings. Such an approach might also help address any inaccuracies inherent in estimating annual energy savings from a two-hour metering test.
- Consider allowing the auditors to utilize the AHAM book to estimate annual energy savings in situations where they encounter a particularly old and large refrigerator, or when a unit is in extremely poor condition. In addition, given the database of hundreds of different models tested over the past few years, the program could undertake a comprehensive effort to compare its metering results with the AHAM savings estimates to examine the validity of using this approach on a broader basis. Eliminating refrigerator testing in all (or most) situations, if coupled with the elimination of the blower door test, would result in substantially less time spent onsite by auditors (from 2.5 hours to probably less than one hour), which should yield substantial cost savings as well.
- Consider relaxing the energy savings requirements for smaller-sized refrigerators, which may be less likely to meet the 750 kWh annual energy savings requirement than larger models which use more electricity. These smaller refrigerators cost less than larger models, and thus should still yield cost-effective replacements.

Consider adopting the estimated impact parameters. Based on the results of the impact evaluation, we recommend that the LIARP utilize the impact parameter estimates displayed in Table ES-9 in order to calculate program energy savings. Where applicable, Table ES-9 also displays the sampling error for the estimates at the 80% confidence level.

The estimates of in-service rate, wattage reduction, daily hours of use, and energy savings for both refrigerators and CFLs are developed from the onsite visits. Although the onsite visits rely on a smaller sample size than the telephone survey, we believe that the onsite results are more accurate and unbiased because an auditor was physically present to account for the installation of bulbs and loggers were used to record actual usage, whereas the telephone respondent has to recall this information.[7] The spillover rate (for CFLs) is estimated from the telephone survey while the spillover for refrigerators is assumed to equal zero. The estimates of product lifetime are developed from the results of other studies.

Table ES-9: LIARP Impact Parameter Estimates

Source	In-Service Rate	Average Wattage Reduction (Watts)	Average Daily Hours of Use	Gross First-year Energy Savings per Unit (kWh)	Participant Spillover Rate	Lifetime (years)
Refrigerators	100% ± 0.0%	190.5 ± 6.9%	n/a	1,361 ± 9.7%	0%	20.0
CFLs	83.5% ± 3.1%	46.9 ± 2.4%	2.5 ± 9.8%	35.7 ± 3.1%	6.4% ± 0.9%	8.8

In light of the fact that 39% of survey respondents report having purchased CFLs prior to receiving the program energy audit, we recommend that future evaluations ask participants a battery of questions regarding freeridership in order to determine if, in fact, the assumption of zero CFL freeridership is valid.

In addition, 4% of respondents report that they would have purchased a new refrigerator within the next six months if the program had not been available. This indicates that freeridership may not equal zero (though still likely small) for refrigerators, and suggests that future evaluations should also ask participants questions regarding refrigerator freeridership.

[7] In order to control bias and ensure adequate geographic coverage for the telephone surveys and onsite visits, efforts were made to complete a similar proportion of surveys and visits with participants from each CAP agency as the proportion of program audits conducted by each CAP agency during 2006. In addition, several other factors suggest that bias should not be a major concern. First, the LIARP participants are all low-income, which means they are homogenous in terms of income, and possibly other demographic characteristics too. Second, all program refrigerators and light bulbs were logged in each home that received an onsite visit, thus there should be no bias in terms of product selection. Lastly, the LIARP impact estimates are generally consistent with the results of other studies, and any differences are readily explainable.

1. Introduction

This section presents a brief program description and the methodology of the evaluation.

1.1 Program Description

Potential LIARP participants are usually identified by CAP agencies through the face-to-face Low Income Home Energy Assistance Program (LIHEAP) application process. The CAP staff will distribute a flyer that the customer takes home and fills out with information on their refrigerator model. The customer then calls the CAP agency and staff conducts a brief screening interview over the telephone to ensure that the customer owns the refrigerator, pays the electric bill, and that the refrigerator was manufactured before 1995. If the client meets all the eligibility criteria, the program schedules an appointment for an auditor to visit the home.

Each audit lasts about two and one half hours, which includes metering the refrigerator, providing CFLs, conducting a blower door test, and educating the client. The auditor meters the refrigerator for two hours in order to estimate annual kWh usage. While metering the refrigerator, the auditor provides CFLs, educates the client regarding appliance usage and lifestyle habits that may affect energy usage, and distributes LIARP information regarding refrigerator maintenance and CFL recycling. The auditor may also replace halogen torchieres with CFL models, recommend the replacement of waterbeds, and test freezers, though the need for these measures is not often encountered.

If the estimated annual energy savings between the existing refrigerator model and the appropriate ENERGY STAR model are greater than 750 kWh, the refrigerator is approved for replacement. The auditor places an order for the new refrigerator upon returning to the CAP agency office; the refrigerator vendor schedules the delivery appointment and removes the old refrigerator to a local disposal facility.

Table 1-1 displays the number of refrigerators and CFLs replaced by each CAP agency in 2006. Four CAP agencies—Aroostook, Community Concepts, Washington-Hancock, and York—account for the majority of program participation.

Table 1-1: Number and Percent of Distributed Refrigerators and CFLs in 2006, by CAP Agency

CAP Agency	Refrigerators		CFLs	
	n	Percent	n	Percent
Aroostook County Action Program	319	11%	4,404	15%
Coastal Economic Development Corp.	103	4%	1,156	4%
Community Concepts, Inc.	425	15%	7,247	24%
Kennebec Valley Community Action Program	133	5%	856	3%
Penquis Community Action Program	337	12%	1,799	6%
People's Regional Opportunity Program	274	10%	2,744	9%
Waldo Community Action Partners	99	4%	492	2%
Washington-Hancock Community Agency	474	17%	4,617	15%
Western Maine Community Action	100	4%	1,012	3%
York County Community Action Program	532	19%	5,476	18%
Total	**2,796**	**100%**	**29,803**	**100%**

1.2 Program Tracking Summary

Program data were provided to the NMR team at the outset of the study for the 2006 LIARP participants who volunteered for the telephone survey and were selected for the sample. These datasets included the following information on the products purchased:

Lighting

- Customer Information (Name and Address),
- Replaced Lighting Data (Room, Wattage, Estimated Daily Hours of Use), and
- Installed Lighting Data (Room, Wattage, Estimated Daily Hours of Use).

Refrigerators

- Customer Information (Name and Address),
- Replaced Refrigerator Data (Age, Manufacturer, Model #, Size (cu. ft.), and estimated annual energy consumption (kWh), and
- Installed Refrigerator Data (Age, Manufacturer, Model #, Size (cu. ft.), and estimated annual energy consumption (kWh).

The lighting and refrigerator data in the tracking system are based on estimated energy savings, the former likely driven by regionally available parameters as gathered from reports and studies that collected and analyzed primary data and the latter gathered from EPA energy consumption estimates.

The average CFL program assumptions for the 2006 sample participants are shown by room in Table 1-2 below. As the table shows, on average the program assumes 3.44 hours of use per day (1,255.6 annually) and an average of 47.4 displaced watts. The program also assumes an in-service rate of 100%. The savings per unit have been calculated using the following formula:

Average Energy Savings per Unit	=	*Displaced Wattage*	** Hours of Use/day*	** Days per Year*	** In-service rate*	*Divided by 1000 watts/kW*

Table 1-2: CFL Program Data for Sample Participants

Location	# of Bulbs	Avg. Daily Hours	Avg. Displaced Wattage	Avg. Annual Savings (kWh)
Addition	2	4.0	55.0	80.3
Basement	22	3.8	61.3	85.5
Bathroom	199	2.1	43.5	33.8
Bedroom	380	2.5	47.1	43.6
Den	32	4.0	49.9	72.2
Dining room	87	4.0	47.3	69.9
Foyer	7	2.1	55.4	41.9
Hallway	71	2.4	45.5	39.9
Kitchen	444	4.4	46.1	73.6
Laundry Room	31	1.2	45.2	19.4
Living Room	466	4.0	49.7	73.0
Office	5	1.7	59.0	36.6
Pantry	2	1.0	45.0	16.4
Spare Room	2	2.0	77.0	56.2
Stairs	1	4.0	46.0	67.2
Utility Room	2	4.0	46.0	67.2
Totals	**1,753**	**3.44**	**47.36**	**59.4**

Table 1-3 shows the average program assumptions for sample participants by refrigerator size (in cubic feet) of the original unit. The average replaced unit was 21.0 years old at the time of replacement, 17.1 cubic feet in size, and consumed 1,734 kWh per year. The average ENERGY STAR unit installed through the program is 17.3 cubic feet and consumes 434 kWh per year; a savings of 1,299 kWh annually.

Table 1-3: Refrigerator Program Data for Sample Participants

Original Refrigerator				New Refrigerator		
Size (cu. ft.)	**# of Units**	**Avg. Age* (Yrs)**	**Avg. Estimated Annual Consumption (kWh)**	**Avg. Size (cu. ft.)**	**Avg. Estimated Annual Consumption (kWh)**	**Annual Savings (kWh)**
12.0	9	25.9	1,475	15.6	408	1,067
13.0	4	23.5	1,946	15.8	402	1,544
14.0	39	23.1	1,614	15.1	416	1,198
15.0	25	22.1	1,703	15.6	406	1,297
16.0	19	21.8	1,645	16.5	429	1,216
16.5	1	23.0	2,306	17.0	464	1,842
17.0	29	24.4	1,855	17.2	421	1,433
18.0	50	18.7	1,648	17.8	437	1,211
19.0	19	18.9	1,809	18.9	450	1,359
20.0	21	16.5	1,813	19.5	459	1,354
21.0	12	17.1	1,798	20.1	465	1,333
22.0	8	17.9	1,975	20.4	475	1,500
24.0	2	24.0	1,852	18.0	475	1,377
25.0	1	25.0	3,840	18.0	407	3,433
27.0	1	17.0	2,622	25.0	715	1,907
Unknown	5	27.6	1,664	19.0	489	1,175
Total	**245**	**21.0**	**1,734**	**17.3**	**434**	**1,299**

***** At the time of replacement.

1.3 Methodology

The evaluation relies on several different research tasks, including interviews conducted with program staff from EM, the MSHA, and the CAP agencies; computer-assisted telephone interviews conducted with program participants; and onsite inspections of participants' homes.

In order to control bias and ensure adequate geographic coverage for the telephone surveys and onsite visits, efforts were made to complete a similar proportion of surveys and visits with participants from each CAP agency as the proportion of program audits conducted by each CAP agency during 2006. In addition, several other factors suggest that bias should not be a major concern. First, the LIARP participants are all low-income, which means they are homogenous in terms of income, and possibly other demographic characteristics too. Second, all program refrigerators and light bulbs were logged in each home that received an onsite visit, thus there should be no bias in terms of product selection. Lastly, the LIARP impact estimates are generally consistent with the results of other studies, and any differences are readily explainable.
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1.3.1 Staff Interviews

Program Staff Interviews. Three in-person interviews were conducted in July of 2007, including two with EM staff and one with MSHA staff. A fourth interview was conducted over the telephone with another MSHA staff person in October 2007. These interviews covered a wide variety of topics regarding the LIARP, including program development, planning, design, budgets, participation, delivery, tracking, and quality assurance.

CAP Staff Interviews. A total of nine telephone interviews were conducted in July and August of 2007 with CAP staff who manage the LIARP program at their respective agencies. These interviews covered a variety of topics regarding the LIARP, including program design, recruitment, participation, delivery, and quality assurance.

1.3.2 Participant Telephone Surveys

A computer-assisted telephone survey was conducted in September of 2007 with customers who participated in the LIARP during 2006. Because MSHA was required to maintain the confidentiality of its clients, volunteers for the telephone survey were recruited through a mail survey that asked them to complete, sign, and return a brief form. In order to encourage volunteers, participants were offered $5 if they returned the mail survey and completed a telephone interview. The telephone survey was conducted with a random sample of volunteers from the mail survey. Table 1-4 displays the number of completed surveys by CAP agency. Efforts were made to complete surveys with participants from two CAP agencies - Washington-Hancock and York - that were underrepresented in the returned mail surveys, in order to ensure adequate geographic coverage; MSHA sent records for additional volunteers from these two agencies.

Table 1-4: Number and Percent of Survey Respondents to Participant Survey, by CAP Agency

CAP Agency	N	Percent
Aroostook County Action Program	18	13%
Coastal Economic Development Corp.	5	4%
Community Concepts, Inc.	22	15%
Kennebec Valley Community Action Program	13	9%
Penquis Community Action Program	23	16%
People's Regional Opportunity Program	15	11%
Waldo Community Action Partners	9	6%
Washington-Hancock Community Agency	15	11%
Western Maine Community Action	12	8%
York County Community Action Program	10	7%
Total	**142**	**100%**

The estimated sampling error for the 142 surveys is ±5.3% at the 80% confidence level, assuming that proportions are 50% (i.e., 50% of respondents reply "yes" to a given question). A proportion of 50% results in the maximum sampling error and thus presents the worst-case scenario.

The participant telephone interviews covered a variety of topics regarding the program, including the following:

- How the participant learned of program
- Experience with the audit
- Satisfaction with program services and products
- Information on old refrigerator and new refrigerator
- CFL installations and removals
- CFL hours of use and spillover
- Bill impacts
- Demographics

1.3.3 Onsite Inspections

On-site visits were performed in the homes of 40 customers who participated in the program by receiving an ENERGY STAR refrigerator and CFLs.

Participation for the on-sites was solicited from the customers who completed the participant telephone survey, which was performed to inform both process and impact results. The pool of customers who expressed interest in the on-sites during the telephone survey was selected randomly within the various participating CAP agencies and given $35 to participate in the on-site portion of the study. During the visit, lighting and refrigerator loggers were installed and a survey was performed to gather information on the installation and/or removal of the program measures, including the displaced wattage and current the use of the CFLs in question.

Appliance saturation, general demographics, and information on additional opportunities were also gathered through the on-site survey. The loggers were left in for a period of approximately two weeks.

Recruitment. While performing the telephone surveys, customers were offered a $35 incentive to participate in an on-site visit. Ninety-eight respondents expressed interest in participating in the on-site portion of the study and became the sample frame. Forty of these customers were contacted by RLW staff in order to achieve a reasonable geographic distribution of sites, by CAP agency, as shown in Table 1-5 below. Recruitment calls and on-site visits were performed at various times and on various days of the week (including nights and weekends) in order to minimize bias.

Table 1-5: Number of On-sites by CAP Agency

CAP Agency	Number of Volunteers from Telephone Survey	Number of On-site Visits
Aroostook County Action Program	9	5
Coastal Economic Development Corp.	5	3
Community Concepts	17	5
Kennebec Valley Community Action Program	10	3
Penquis Community Action Program	18	7
People's Regional Opportunity Program	6	3
Waldo Community Action Partners	6	2
Washington-Hancock Community Agency	12	5
Western Maine Community Action	9	2
York County Community Action Program	6	5
Total	**98**	**40**

On-Site Visit Data Collection. During the on-site, the auditor used the tracking system information on lamp location to identify the CFLs that were installed through the program. If they could not be found, the auditor asked the customer to identify the program CFLs. In many instances, the CFLs that the customer reported had been installed through the program were in a different location or had different wattages than what was reported in the tracking system. In order to decide which bulbs would be considered program bulbs, we generally employed two rules:

- If a CFL of the same wattage listed in the tracking system is found in a different room within the home and the customer claims that it was received through the program, it was considered to be a program CFL. This was the case for 70 CFLs or 25.5% of the bulbs that were installed.

- If a CFL of a different wattage from what is listed in the tracking system is found in a room that is listed in the tracking system and the customer claims that it was received

through the program, it was considered to be a program CFL. This was the case for 61 CFLs or 22.3% of the bulbs that were installed.

One exception was made when the tracking system reported the installation of two 13W CFLs in a customer's bathroom and one 25W CFL in the living room. During the on-site visit, the auditor found only three CFLs in the entire house: two 20W CFLs in the bedroom and one 15W in the kitchen. All three were considered to be program CFLs.

The on-site data collection activities also included a brief interview with the participant to gather information on the products installed through the program and the installation of an Electronic Educational Devices (EED) Watts Up Pro Extended Memory plug meter to monitor the power consumption of the refrigeration unit in 3-minute intervals for a two week period. The metering period for the project was October and early November, 2007.

Appliance saturation, general demographics, and information on additional opportunities were also gathered through the on-site survey. Dent lighting loggers were installed to accurately measure lighting hours of use for a period of two weeks. The lighting logger data set was used to support the evaluation through the development of annual hours of use for lighting measures. A total of 187 lighting loggers and 40 refrigerator loggers were installed across the 40 homes visited in support of the study. The lighting loggers captured the hours of operation of 265 CFLs.

Analysis Methodology Overview. This section presents the methodology used to calculate the various lighting and input parameters and refrigerator results based on the data collected in the on-site visits. All of the lighting data collected came from Dent Instruments Time of Use (TOU) Lighting Loggers while the refrigerator logger data were collected with Wattsup Pro power monitors. The lighting loggers use a photocell and an internal time clock to measure when the lights go on and off. The logger software exports interval data in a text format that provides the percent "on time" during each interval in the metering period. The refrigerator power monitors were plug-in style monitors that gather true power at specified time intervals. The following paragraphs describe the steps that RLW takes to ensure that the data gathered are as accurate and free of bias as possible.

Accuracy, Calibration and Logger Maintenance. Periodically, RLW checks the battery voltage of lighting loggers to make sure that the voltage is sufficient to power the unit. The loggers are equipped with a 3.0 Volt battery that typically provides 3.2 Volts, but the loggers will continue to function properly until the voltage drops below 2.6 Volts. RLW replaces all batteries when the voltage is below 3.0 Volts, which usually occurs after the loggers have been in use for three years or more. Records of battery testing and maintenance are maintained on the network drive of the RLW server, which is backed up on a daily basis.

Section 10.2 of the ISO-NE M&V manual[8] specifies that measurement tools must be synchronized in time within an accuracy of ±2 minutes per month with the National Institute of Standards and Technology ("NIST") clock. The Dent TOU Lighting Logger contains a solid

[8] ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources, Revision: 1. October 1, 2007.

state circuit that exceeds the ±2 minutes per month standard for time drift. For this study, RLW synchronized all lighting loggers at the start of the project to a desk top computer clock that is linked to our network server and maintained in synch with the NIST clock.

The kWh data logger used for the refrigerator monitoring was the WattsUp Pro. This logger records cumulative true kWh usage to a 0.1 Watt resolution and a rated accuracy of +/- 1.5%. RLW synchronizes the logger data to their personal computers which maintain the official NIST time via a synchronization link over the Network Time Protocol (NTP). Meter calibration on the WattsUp Pro was performed by The Electronic Educational Devices Company at the time of logger manufacture and a certificate of calibration to the NIST standard is available.

Logger Placement. Lighting loggers were installed to gather hours of operation of every bulb installed at the time of the on-site visit. In many cases multiple bulbs were on the same switch and one logger was used to gather the hours of use for these bulbs. Loggers are placed so that they will not be affected by ambient light or by light from another fixture. The sensitivity of the logger is set so that data are only being recorded when the fixture of interest is in use. This is tested by the on-site auditor at the time each logger is installed. If the auditor is concerned that other light sources may affect the logger data, a fiber optic wand is used which fits over the photocell of the lighting logger and can be pointed directly at the intended light source. The refrigeration loggers were similarly installed on each program unit observed at the home.

Refrigeration Metered Data. All of the individual three-minute interval metered data were processed into hourly data and included average volts, amps and wattage data. From these data, RLW was able to determine the annual consumption of the unit(s) through a simple expansion of the metered data as well as the activity of each unit at various times of the week and day. It should be noted that of the 40 loggers installed, nine loggers were not able to be used. Five of these were due to what appeared to be malfunctioning meters in which the data appeared unreliable and four were due to what appeared to be intermittent power problems that caused the loggers to reset multiple times during the metering period.

Lighting Logger Data Expansion. When using short-term lighting loggers, the logged hours must be adjusted to compensate for the fact that people use their lights differently at different times of the year (i.e., more in the winter months and less in the summer months). In order to determine the annual hours of operation, the NMR team used the information provided in Table 1-6 from a long-term metering study performed in Massachusetts, Rhode Island, and Vermont from 2004-2005.[9] Specifically, the long-term study was used to calculate the percentage of total annual hours that fell into each month of the year. The long-term study was performed with a sample of participants from a utility-sponsored lighting program. Although the annual hours of use would most likely be lower in low income households when compared to homes from the general population, we would not expect the percentage of lighting use by month to be much different between the two groups. These data were used to annualize the short-term monitored data in this study to a full year by multiplying the monthly hours observed in the short-term metering by the fraction of annual hours determined to fall during the same month from the long-term study. In this study all of the metering occurred in October so the raw logger data was expanded to represent an entire month's worth of use and then divided by 9.27% to estimate annual use.

Table 1-6: Monthly Hours of Use

Month	2004-2005 MA Study	
	Total Hours	**Percentage of Total Annual Hours**
January	97.3	9.76%
February	79.9	8.01%
March	87.0	8.73%
April	76.7	7.69%
May	74.7	7.49%
June	71.5	7.18%
July	69.3	6.96%
August	73.5	7.37%
September	79.8	8.01%
October	92.4	9.27%
November	96.8	9.71%
December	97.9	9.82%
Total	**996.7**	**100.00%**

[9] http://publicservice.vermont.gov/pub/other/marivtfinalresultsmemodelivered.doc.

2. Staff Interview Results

This section presents the results of the interviews with EM, MSHA, and CAP Agency staff.

2.1 Roles and Communication

The role of EM in the LIARP is to provide funding and guidelines to MSHA which operates the program, in accordance with the Maine statutes regarding the expenditure of energy efficiency funds. In addition, EM is responsible for overall program planning and budgeting, as well as assessing the cost-effectiveness of the program and specific measures. Two EM staff provide program oversight in reviewing annual plans, budgets, and monthly reports; the director spends about 5% of his/her time in supervision and the program manager spends 15% to 20% of his/her time on the program. The EM program manager assumed responsibility for managing the LIARP from the director in early 2007.

MSHA manages the LIARP on a day-to-day basis, in terms of detailed planning, budgeting, and overseeing the CAP agencies and other contractors that implement the program; the MSHA program manager spends about 5% of his/her time on the program. A second MSHA employee is involved in training CAP agency staff, conducting inspections of homes, handling waiver requests, processing invoices, entering tracking data into spreadsheets, and responding to CAP questions; this employee spends about 50% of his/her time on the program. Other MSHA employees are involved in the program on a part-time basis as needed.

The CAP agencies typically employ a program manager who spends between 5% to 15% of their time handling program contracts, budgeting, reporting, and managing field staff. The CAPs typically have one or two auditors who spend a substantial portion of their time (between 20% and 60%) conducting LIARP audits; other auditors become involved if they encounter older refrigerators during audits conducted for other programs.

Table 2-1 displays the ten CAP agencies in Maine that deliver the LIARP and the region served by each agency.

Table 2-1: Community Action Program Agencies and Regions Served[10]

Community Action Program Agency	Region Served
Aroostook County Action Program	Aroostook County
Community Concepts, Inc.	Androscoggin, Oxford Counties
Kennebec Valley Community Action Program	Kennebec, Somerset Counties
Midcoast Community Action	Brunswick/Freeport/Harpswell/Pownal, Lincoln, Sagadahoc Counties
Penquis Community Action Program	Penobscot, Piscataquis, Knox Counties
Peoples Regional Opportunity Program	Cumberland County
Waldo Community Action Partners	Waldo County
Washington-Hancock Community Agency	Washington, Hancock Counties
Western Maine Community Action	Franklin County East
York County Community Action Corp.	York County

The CAP agencies all offer other housing and energy programs, including Section 8 assistance, LIHEAP, DOE Weatherization, CHIP, oil tank replacement, and low-income ratepayer assistance. One CAP also mentioned BPI certification through Home Performance with ENERGY STAR.

Communication. The EM staff handle the annual reporting for the LIARP as well as inquiries from the legislature. The EM staff are in regular contact with the MSHA staff via email and telephone regarding program planning, budgeting, and tracking. The CAPs provide monthly reports and invoices to MSHA; in addition, they are in regular email and phone contact with MSHA staff regarding waiver requests, eligibility, program changes, and other questions. The CAPs also deal directly with the local vendors who deliver the refrigerators. The CAPs generally do not communicate with each other regarding the LIARP except during the meetings for the Maine Community Action Housing Council.

One program staffer notes that EM is somewhat disconnected from the operation of the program, because they have little contact with the CAP agencies, and do not attend any meetings between the MSHA and the CAP agencies. In addition, all of the CAP agencies report that they have little or no communication with EM.

2.2 Program Development

The Maine legislation, which authorized funding for energy efficiency programs, mandates that 20% of the overall budget is spent on low-income programs. In addition, this legislation directed the PUC to work with the MSHA to deliver energy efficiency to low-income customers. One EM staffer notes that this no-bid process with MSHA is relatively simple to manage.

[10] http://www.mainehousing.org/DATACapAgencies.aspx?PageCMD=4

The MSHA and the CAP agencies implement the LIHEAP program and other low-income programs, such as DOE Weatherization and CHIP, and thus have established pre-existing relationships with low-income customers. The eligibility criteria varies from year to year for the LIHEAP program, depending on federal funding levels; in 2007, the criteria was 150% of federal poverty guidelines or 170% of federal poverty guidelines if the household includes an adult aged 60 or older or children aged 2 and under. According to staff, LIHEAP participants (and by extension, LIARP participants) tend to be elderly homeowners, and of course, low-income; some non-elderly participants include the disabled or families.

Program staff report that landlords and property managers occasionally contact the program, but they are required to transfer ownership of the refrigerator to the tenant prior to participating. If landlords or property managers contact the MSHA, they are also referred to other MSHA programs or to Efficiency Maine. In addition, callers are asked to encourage their tenants to apply for the LIARP if eligible.

Refrigerators and CFLs presented the best opportunities to save electricity in low-income households, according to one staffer, and thus were selected as the primary measures eligible for the program. MSHA had prior experience in metering refrigerators with the Residential Energy Assistance Challenge Option Program (REACH) program, which facilitated the implementation of the current LIARP testing process. In addition, several other measures are eligible but infrequently encountered or replaced: halogen torchieres are eligible for replacement with CFL torchieres; waterbeds are eligible for replacement with a standard mattress, and older freezers are eligible for replacement with ENERGY STAR models.

2.3 Program Planning and Budgeting

According to MSHA staff, there are roughly 50,000 LIHEAP applications each year in Maine, which are mostly conducted in-person at the local CAP agency offices. The LIARP serves approximately 3,000 homes annually and attempts to piggyback with other low-income energy programs whenever possible. The CAP agencies annually conduct roughly 800-900 DOE weatherization jobs and another 400-500 CHIP jobs in Maine. The LIARP piggybacks on nearly all of these 1,200-1,400 jobs, with the remaining visits completed as stand-alone projects. Customers who receive stand-alone LIARP services are referred to the DOE weatherization program if they are eligible.

With the expanding budgets for EM energy efficiency programs, the annual low-income budget is expected to increase by roughly 50% over the next several years, from over $2 million in 2007 to over $3 million in 2011. In order to allocate the LIARP budget, the CAP agencies are provided an annual budget from MSHA based on the anticipated number of LIHEAP applications, which is usually estimated based on the previous year's figures. However, MSHA holds some funds in reserve to shift to CAPs that are exceeding their goals; similarly, if a CAP is not meeting its annual goal, MSHA may shift its budget to CAPs exceeding their goals. All of the CAP staff believe that the distribution of funding across the state is fair and reasonable.

CAP Agency Fees. The CAP agencies receive $100 each for piggybacked jobs, and $150 each for stand-alone jobs. However, some CAP agencies complain about the size of the fee and the fact that it has not increased since the program began in 2003. One respondent from a rural CAP agency says that "the fee is too low—we have a two-hour travel time. We are lucky to break even this year due to higher travel costs." Another says "the fee structure is still the same after three or four years. The program should cover itself; all programs expect coordinated work with other programs to help defer costs. In rural areas, greater distance for travel incurs greater expenses and more labor. Though we try to schedule multiple visits in the same region, it is sometimes less production than we like. One size does not fit all." One CAP respondent suggests that the LIARP could re-design the fee structure to be similar to the oil tank replacement program or the lead paint program; the lead paint program allows projects over 50 miles a travel surcharge. While noting that some CAP agencies do complain about the fee structure, one program staffer mentions that "some [CAPs] are more efficient than others."

In cases where the refrigerator does not qualify for replacement, the CAP agency is paid for the visit from the LIARP funds, assuming the agency followed proper screening procedures. However, according to program staff, there have been a few CAP agencies that were not appropriately following procedures and thus were denied payment.

2.4 Program Design

Recruitment. LIHEAP participants are required to apply each year for funds, with the application process beginning in July. CAP agencies identify potential LIARP participants through the LIHEAP application process; therefore, there is no separate application process for the LIARP. The CAP agency staff usually inform clients of the LIARP during their face-to-face LIHEAP application, though sometimes a customer will call after learning of the program. Some CAP agencies will also call prior LIHEAP clients or send out mailings occasionally; for example, one CAP mails out a quarterly newsletter to its LIHEAP clients—this newsletter serves to promote programs and they "get an influx of requests" and use a clip-out form for clients to mail back.

During the LIHEAP application process, the staff will distribute a flyer that the customer takes home and fills out with information on their refrigerator model. Once completed, the customer calls the CAP agency to provide the information. CAP staff conducts a brief screening interview over the telephone to ensure that the customer owns the refrigerator, pays their electric bill, and that the refrigerator was manufactured before 1995; one CAP respondent notes that "sometimes people misjudge the age of their refrigerator." If the client meets all the eligibility criteria, the program schedules an appointment for an auditor to visit the home. Note that CAP auditors may also test a refrigerator when they are auditing a home for the Weatherization, CHIP, or Oil Tank Replacement programs.

LIARP participants must own their refrigerator, which is common for homeowners but not as common for tenants; this is also true for the requirement that participants pay their electricity bill, though to a lesser extent. Thus, if a tenant does not own the refrigerator, the landlord must sign an agreement to pass ownership of the refrigerator to the tenant before they can participate.

The CAP agencies will prioritize customers for LIARP using a mixture of factors—electricity consumption, homes with children under 2 years old, the disabled, or the elderly. In addition, CAPs will try to quickly serve homes if they receive a call that the refrigerator is broken. Several CAPs also target participants based on their geographic location in order to maximize the efficiency of travel for the auditors.

Audit. Each audit lasts about 2.5 hours, which includes metering the refrigerator, providing CFLs, conducting the blower door test, performing the audit, and educating the client. Once at the home, the auditor sets up the fan equipment to run the blower door test in order to measure air infiltration and sets up the metering equipment to test the refrigerator operation for two hours; the blower door test and refrigerator metering results are recorded on the Maine Energy Audit Form (MEAF) form. While metering, the auditor provides CFLs based on room location and the daily hours of use estimated by the client. The auditor also educates the client regarding appliance usage and lifestyle habits that may affect energy usage, and distributes LIARP information regarding refrigerator maintenance and CFL disposal. The auditor may replace halogen torchieres with CFL models, recommend the replacement of waterbeds with standard beds, and test freezers for potential replacement, though all of these products are rarely encountered.

Since the auditor is required to be in the home for two hours to test the refrigerator, the program requires him or her to conduct a blower door test in order to collect information on air infiltration levels, for weatherization program planning. However, several of the CAP respondents question the value of conducting blower door tests, since the LIARP does not utilize the data collected. One respondent asks "Why require the blower door test? The PUC does not need it. It is a snapshot condition of the home, and can change over time especially in low-income homes." Yet another respondent asks "Why are we doing it if we are not air sealing? It could create problems – blow around vermiculite in the attic." Lastly, one CAP respondent notes "There is not enough weatherization funding to serve the current waitlist. Why identify more clients when the current ones won't get served for years? The heating bill is more important."

Refrigerator Replacement. The auditor will meter the refrigerator for two hours in order to estimate annual kWh usage. If the estimated annual energy savings between the existing model and the appropriate ENERGY STAR model is greater than 750 kWh, the refrigerator will be replaced. Another staffer notes that there are inaccuracies in metering that may affect the replacement of units with readings near the 750 kWh point.

CAP agencies can request a waiver for refrigerator replacement in several situations:

- The refrigerator cannot be accurately metered because it is not operating frequently enough or it is not operating at all
- The refrigerator does not meet the energy savings criteria but appears to be in poor condition (poor seals, hinges, leaks, etc)

Other waivers include requests for clients who prefer a different size or style refrigerator than program guidelines allow; sometimes these are necessary due to a medical condition. MSHA staff decide whether to approve or deny a waiver based on a variety of factors on a case-by-case basis.

According to CAP staff, the vast majority of metered refrigerators qualify for program replacement. The auditor discusses with the client the types of refrigerator models available and assists them in selecting the appropriate model. MSHA has developed guidelines for CAP agencies to follow in order to determine the size of the replacement refrigerator, based on the number of people in the household. The auditor places an order for the new refrigerator once they return to the CAP office; the refrigerator vendor schedules the delivery appointment, removes the old refrigerator to a local disposal facility, and provides the CAP agency with paperwork documenting the disposal of the refrigerator.

Refrigerator Testing Criteria. Most CAP respondents believe that the current criteria for testing refrigerators are fair and reasonable. However, one respondent believes that "The refrigerator criteria may be too stringent; I'm not clear what criteria is used by the PUC. I've argued for more flexibility in metering—use age instead, but [we have] needed to demonstrate energy savings." Another respondent notes that "Small refrigerators don't pass even if [they are] in bad condition because of lower electricity usage. Sometimes units will squeak by even though they are in poor shape."

Others believe that the pre-1995 criteria should be updated as the program matures, in order to maintain a 10-year gap (i.e. 1998 models for the 2008 program year).[11] A few respondents note that some 1996 and 1997 models are in poor condition, and others think the program may eventually reach all eligible pre-1995 models. Several respondents suggest allowing auditors to recommend replacement based on the condition of the model—if the hinges and gaskets are not operating well, then they believe the unit will fail soon even if it does not qualify for replacement through metering.

One CAP employee notes that the program now requires ENERGY STAR refrigerators[12], rather than equivalent models. This respondent believes that this requirement "adds $50 to $150 to the cost, without much incremental energy savings. What is the net effect on overall energy savings, if [the program is] replacing fewer refrigerators but they are all ENERGY STAR?"

CFLs. According to MSHA staff, when the LIARP first began, the auditors replaced bulbs that operated more than two hours per day. The program currently replaces all bulbs in the house, with no limit, as long as the bulb replacement produces energy savings. According to MSHA staff, the program replaces about eight bulbs per home on average. However, each agency approaches bulb replacement differently, and MSHA has worked with the CAPs to implement a consistent approach. According to program staff, the auditors are required to install the CFLs, and the replaced bulbs are left with the homeowner because they own the bulbs.

According to the CAPs, the auditors use their judgment in deciding how many CFL bulbs to provide the home based on the room location and the hours of use estimated by the client. Most CAPs will provide CFLs for sockets that are used more than two hours per day, with no limit on

[11] Participants are asked if their refrigerator model was manufactured prior to 1995 before they are scheduled for an audit.

[12] This requirement was instituted because some CAP agencies were not purchasing ENERGY STAR equivalent models or were purchasing discontinued models.

the number provided to each household. One CAP respondent notes that "lately the average number [of CFLs] installed per home has declined since people tend to already have [CFLs] due to the Keep ME Warm and the Efficiency Maine CFL program." Another says that "some people are installing themselves, a lot of people are already switching them one-by-one as they fail."

Most CAP agencies remove the old bulbs and install the CFLs into light sockets, though at least one agency leaves the CFLs for the client to install, unless they are elderly. This respondent says that "we just leave the CFLs, we don't install them; we are concerned about the breakage issue with mercury. If asked to, we will install them. There has been no direction from MSHA regarding installation, some CAPs install and others don't—some think it is not cost-effective [given the level of the program fees]."

Freezers. Due to the recent introduction of freezers as an eligible measure, most CAP agencies have little experience in freezer metering and replacement, though one respondent believes the criteria (annual energy savings of 978 kWh) is set too high, resulting in few units qualifying for replacement. Several mention the challenges in accurately metering freezers; one says there have been "few replacements because the units don't turn on often, and are often located in colder rooms so it's really hard to meter in winter." Another interviewee states that "the method for testing is complicated. We proposed checking instantaneous demand, because the freezer may not turn on during the two-hour test and we cannot meter for 24 hours."

Lastly, two CAP staff note that the program will not allow an auditor to return to meter a freezer if the home already replaced a refrigerator through the program, which restricts the pool of eligible households. One states that his auditors "run into old freezers a lot—due to seasonal employment, people pick and store blueberries. It would be good to allow a little flexibility in [returning] to households that already received a refrigerator [in order] to test the freezer."

Relationship with Other Programs. Beyond piggybacking with the DOE Weatherization program and the CHIP program, the LIARP also coordinates with the aboveground oil tank replacement program; all of these programs use LIHEAP as a method of reaching potential participants. EM also sponsors a low-income pilot CFL replacement program that began in April 2007 and works with housing authorities to distribute five CFLs each to low-income tenants. The program is operated by the Residential Initiatives for Maine (RIFME) association, which is affiliated with the Maine Association of Public Housing Directors. The program serves tenants who are Section 8 qualified or tenants who are below 150% of federal poverty guidelines (i.e., LIHEAP eligible) and who pay their own electric bills. The RIFME pilot, which began after the PUC directed EM to pursue alternative strategies to expand low-income portfolio beyond the LIARP, generally does not coordinate with the LIARP.

2.5 Program Revisions

Measures. The criteria for replacing refrigerators was lowered from projected annual energy savings of 1,000 kWh to 750 kWh, after revised avoided energy cost numbers reduced the level of energy savings necessary to pass the cost effectiveness tests. In addition, the program added

waterbeds and freezers as eligible measures; while waterbeds are rare, the savings can be substantial. The freezers were added in early 2007 and none had been replaced at the time of the staff interviews.

EM and MSHA recently began a program to test the effectiveness of replacing electric water heaters in LIHEAP eligible homes with at least four people. This pilot is operating in northern Maine (selected due to recent electricity rate hikes) and southern Maine (selected due to the prevalence of natural gas). The southern Maine program partners with Northern Utilities to replace old or malfunctioning electric hot water heaters with energy efficient natural gas units. The northern Maine pilot replaces old or malfunctioning electric units with energy efficient propane, oil, or new electric models, depending on the availability of fuel in the home.

While one program staffer believes that the program has already targeted the major electric end uses, others mention hot water heaters (DHW), clothes washers, clothes dryers, room air conditioners, stoves, and heat pumps as potential measures for consideration. According to one staff member, the program was "inundated with requests" for water heater replacements. Several CAP respondents suggested DHW for inclusion (and a few mentioned the ongoing pilot program) as they receive many telephone calls regarding DHW. However, some are concerned about the length of the payback period, the difficulty of metering, and the complexity and cost of hiring a plumber and/or electrician to install. Several CAP respondents also mention replacing clothes dryers, as one respondent says "some [clothes dryers] are 25 years old and run a lot to do little drying. Though most clients are elderly, there are a few young families [who do] lots of washing and drying." One staff member suggests that the LIARP should embrace a whole house approach in order to more effectively integrate with other programs.

Statewide Purchasing. Some CAP agencies have obtained lower prices for refrigerators and CFLs than others; in addition, some CAPs had purchased discontinued models or models that were not equivalent to ENERGY STAR. In order to obtain the lowest statewide prices, in early 2007 MSHA issued bids to select a contractor to provide statewide delivery and removal of refrigerators and to supply CFLs statewide. MSHA recently entered into agreements with Sears to provide refrigerator delivery and removal services and with Home Depot to supply CFLs directly to CAP agencies. In addition, refrigerators will be available in only three sizes: 15 cubic feet, 18 cubic feet, and 21 cubic feet. Three CAP agencies are piloting the Sears program in late 2007, with all agencies planning to use Sears and Home Depot in 2008.

Several CAP staff expressed concerns about the upcoming change to statewide delivery of refrigerators. As one respondent says "[We receive] good quality refrigerators from a local vendor, with warranties. We will lose local control if the program shifts to national chains for statewide service"; another says "Sears does not provide as good service in rural areas; the local Sears is a franchise and so can choose not to participate." Another believes that the "new Sears system offers fewer models, so it will be more complex to get a waiver, etc." However, one CAP respondent thinks that "central purchasing for refrigerators and CFLs will reduce costs" and "with the statewide bid, we will have the same level of service."

2.6 Program Participation

Program staff members believe that customers choose to participate because they "need to replace their refrigerator but can't afford it, and have no other option" and want to reduce their electricity bills. The CAP employees also believe that customers choose to participate because their current refrigerator is in poor condition and they need a new one; the energy cost savings are secondary. One respondent says that "the clients are appreciative, they need help and generally are not aware of the program until we tell them. They usually don't replace appliances unless they break." Another respondent says "most are on a fixed income, so a few hundred dollars for a new refrigerator is too much."

Barriers to Participation. The major obstacles to participation are eligibility issues; customers may not be LIHEAP eligible, they may not own their refrigerator, or the electricity bill may not be in their name. In addition, some customers do not want the auditors in their home because it is "intrusive", while others believe that they simply do not need assistance. CAP staff report that rental units present obstacles in terms of refrigerator ownership and payment of the electric bill. One CAP interviewee reports that "we haven't pursued tenants, since we would need the landlord to sign over the refrigerator." Another says that "sometimes the landlords will sign the refrigerator over, but it is Catch-22 since then they have to buy a new one when the tenant moves out."

In a few instances, eligible customers have chosen not to replace their refrigerator because they prefer a model with different features and are not willing to pay for the upgrade. Some of these features include different colors, a side-by-side model, through-the-door ice/water dispenser, or providing a larger size model than the program guidelines allow. Also, the newer refrigerator models have different dimensions than older models (typically deeper but shorter), which can pose problems, especially with existing cabinetry in place.

One CAP respondent notes that "we don't know why they choose not to call after receiving the program flyer; we only hear back if they are interested."

Waitlists and Scheduling. The length of time that a participant spends waiting for service depends on whether or not the job is piggybacked with DOE Weatherization. If the job is piggybacked, the customer may wait up to three months; if the job is stand-alone, the customer should be served in less than 30 days. Most CAP respondents report that their agency maintains a LIARP waitlist of a few weeks, though several agencies serve customers within a few days of approval. They use a first-come, first-served approach to prioritizing their visits, though specific clients will be served sooner if their refrigerator fails or if extreme conditions exist in the home. Most CAP agencies also target specific geographic areas in order to cluster visits together; thus, participants located in those regions will tend to be served prior to those located in non-targeted areas.

Most CAP agencies report that very few customers are not home during scheduled appointments; however one agency reports that customers are not home for 30% of visits. Clients usually miss

appointments because they forget, had an emergency, or could not get time off from work. In these situations, the agency will usually reschedule the appointment.

Languages. Most CAP agencies report that they rarely encounter LIARP customers who cannot speak English. However, several CAPs report that a few clients only speak French, though there is often one person in the household who speaks English and thus serves as an interpreter. The CAPs will usually learn about any language barriers during the LIHEAP application process; in addition, a few CAPs have foreign language speakers on their staff – mostly French.

Participant Feedback. Program staff report that customer feedback regarding the program is largely positive, with customers saying the program "saves money on our electric bill" and "we love it". The CAP respondents also report that the vast majority of clients are appreciative and satisfied with the refrigerator and CFLs distributed by the program; the program receives "99% good responses" and the "postcards we receive are usually grateful." One CAP staffer says "the [customers] love [the program], a lot of positive feedback compared to other programs" and another says "they love the new refrigerator, it keeps ice cream cold, and works perfectly. They don't need to visit the store every day."

CAP respondents report that they receive few complaints about the refrigerators; if so, usually because of the lack of choice in features (colors, side-by-side doors, an ice-maker, or glass shelves), the dimensions of the newer models, the size, or because an occasional refrigerator fails due to a poor gasket. In cases where the refrigerator fails prematurely or has other problems, the delivery vendor will handle the complaint.

Regarding CFLs, one CAP respondent mentions that "everyone loves CFLs" and another says that "some [clients] call and want more [CFLs]". Other respondents report that there are few complaints because the bulbs rarely break; however during the first year of program operation, elderly participants sometimes complained about the level of light or the delay in lighting. The program has since boosted the replacement wattage for bulbs and the newer CFL models have shorter delays. In addition, the newer CFLs are more compact (and thus fit into more fixtures) and people are more familiar with the technology.

One CAP respondent reports that people sometimes call back and ask for more CFLs though another says that "anecdotally, if we go back for weatherization, some [CFLs] have been removed." Two CAP staff mention the mercury disposal issue; one says the "mercury issue with CFLs – there was a little panic regarding disposal" and another thinks that "recycling in rural areas is a challenge, most will just be thrown out."

Bill Reductions. Program staff and CAP staff believe that most participants see reductions in their electricity bills, on average $10 to $30 per month. One CAP staffer reports that "clients will call and say their bill went down $10 to $20, and thank you for new refrigerator." However, respondents note that energy usage is affected by other factors such as seasonal changes, the addition or removal of major appliances (such as a room air conditioner), as well as client behavior (which may be influenced by the LIARP customer education).

2.7 Program Delivery and Administration

According to program staff, the LIARP is achieving the annual targets for homes served, refrigerator replacements, and CFL installations, though one staffer believes the program could "do more units with more money." Most staff believe that the program has adequate staffing at both EM and MSHA, and that turnover is not an issue. One staffer notes that the CAPs are more active in conducting audits from April through November because the blower door test can cool off the home in the winter months. In addition, some CAPs hire seasonal staff for the summer months to conduct LIARP audits.

Most CAP staff believe that the LIARP has provided a consistent volume of projects from year to year, and most believe that they are on target to meet their 2007 goals. One CAP respondent says that it's an "easy program to implement to meet demand; 250 is all we can handle with current staffing. It's a good level." Another says that his agency "could do more refrigerators, but we will run out of funding before year ends" while another reports that his agency is "way behind."

One CAP respondent notes that his agency is "starting to saturate the market—we are now hitting fewer old refrigerators in the homes we visit. So it may slow down in the next few years." Another CAP staff member reports that "It is getting harder to find clients for refrigerator replacement. There is a 20% turnover in the LIHEAP client base each year, so 80% are the same. We are struggling to find [homes with eligible refrigerators]. It is becoming more of a CFL replacement program—CFLs are not saturated as much as refrigerators." One program staffer also believes that several CAP agencies are exhausting the pool of low-income households to replace refrigerator—either their refrigerator does not qualify or it has already been replaced.

Program Administration Structure. According to program staff, the advantages of delivering the LIARP through the MSHA and CAPs is that the agencies serve as a "one-stop shop" for heating fuel assistance, weatherization, and replacement of heating systems, appliances, and light bulbs. In addition, the CAP agencies already have established relationships with low-income customers, which facilitates their participation in the LIARP.

In terms of expanding the program, the MSHA already works with housing authorities; however, the housing authorities typically own the refrigerator and often pay their tenants' electric bills, posing obstacles to LIARP eligibility. Another staffer believes that housing authorities would offer a broader range of low-income customers beyond the single-family elderly homeowners that have traditionally participated in the LIARP. Another staffer suggests that the LIARP could serve additional households that are low-income but do not meet LIHEAP income requirements; one possibility is using 60% of median household income as the eligibility criteria.

Asked about the possibility of a private contractor operating the program, one program staff member notes that such contractors would not have access to the confidential client information that CAP agencies have access to. In addition, the $100 fee would only cover refrigerator and CFL replacement, and would not include any piggybacking with other low-income programs.

Another respondent notes that a private contractor would need to direct recruited customers to CAP agencies to apply for LIHEAP before participating.

Several CAP staff question the role of MSHA as the "middleman" in managing the LIARP. They recommend that EM administer the program directly; one cites the example of the oil tank replacement program, where the CAP agencies work directly for the Department of Environmental Protection. Other respondents believe that "there must be some administrative costs from MSHA." However, eliminating MSHA as the management agency might require the PUC to hire additional staff to manage the subcontracts with each of the CAP agencies, according to one program staffer.

2.8 Program Tracking and Quality Control

Program Tracking. Staff members indicate that the current tracking system, which records the number of units served, refrigerators replaced, CFLs installed, and estimated energy savings is sufficient to measure the program's progress towards it goals. EM receives monthly tracking reports from MSHA providing the information listed in Table 2-2. In addition, MSHA provides data on the number of halogen torchieres (and their room location), waterbeds, and freezers replaced in each home.

Daily hours of use for CFLs are typically estimated by the customer during the program audit. While the results of the blower door tests are not included in the tracking reports, they are recorded on the MEAF forms.

Table 2-2: Data Included in Monthly Tracking Reports

Participant	Refrigerator (Old & New Model)	CFLs
• Month Served • LIHEAP Applicant number • Address • Town • Zipcode	• Year • Manufacturer • Model Number • Size (cu. Ft.) • Annual electricity usage (kWh) • Cost for new model	• Room Location • Number of CFLs • Daily Hours of Use • Existing Wattage • Replacement Wattage • Lifetime energy savings (kWh) • Payback period (years) • Cost per CFL

Since the CAP agencies provide the MSHA with the hardcopy MEAF forms for each program audit, the information has to be entered into an electronic spreadsheet in order to track overall program progress; this process can be time-consuming. However, the program is expected to shift to an electronic platform by mid-2008, which will capture electronic data from the CAP agencies. This platform, which LIHEAP is already using, will eliminate the need for data entry on the part of MSHA staff and also allow for easier reporting and queries. While most of the CAP agencies report their program data in a timely manner, one program staffer notes that monthly reports appear to regularly not include data from certain agencies.

Quality Control. The MSHA trains the CAP auditors regarding the LIARP and the steps involved in the auditing process. In addition, MSHA staff review the monthly invoices and check for errors or abnormalities during the data entry process; MSHA will question charges from CAP invoices that appear to be unusual.

MSHA currently conducts onsite inspections at about 5% of homes served by LIARP, though the goal is 10%. MSHA targets CAP agencies that have had problems following program guidelines for the on-sites. The on-sites confirm that the refrigerator is installed, operating correctly, correctly-sized, and is an ENERGY STAR model with a model numbers that matches the paperwork. The on-sites also confirm that the old refrigerator has been removed. In addition, the on-sites confirm that the documented number of CFLs are installed, and that the clients received the educational materials. Finally, the inspections assess client satisfaction by conducting a brief survey. According to one program staffer, the participants are "usually ecstatic" and there are very few complaints.

In addition to the MSHA inspections, most CAP agencies conduct telephone surveys with a random selection of program participants to ensure the clients received the new refrigerator and CFLs, and are satisfied; the CAPs also handle all client complaints.

In terms of other quality assurance measures, the refrigerator vendors provide paperwork to the CAP agencies that verify the refrigerator was delivered (with the client's signature) and documentation that the old refrigerator was properly disposed. Other measures mentioned by CAP agencies include: using the MEAF form, calibrating refrigerator meters, and the one-year refrigerator warranty. While the LIARP does not require post-inspections by the CAP agencies, the Weatherization program does, so piggybacked jobs are inspected.

2.9 Strengths and Weaknesses

Program Strengths. Program staff believe a major benefit of the LIARP is the streamlined administration that uses a single LIHEAP application to deliver the LIARP and other low-income programs. This design results in low administrative costs due to piggybacking with other low-income programs, while providing the convenience of a "one-stop shop" for low-income residents in obtaining comprehensive services. As one CAP staffer puts it "people like CFLs and a new refrigerator. The MSHA payment process is good. It's a better structured program than others. Plus clients save [up to] $30/month."

Several staff members think that the LIARP targets a "real need" by replacing old refrigerators with new ENERGY STAR models, helps reduce household expenses, and educates customers via the face-to-face application process and the audit—one respondent says the program "opens up their eyes to energy conservation". Another says it's "an easy sell for a new refrigerator" and the program "enables [refrigerator] replacement before the [clients] could otherwise [afford]."

One CAP says that it is a "community-based program, not from Augusta; thus it's hooked into the [local] pulse, and funding goes to the community." In addition, one staffer notes the

partnership developed between MSHA and the PUC, and two CAP staff cite the support of the PUC with comments such as it's a "win-win" and their "hopefully long-term [support]."

Program Weaknesses. In terms of communications, the MSHA serves as the 'middleman" between EM and the CAP agencies and also establishes program guidelines and handles direct program management. However, one staffer believes that communication could be improved and that there is "less information available than on other programs." Recent changes to improve communication include the establishment of quarterly meetings between the MSHA and the PUC, plus monthly (rather than quarterly) tracking reports. In addition, several CAP staff members believe that there should be more communication with MSHA, and the program should be more flexible in administration. One suggests that the program "allow CAPs more input on rules based on our judgment regarding the blower door test, refrigerator condition, and fee structure."

Other CAP respondents believe the program should attempt to "reduce time in the house—we do not always need to meter the refrigerator; allow us more flexibility in judgment regarding the refrigerator condition." In addition, one asks "is two hours for metering the refrigerator necessary? We could use the AHAM book or database instead. We use the book for the Weatherization program, and it is simpler. It's worth exploring." One CAP respondent asks "why test really old refrigerators, when we know they will fail? It would be quicker [to not test]."

Several CAP respondents believe that the fee structure is either too low or not fair to rural agencies. One respondent notes that the "fees remain the same as costs increase" and another asks "one size does not fit all regarding the fee structure. Is the program paying for itself?"

Another weakness in the program design is due to the fact that multiple CAP agencies, which are all separate organizations, implement the program; thus, it can be challenging to provide consistent program services, especially regarding CFLs. One staffer says that the program services have become more consistent as the program has matured. However, this staffer also notes that some CAPs are "on board" and effectively promote the program to eligible customers with the appropriate staff devoted to the program; in contrast, other CAP agencies do not have the funding or the staff to promote the LIARP as strongly.

As discussed earlier, a few CAP staff are concerned about the loss of local control when shifting to a statewide refrigerator delivery system. One CAP staffer asks "who would pay for spoiled food if the refrigerator fails? We may lose customer service and warranty service and [have a] longer delivery time too."

Another weakness is the fact that the program reaches only a small fraction of the population; however, one staff member believes that the program may incur greater administrative costs in reaching more customers. Other weaknesses include the long delay for the delivery of piggybacked weatherization projects, the lack of public recognition for the program, and the time-consuming tracking and billing process.

2.10 Budget Expansion

Budget Expansion by 25%. If the program budget were expanded by 25%, several program staff suggest that the program simply serve more households. However, other CAP respondents are concerned about the relatively small number of clients who are eligible for refrigerator replacement under current program guidelines. One suggests allowing the replacement of newer refrigerators saying that "some 1996 and 1997 models are not good." One CAP staffer suggests that the program broaden its income base to reach customers who are not eligible for LIHEAP.

Program staff suggest including hot water heaters as an eligible measure. About one-half of the CAP respondents also suggest this option, due to the high saturation of electric hot water heaters. However, several are concerned about the high cost of replacement (est. $600-$800) and working with electricians or plumbers for the installation. One CAP staffer cautions that it could be a "nightmare to implement. We have trouble finding plumbers and electricians willing to work with us on small jobs."

Several CAP respondents mention that many clients have electric stoves or ovens, so the program should consider adding those measures. In addition, several CAP staff suggest that the program increase the CAP agency fees to cover travel costs. As one respondent says "look at the fee structure, it's the same as four years ago; even a 5% increase [would help]."

Other suggestions include the following:

- One program staff member suggests that the program spend future budget increases on other low-income programs instead of expanding the LIARP.
- Another recommends installing shell measures (such as insulation and sealing air leaks) since the program is already conducting blower door tests.

Budget Expansion by 50%. If the program budget were increased by 50%, program staff believe that the program should add several new eligible measures, such as heat pumps, clothes washers, and room air conditioners. In fact, one program staffer questions whether the pool of low-income customers is large enough to support that level of spending, and that the program would need to expand measures. Two CAP staff recommend that the program "keep whole house usage in mind" and "move beyond appliances and do more weatherization." One suggests the program could provide microwave ovens to clients with electric stoves so they don't use the stove as often; apparently this approach was used in the REACH program.

One CAP respondent thinks that the refrigerator replacement market may become saturated in his region in the near future, and another CAP respondent suggests lowering the test criteria for refrigerators, since the program may be overlooking some models. Several CAP respondents suggest expanding the income eligibility criteria to include the "working poor who fall into coverage gaps."

Other suggestions include targeting electrically heated homes, or homes with older heating systems, and working with landlords to serve low-income tenants assuming that "energy savings are reflected in the rent."

3. Participant Telephone Survey Results

This section presents the findings from the participant telephone survey.

3.1 Program Participation

Program participants most commonly first learned of the program through the CAP agency (29% of respondents) followed by social contacts (such as neighbors, family, friends or co-workers) and while applying for fuel assistance, presumably at their local CAP agency. (Table 3-1) Thus, as expected, nearly one-half recall that they learned of the program through a CAP agency; in addition, another 23% say they received a phone call or a letter about the program, also likely from a CAP agency.

Table 3-1: How Participants First Learned about the Appliance Replacement Program
(Base – All respondents)

How first learned about program	Percent
Through CAP agency	29%
My neighbor, friend, co-worker, or family member told me	20%
While applying for fuel assistance	18%
I received a letter about the program	12%
Someone called me about the program	11%
Other	1%
Don't know	8%
Number of respondents	142

When asked why they chose to participate in the LIARP, respondents most frequently replied that their refrigerator was not working well (41% of respondents) or in order to receive a new refrigerator (38%). (Table 3-2) Concerns about energy or electricity bill savings are cited less frequently (18% and 12% of respondents, respectively) as was the benefit of free CFLs (10% of respondents). This supports the contention of program staff that most people participate in order to replace their old refrigerator, and that energy savings are of secondary importance.

Table 3-2: Why Participants Decided to Participate in the Appliance Replacement Program

(Base – All respondents, multiple responses permitted)

Why participated	Percent
Old refrigerator was not working well	41%
To receive a new refrigerator	38%
To save on electricity bill	18%
To save energy	12%
To receive free CFLs	10%
Low income	3%
To save money, to save on utility bills	1%
To help the environment	1%
Other	1%
Don't know	5%
Number of respondents	142

Only 5% of respondents had concerns about the LIARP before participating. (Table 3-3) These concerns are about their costs, such as whether the refrigerator was actually provided free of charge (four respondents), whether the respondent was eligible (two respondents) and whether the respondent would have to pay something (one respondent).

Table 3-3: Participant Concerns about the Program before Participating

(Base – All respondents)

Had concerns about the program	Percent
Yes	5%
No	94%
Don’t Know	1%
Number of respondents	142

3.2 Refrigerator Replacement

Refrigerators replaced by the program tended to be very old, as over 60% of replaced refrigerators were 16 years old or older, according to survey respondents (62%). (Table 3-4) None of the replaced refrigerators was less than six years old and 91% were 11 years old or

older. These results appear consistent with program guidelines to replace refrigerators manufactured prior to 1995.

Table 3-4: Approximate Age of Replaced Refrigerator

(Base – Respondents who participated in refrigerator replacement program)

Age of replaced refrigerator	Percent
6 to 10 years old	4%
11 to 15 years old	29%
16 to 20 years old	25%
More than 20 years old	37%
Don't know	5%
Number of respondents	117

Nearly all (89%) of the replaced refrigerators were in working condition when the respondents decided to replace them through the program. (Table 3-5)

Table 3-5: Condition of Refrigerator When Respondent Decided to Replace It through the Program

(Base – Respondents who participated in refrigerator replacement program)

Condition of replaced refrigerator	Percent
Refrigerator was in working condition	89%
Refrigerator was not in working condition	11%
Number of respondents	117

All of the replaced refrigerators were the main refrigerators used by respondents; none was a second or supplemental refrigerator. Thus, nearly all refrigerators replaced by the program were plugged in and in use all of the time by respondents. (Table 3-6)

Table 3-6: Frequency that Replaced Refrigerator was Plugged in During Last Year of Use

(Base – Respondents who participated in refrigerator replacement program)

Frequency of use	Replaced Refrigerator (Percent)
All the time	99%
Don’t know	1%
Number of respondents	117

When asked why they replaced their refrigerators, respondents most commonly replied that their old refrigerator was not working well (51% of all respondents), and that they wanted a new refrigerator (49%). (Table 3-7) Fifteen percent of respondents said they wanted to save electricity or that their old refrigerator was inefficient.

Table 3-7: Reasons for Replacing Refrigerator

(Base – Respondents who participated in refrigerator replacement program, multiple responses permitted)

Reasons for replacing refrigerator	Percent
Old refrigerator was not working well	51%
Wanted a new refrigerator	49%
Save electricity; old refrigerator was inefficient	15%
Program recommendation; program replaced it for me	8%
Other	1%
Don't know	1%
Number of respondents	117

Refrigerator Usage in Absence of Program. When asked what they would have done with their refrigerator if the program had not been available, 70% of respondents replied that they would have continued to use the old refrigerator. (Table 3-8) Few respondents, 14%, would have purchased a new refrigerator.

Table 3-8: What Respondents Would Have Done with Refrigerator without Program

(Base – Respondents who participated in refrigerator replacement program)

What would have done without the program	Percent
Continued to use it	70%
Kept it but not used it	5%
Given it away or sold it	5%
Bought a new one	14%
Or would you have done something else?	2%
Don't know	4%
Number of respondents	117

Of those respondents who would have purchased a refrigerator without the program, nearly one-third (five of 16) would have waited six months or less to purchase the new refrigerator while nearly another one-third (five of 16) would have waited until the refrigerator broke. (Table 3-9)

Table 3-9: Length of Time Respondents Would Wait to Purchase a New Refrigerator on Their Own

(Base – Respondents who would have purchased a new refrigerator without the program)

Length of time	n
6 months or less	5
6 months to one year	1
1 to 2 years	1
3 to 5 years	1
Until the old unit broke	5
Don't know	3
Number of respondents	16

Program Refrigerator. Nearly all of the refrigerators provided by the program, 99%, are the main refrigerators used by the respondents. (Table 3-10) For the one respondent who responded "Don't Know," it is likely that the new model is the main refrigerator, as all of the replaced models were the main refrigerator.

Table 3-10: Type of Refrigerator Provided by the Program

(Base – Respondents who participated in refrigerator replacement program)

Type of refrigerator	Percent
Main refrigerator	99%
Don't Know	1%
Number of respondents	117

Nearly all of the new refrigerators provided by the program are plugged in and in use all of the time by respondents. (Table 3-11)

Table 3-11: Frequency that New Refrigerator is Plugged in

(Base – Respondents who participated in refrigerator replacement program)

Frequency of use	Percent
All the time	99%
Don't know	1%
Number of respondents	117

Nearly all refrigerators, 98%, are located in the respondents' kitchens. (Table 3-12)

Table 3-12: Location of New Refrigerator
(Base – Respondents who participated in refrigerator replacement program)

Location	Percent
Kitchen	98%
Dining room	1%
Not in the house	1%
Number of respondents	117

Nearly all program provided refrigerators, 95%, are located in a heated space in winter, while 62% of the program refrigerators are located in cooled spaces in the summer. (Table 3-13)

Table 3-13: Refrigerators Located in Heated and Cooled Spaces
(Base – Respondents who participated in refrigerator replacement program)

	Refrigerator is located in heated space in winter	Refrigerator is located in cooled space in summer
Yes	95%	62%
No	4%	34%
Don't know	1%	3%
Number of respondents	117	117

3.3 CFL Impact Parameters

This section presents impact parameter estimates derived from the results of the telephone survey of LIARP participants and program data recorded by CAP staff during the program audit. For most tables displaying data on bulb installations, comparative use of bulbs, and hours of use, the percentages reported are adjusted for the number of CFLs reported by respondents in the participant survey. Because of the variability in the number of bulbs provided by the program to participants, we believe it is more appropriate to adjust bulb installations, comparative use, and hours of use by the number of CFLs reported by respondents. Thus, the results to these questions are weighted by the number of CFL bulbs provided to each respondent.

The wattage replacement data are based on program auditor data. Because program auditors are expected to remove incandescent bulbs and replace them with CFLs during the home audit, the telephone survey did not ask participants for the wattage of the incandescent bulbs removed nor the wattage of the CFLs installed. This was done because it was assumed that the respondents would not recall the wattages as they were not involved in the removal or installation process.

CFL Installations and Removals. We used a two-step process to estimate the total number of CFLs provided to respondents. First, using data from program records, we asked respondents if they could confirm the number of CFLs provided by energy auditors. If the respondent confirmed the number, we used the number from the program records as the actual number of CFLs installed. For those who said that a different number of CFLs was provided, we recorded the number they recalled as the actual number provided.

Table 3-14 displays the number of CFLs respondents recall being provided through the program; on average, program participants had 8.5 bulbs installed.

Table 3-14: Number of CFLs Provided through the Program
(Base - All respondents)

	n	Number of Respondents
Number Obtained	1,208	142
Average per respondent	8.5	142

Table 3-15 summarizes the installation status of products installed through the program as reported by survey participants. We asked respondents how many of the CFLs provided by the program were installed in their homes at the time of the interview. If all the CFLs were not installed, we asked respondents to estimate the number of CFLs that they had removed. The remainder represents the not-yet-installed CFLs.

Ninety percent of the CFLs provided by the program are currently installed, according to respondents. Few CFLs (3%) have been removed by respondents, while the remaining CFLs (7%) have never been installed.

Table 3-15: Number of CFLs Reported as Installed, Removed, or Not Yet Installed
(Base - All respondents)

Statistic	Installed	Removed	Not Yet Installed
n	1,085	42	81
Percent	90%	3%	7%

Table 3-15 displays both the numbers and the proportions of CFLs that are currently installed, as reported, as well as the numbers and proportions of CFLs respondents plan to install in the coming year. In total, respondents have installed or plan to install 94% of CFLs provided by the program.

Table 3-16: Number of CFLs Reported as Installed and Plan to Install

(Base - All respondents)

Statistic	Installed	Plan to Install within Next Year	Cumulative Installations within Next Year
n	1,085	53	1,138
Percent	90%	4%	94%

For the handful of respondents who did remove a CFL from service, most say they either threw the bulb away or put it away. (Table 3-17)

Table 3-17: What Respondent Reported Having Done with CFLs that Were Removed

(Base – Respondents who removed bulbs from service, multiple responses permitted) [a]

Disposition reported	n
Threw bulbs away	9
Put the bulbs away	3
Recycled the bulbs	2
Don't remember	2
Number of Respondents	16

[a] Number of respondents shown, rather than percentage, due to small sample sizes.

Respondents most commonly removed a CFL because it burned out (seven of 16 respondents) or because it broke (four of 16 respondents). Few respondents removed CFLs because of light quality (Table 3-18).

Table 3-18: Reasons for Removing CFLs

(Base – Respondents who removed bulbs from service) [a]

Reason CFL was removed	n
Burned out	7
Broke	4
Bulb is not bright enough	2
Light beginning to dim	1
Other	1
Don't know	1
Number of Respondents	16

[a] Number of respondents shown, rather than percentage, due to small sample sizes.

Respondents who reported throwing away or recycling CFLs most frequently threw them in the garbage (ten of 22 respondents), followed by six respondents saying they still have the bulbs and do not know how to dispose of them. (Table 3-19) Only one respondent reported bring the CFLs to a store that recycles CFL bulbs.

Table 3-19: How Respondent Reported Having Disposed CFLs that Were Thrown Away or Recycled

(Base – Respondents who reported throwing away or recycling CFLs, multiple responses permitted) [a]

Method of disposal	n
Disposed of them with the garbage	10
Still have the bulbs; don't know how to dispose of them	6
Disposed of them with hazardous waste	1
Brought them to a store that recycles CFLs	1
Other	1
Don't know	5
Number of Respondents	22

[a] Number of respondents shown, rather than percentage, due to small sample sizes.

Table 3-20 lists what respondents say they did with the CFLs that they have yet to install; nearly all indicate that they put the bulbs away (presumably for later use). A few respondents either gave the bulbs away, returned the bulbs to the auditor, or installed the bulbs elsewhere in the state.

Table 3-20: What Respondents Report Having Done with CFLs Never Installed

(Base - All bulbs not yet installed, multiple responses permitted)[a]

Disposition reported	N
Put the bulbs away	17
Gave the bulbs away	2
Returned the bulbs to the auditor	1
Installed the bulbs at another address	1
Don't remember	1
Number of Respondents	22

[a] Number of respondents shown, rather than percentage, due to small sample sizes.

Of the respondents who had not installed all of the CFLs provided by the program, nearly all were unable to offer a reason as to why the CFLs had not been installed. (Table 3-21) However, two respondents were not satisfied with the quality of the light.

Table 3-21: Reasons Given for Not Installing CFLs

(Base - All bulbs not yet installed, multiple responses permitted) [a]

Reason	n
Not satisfied with the light quality (of the CFL)	2
Bulbs don't fit the fixture	1
Keep the bulbs as spares	1
Bulbs contain mercury	1
Other	1
Don't know	14
Number of Respondents	19

[a] Number of respondents shown, rather than percentage, due to small sample sizes.

Bulb Replacement. Table 3-22 displays the reported dispositions of those bulbs that were installed, whether replacing an incandescent bulb, replacing another CFL, or being installed into a new fixture. The percentages in the table are adjusted for the number of CFLs per respondent, as reported in the participant survey. Nearly all CFLs replaced incandescent bulbs (96%). Sixty four percent of respondents installed six or more bulbs.

Table 3-22: CFLs Reported as Installed to Replace Existing Bulbs or to Put into New Fixtures

(Base - All respondents with CFLs installed)[13]

Number of CFLs	Replace Incan-descent Bulbs	Replace Another CFL	New Fixture
n	141	141	141
0	1%	96%	97%
1	2%	0%	1%
2-5	32%	4%	1%
6-10	45%	1%	0%
More than 10	19%	0%	1%
Total Number of CFLs	1,041	21	23
% of CFLs Installed	96%	2%	2%

[13] The percentages of reported installations are adjusted for the number of CFLs per respondent from the participant survey data.

Table 3-23 displays the percentage of program CFLs reported as installed in each room. CFLs are most often installed in living rooms, followed by kitchens, bedrooms and bathrooms.

Table 3-23: Percent of CFLs Reported as Installed in Each Room
(Base - All respondents with CFLs installed)[14]

Room	n	% of CFLs
Living Room	103	24%
Kitchen	107	24%
Bedroom	92	21%
Bathroom	64	12%
Dining Room	25	5%
Hallway	34	5%
Den	10	2%
Cellar	7	2%
Laundry	12	1%
Spare Room	5	1%
Other room	5	1%
Entry	4	1%
Office	2	0%
Addition	1	0%
Utility Room	1	0%
Stairway	1	0%
Pantry	0	0%

[14] The percentages of reported installations are adjusted for the number of CFLs per respondent from the participant survey data.

Wattage Replaced. Since program auditors are expected to remove incandescent bulbs and replace them with CFLs during the home audit, the telephone survey did not ask participants for the wattage of the incandescent bulbs removed nor the wattage of the CFLs installed. This was done because it was assumed that the respondents would not recall the wattages as they were not involved in the removal or installation process. Thus, this analysis relies on the data recorded by the auditors regarding the wattage of the removed bulbs and program-provided CFLs.

Table 3-24 is based on program data provided by auditors and reports the average wattage of bulbs replaced, CFLs installed, and per-bulb wattage reduction, by room and overall. It is important to note that respondents may have removed bulbs between the time of the audit and the survey, so replacement wattage estimates may include some minor errors. According to program data, the average wattage of replaced bulbs was 63.8 watts. Over one-half of all replaced bulbs were 60-watt bulbs, followed by 75-watt bulbs, 40-watt bulbs, and 100-watt bulbs. The per-bulb wattage varied across rooms, with bulbs replaced in dens having the highest per-bulb average and bathrooms the lowest.

The average wattage of installed CFLs was 16.1 watts. The most commonly installed CFL wattage were 15-watt bulbs, followed by 20-watt bulbs, 14-watt bulbs, 13-watt bulbs, 11-watt bulbs, and 25-watt bulbs. As with the bulbs they replaced, the per-bulb wattage varied across rooms, with installed CFLs in dens having the highest per-bulb average and bathrooms the lowest.

In order to calculate the wattage reduction (not wattage replacement), the estimated average wattage of the program CFLs was subtracted from the estimated average replaced wattage. CFLs provided by the program are estimated to displace an average of 47.7 watts per installed bulb. Wattage reduction varies by room, with the highest per-bulb wattage reduction occurring in dens, followed by living rooms.

Table 3-24: Estimated Average Wattage, per Bulb, of Bulbs Replaced by CFLs in Each Room and Overall

(Base - All respondents replacing existing bulbs with CFLs in each room)

Room	n	Ave. Watts per Bulb Replaced[a]	Ave. Watts per CFL Bulb Installed[a]	Ave. per Bulb Watts Reduction[a]
Kitchen	109	62.0	15.5	46.5
Living Room	107	66.8	16.7	50.0
Bedroom	89	63.4	16.3	47.2
Bathroom	61	57.6	14.7	42.9
Hallway	36	60.7	15.1	45.6
Dining Room	25	62.0	15.7	46.3
Laundry	14	63.4	16.1	47.3
Den	11	70.3	17.7	52.6
Overall	142	63.8	16.1	47.7

[a] Note that we do not display results for rooms where the sample size is less than 10.

While the data in Table 3-24 provide an estimate of the average per-bulb wattage replaced, the data in Table 3-25 offer estimates of the average wattage replaced, installed, and reduced *by room* for all CFLs located in that room. Living rooms have the most wattage replaced, followed by bedrooms, kitchens and dining rooms, most likely because respondents tend to install more CFLs in those rooms (or, in the case of bedrooms, they are considering multiple rooms as one category). Overall, each respondent had an average of 545.6 watts replaced by CFLs throughout the entire home.

Living rooms have the highest average per room wattage installed, followed by bedrooms, kitchens and dining rooms. Overall, each respondent had an average of 137.8 watts of CFLs installed throughout the entire home. The highest per-room wattage reduction occurred in living rooms, followed by bedrooms, kitchens and dining rooms. Overall, each respondent had an average of 407.8 watts reduced throughout the entire home by the program.

Table 3-25: Estimated Average Wattage per Room of Bulbs Replaced by CFLs

(Base - All respondents replacing existing bulbs with CFLs in each room)

Room	n	Ave. Watts per Room Replaced[a]	Ave. Watts per Room Installed[a]	Ave. Watts per Room Reduction[a]
Kitchen	109	171.8	42.9	128.8
Living Room	107	195.3	48.9	146.4
Bedroom	89	187.5	48.1	139.3
Bathroom	61	129.3	33.0	96.3
Hallway	36	87.6	21.8	65.8
Dining Room	25	163.8	41.5	122.3
Laundry	14	113.2	28.8	84.4
Den	11	121.4	30.5	90.8
Overall	142	545.6	137.8	407.8

[a] Note that we do not display results for rooms where the sample size is less than 10.

Comparative Usage. Behavioral changes due to program participation can affect energy usage. Customers may leave their new lights on longer since they cost less to operate, which reduces energy savings. Of course, customers may also use their new lights less or use them more, but instead of other presumably less efficient bulbs or fixtures. In these situations, energy savings are greater. These effects are generally referred to as snapback and snapforward, respectively. In order to remain consistent with the analysis utilized in the previous Efficiency Maine lighting evaluation[15], we do not adjust the energy savings estimates by snapback and snapforward; instead, we provide the information solely for information purposes.

The survey asked customers whether they used each light more, less, or the same as the light it replaced. A fourth option was "more, but instead of others." Table 3-26 indicates that respondents report the majority of CFLs (66%) are being used "to the same extent" as the bulbs they replaced, while 23% are being used more than the bulb it replaced and 7% are being used less.[16] The comparative usage of installed CFLs is fairly consistent across room type – most are used "to the same extent as the one replaced," though CFLs appear to be more likely to be used more often in the entry, living room, laundry room and kitchen. .

Table 3-26: Reported Use of Installed CFLs Compared to the Bulbs that Were Replaced, by Room

(Base - All respondents replacing existing bulbs with CFLs)

Room [a]	n [a]	More than one replaced	More than one replaced but instead of others	To the same extent as the one replaced	Less than the one replaced	Don't Know
Living Room	114	27%	0%	61%	7%	6%
Kitchen	110	26%	0%	62%	6%	6%
Bedroom	94	20%	0%	72%	7%	1%
Bathroom	66	20%	0%	73%	5%	2%
Hallway	37	18%	3%	63%	10%	5%
Dining Room	27	17%	0%	53%	16%	13%
Laundry	12	19%	0%	74%	6%	0%
Den	10	0%	0%	100%	0%	0%
Total	**142**	**23%**	**0%**	**66%**	**7%**	**4%**

[a] Note that we do not display results for rooms where the sample size is less than 10.

[15] Process and Impact Evaluation of the Efficiency Maine Lighting Program. NMR and RLW. 2007.

[16] The percentages of reported usage are adjusted for the number of CFLs per respondent from the participant survey data.

Hours of Use. In order to derive the estimates of seasonal hours of use, respondents were asked to estimate for each room, on average, how many hours of the day they typically used the CFLs obtained through the program in the spring/summer months and, in a separate question, during the fall/winter months.

Table 3-27 shows the reported overall average daily hours of use per bulb; the estimates are based on the sum of the total hours across rooms, divided by the total number of bulbs, as reported by program participants. Program participants report daily usage of 2.6 hours in the spring/summer and 3.8 hours in the fall/winter.

Table 3-27: Reported Average Daily Hours of Use per Bulb by Season
(Base - All respondents installing CFLs)[17]

Program	Average Daily Hours	Number of Respondents
Spring/summer	2.6	141
Fall/winter	3.8	141
Overall[a]	3.2	141

[a] We assume that survey respondents were interpreting both fall/winter and spring/summer as each occupying six months of the year. Thus the annual estimate is an average of the two seasonal figures.

In contrast to Table 3-27**Error! Reference source not found.**, which presents reported hours of use per bulb, Table 3-28 displays the reported average hours of use of CFLs across the entire household. In order to account for multiple installations and provide a more complete accounting of usage, we multiplied the average hours customers say they use bulbs in each room by the total number of bulbs installed in that room. Therefore, if a program participant is using four CFLs for eight hours a day, that person is using an equivalent of 32 “bulb hours” each day.

[17] The percentages of reported installations are adjusted for the number of CFLs per respondent from the participant survey data.

Because of the relatively large number of CFLs provided per household (8.5 per household), the estimated average daily usage of all CFLs is relatively large, 24.9 hours per day. (Table 3-28**Error! Reference source not found.**) The estimated average daily usage is 20.2 hours per day in spring/summer and 29.5 hours per day in fall/winter.

Table 3-28: Reported Average Daily Hours of Use per Household by Season (cumulative bulb hours per home, including multiple CFLs)

(Base - All respondents installing CFLs)[18]

Season	Average Daily Hours	Number of Respondents
Spring/summer	20.2	141
Fall/winter	29.5	141
Overall	24.9	141

Table 3-29**Error! Reference source not found.** displays the average hours per bulb and average hours per room that CFLs are used, by room location. The locations with the highest usage are the kitchen, living room and den.

Table 3-29: Reported Average Daily Hours of Use of CFLs by Season and Room

(Base - All respondents installing CFLs)[19]

Location	n	Spring/summer Hours		Fall/winter Hours	
		Avg per Bulb[c]	Avg per Room[c]	Avg per Bulb[c]	Avg per Room[c]
Living room	113	2.8	6.6	4.2	10.0
Kitchen	109	3.5	8.4	4.8	11.7
Bedroom	94	2.0	5.0	3.5	8.6
Bathroom	65	2.2	4.5	2.8	5.7
Hallway	36	2.4	3.2	2.7	3.6
Dining room	27	2.3	4.9	3.4	7.3
Laundry	12	1.0	1.3	1.6	2.1
Den	10	3.3	6.3	5.3	10.0

[c] Note that we do not display results for rooms where the sample size is less than 10.

[18] The percentages of reported installations are adjusted for the number of CFLs per respondent from the participant survey data.

[19] The percentages of reported installations are adjusted for the number of CFLs per respondent from the participant survey data.

3.4 Program Satisfaction

All respondents are satisfied with the program overall, with 85% very satisfied. (Table 3-30**Error! Reference source not found.**)

Table 3-30: Overall Satisfaction with the Program
(Base – All Respondents)

Level of satisfaction	Percent
Very satisfied	85%
Satisfied	15%
Neither satisfied nor dissatisfied	0%
Dissatisfied	0%
Very dissatisfied	0%
Number of respondents	142

Only three percent of respondents reported a complaint to program staff. (Table 3-31**Error! Reference source not found.**) Of those who reported a complaint, two of three respondents are not satisfied with the resolution of the complaint.

Table 3-31: Complaints Reported to the Program Staff
(Base – All Respondents)

Recorded a complaint	Percent
No	98%
Yes	3%
Number of respondents	142

Satisfaction with Audit. Overall, nearly all respondents (97%) are very satisfied or satisfied with the energy audit they received from the program. (Table 3-32) The single respondent who is dissatisfied with the energy audit reported that it was due to not receiving a refrigerator (likely because it did not qualify for replacement).

Satisfaction with the information received during the energy audit was very high, with 94% of respondents replying they are very satisfied or satisfied. Satisfaction with the time it took to receive the initial energy audit was also very high, with 98% of respondents very satisfied or satisfied.

Table 3-32: Satisfaction with the Energy Audit
(Base – All Respondents)

Level of satisfaction	Energy Audit	Information Received During the Energy Audit	Time it Took to Receive the Initial Energy Audit
Very satisfied	76%	75%	78%
Satisfied	21%	19%	20%
Neither satisfied nor dissatisfied	1%	1%	1%
Dissatisfied	0%	1%	0%
Very dissatisfied	1%	1%	1%
Don't know	1%	2%	1%
Number of respondents	142	142	142

Nearly all respondents think that the auditor who provided the energy audit was very courteous or courteous and nearly all believe that the auditor who provided the energy audit was very knowledgeable or knowledgeable. (Table 3-33)

Table 3-33: Courteousness of Auditor
(Base – All Respondents)

Level of courtesy	Percent
Very courteous	94%
Courteous	5%
Neither courteous or discourteous	1%
Don't know	1%
Level of knowledge	
Very knowledgeable	89%
Knowledgeable	8%
Not knowledgeable	1%
Don't know	2%
Number of respondents	142

Satisfaction with Refrigerator Replacement. Almost all respondents are very satisfied or satisfied (94% overall) with the refrigerator they received through the program. (Table 3-34) Both respondents who are dissatisfied with the new refrigerator report that it is broken or needs repairs; one respondent also says the refrigerator is not large enough.

Nearly all respondents are very satisfied or satisfied (99%) with the time it took to receive the refrigerator through the program and with the quality of the service from the company that delivered the new refrigerator (98%). (Table 3-34) The single respondent who is dissatisfied with the quality of service reported that the refrigerator was dented and scratched.

Table 3-34: Satisfaction with New Refrigerator Received Through the Program
(Base – Respondents who participated in refrigerator replacement program)

Level of satisfaction	New Refrigerator Received Through the Program	Time it Took to Receive the Refrigerator	Quality of Service from the Company that Delivered the New Refrigerator
Very satisfied	79%	83%	90%
Satisfied	15%	16%	8%
Neither satisfied nor dissatisfied	3%	0%	2%
Dissatisfied	1%	0%	1%
Very dissatisfied	1%	1%	0%
Don't know	1%	0%	0%
Number of respondents	117	117	117

Satisfaction with CFLs. The program requires that auditors remove incandescent bulbs and replace them with CFL bulbs. However, when asked how many of the CFLs provided by the program were installed by the auditor, 55% of respondents report all or most bulbs were installed by the auditor while 41% report that none of the bulbs were installed by the auditor. (Table 3-35)

Table 3-35: Number of CFLs Installed by Program Auditor
(Base - All respondents)

	Percent
All	43%
Most	12%
Some	4%
None	41%
Don't know	1%
Number of Respondents	141

Auditors from different CAP agencies tend to either install all the bulbs provided or none of the bulbs. (Table 3-36) According to respondents, some CAP agencies, such as Aroostook and Western Maine, are more likely to install all CFLs, while other CAP agencies, such as Penquis and Waldo, are more likely to install none of the CFLs. This suggests that different auditors at a given agency may have differing practices regarding the installation of CFL bulbs, though these self-reported results should be interpreted with caution.

Table 3-36: Number of CFLs Installed by Program Auditor, by CAP Agency*

(Base - All respondents)

	Number of CFLs Installed by Program Auditor					
Agency	**All**	**Most**	**Some**	**None**	**Don't Know**	**Number of Respondents**
Aroostook County Action Program	61%	6%	6%	28%	61%	18
Penquis Community Action Program	23%	9%	0%	68%	23%	22
Community Concepts, Inc.	45%	27%	0%	27%	45%	22
Coastal Economic Development Corp.	3	1	1	0	0	5
Kennebec Valley Community Action Program	5	2	0	6	0	13
People's Regional Opportunity Program	27%	7%	7%	53%	7%	15
Waldo Community Action Partners	2	0	1	6	0	9
Washington-Hancock Community Agency	33%	13%	7%	47%	0%	15
Western Maine Community Action	10	1	0	1	0	12
York County Community Action Program	5	1	0	4	0	10
Number of respondents	43%	12%	4%	41%	1%	141

*The number of respondents, rather than the percent of respondents, are presented for some CAP agencies due to small sample sizes.

The program also requires that auditors leave the old incandescent bulbs at the home. For those respondents who had at least some CFLs installed by the auditor, 45% report that the removed bulbs were left at their home while 32% report that the auditor took the bulbs with them when the audit was complete. (Table 3-37) There is very little variation among the different CAP agencies with the exception of Aroostook CAP, whose auditors are much more likely to leave the bulbs at the house than auditors from other CAPs.

Table 3-37: How Auditor Disposed of Replaced Bulbs

(Base – Respondents who had at least some bulbs installed by auditor)

Method of Disposal	Percent
Left bulbs at the house	45%
Took the bulbs away	32%
Threw the bulbs away	4%
Other	1%
Don't know	18%
Number of Respondents	82

Nearly all respondents who report receiving CFLs (95%) are very satisfied or satisfied with the CFLs they received from the program. (Table 3-38) Only one respondent is dissatisfied.

Table 3-38: Satisfaction with the CFLs Provided by the Program

(Base –Respondents who reported receiving CFLs through the program)

Level of satisfaction	Percent
Very satisfied	78%
Satisfied	17%
Neither satisfied nor dissatisfied	4%
Dissatisfied	1%
Very dissatisfied	0%
Don't know	1%
Number of respondents	140

3.5 Program Effects on Participants

Sixty percent of program participants report that their electricity bill has decreased a lot (33%) or decreased a little (27%) since participating in the program. (Table 3-39) However, 10% report that their electricity bills have increased. Note that the interviews were conducted in September 2007 and respondents participated in the LIARP during 2006.

Table 3-39: Change in Electricity Bill Since Participating in the Program
(Base – All Respondents)

Level of change	Percent
Decreased a lot	33%
Decreased a little	27%
Stayed about the same	18%
Increased a little	6%
Increased a lot	4%
Don't know	12%
Number of respondents	142

Of those respondents who report a decreased electricity bill, most (58%) report that their bill has decreased by less than $20 per month; this figure equals 35% of all respondents. (Table 3-40)

Table 3-40: Estimated Change in Electricity Bill Since Participating in the Program
(Base – Respondents reporting that their electricity bill decreased)

Level of change	Percent of respondents with decreased electricity bill	Percent of all respondents
Less than $10 per month	25%	15%
$10 to $19 per month	33%	20%
$20 to $29 per month	19%	11%
$30 to $39 per month	2%	1%
$40 to $49 per month	2%	1%
$50 or more per month	5%	3%
Don't know	14%	8%
Number of respondents	85	142

Behavioral Changes. Nearly two-thirds of all respondents (64%) report that the information from the energy audit has changed their energy use behavior. (Table 3-41) Note, however, that these self-reported changes may not reflect actual changes in energy use behavior. We analyzed the reported electricity bill savings and reported changes in energy use, and did not find any trends that indicate that changes in energy use influenced the electricity bill savings.

Table 3-41: Impact of Information from the Energy Audit on Respondents' Energy Use Behavior

(Base – All Respondents)

Energy behavior has changed	Percent
Yes	64%
No	32%
Don't know	4%
Number of respondents	142

For those respondents whose energy use behavior has changed, the most common change is turning off lights (42% of all respondents), followed by using CFLs (15%) and setting the heating thermostat lower (11%). (Table 3-42)

Table 3-42: Changes to Respondent's Energy Use Behavior

(Base – Respondents who have changed their energy use behavior, multiple responses permitted)

How information changed behavior	Percent of respondents whose energy use has changed	Percent of all respondents
I turn off my lights now	67%	42%
Use CFLs	24%	15%
Set heating thermostat lower	18%	11%
Set water heater thermostat lower	8%	5%
Try to save energy; more aware of energy	7%	4%
Use less hot water to wash clothes	4%	3%
Use appliances less; unplug appliances	4%	3%
Recycle more	2%	1%
Seal gaps in house; insulate	2%	1%
Use fans instead of air conditioning	1%	1%
More aware of ENERGY STAR label	1%	1%
Other	8%	5%
Don't know	6%	4%
Number of respondents	90	142

Seventy-six percent of respondents report that there have not been changes in their household that may affect electricity usage since participating in the program, while roughly equal numbers reply that changes occurred that could decrease usage (5%) or increase usage (7%). (Table 3-43) Interestingly, twelve of the fifteen respondents who reported that their electricity bill has increased report no changes in their households that may have affected electricity usage.

Table 3-43: Changes in Household that May Have Affected Electricity Usage Since Participating in the Program

(Base – All Respondents)

Type of change	Percent
No change	76%
Addition of a major electric appliance	6%
Fewer people living in the home	4%
More people living at home	1%
Do not use the air conditioning as much	1%
Other	1%
Don't know	11%
Number of respondents	142

Of the respondents who report that their electricity bill has decreased since participating in the program, 80% are very satisfied with their electricity savings and 19% are satisfied; these figures equal 48% and 11% of all respondents, respectively.

Table 3-44: Satisfaction with the Electricity Savings

(Base – Respondents reporting that their electricity bill decreased)

Level of satisfaction	Percent of respondents with decreased electricity bill	Percent of all respondents
Very satisfied	80%	48%
Satisfied	19%	11%
Neither satisfied nor dissatisfied	1%	1%
Dissatisfied	0%	0%
Very dissatisfied	0%	0%
Number of respondents	85	142

3.6 Other Appliances

This section presents information on the saturation and age of specific appliances in respondents' homes, in order to provide information about potential opportunities for the program.

Water Heaters. The most common fuel used by respondents' water heaters is electricity (53%), followed by oil (30%) and bottled gas (10%). (Table 3-45)

Table 3-45: Type of Fuel Used by Water Heater
(Base – All Respondents)

Type of fuel	Percent
Electricity	53%
Oil	30%
Bottled gas (LP, propane, butane)	10%
Natural gas	5%
Kerosene	1%
Don't know	2%
Number of respondents	142

For those respondents with electric water heaters in their homes, 39% of units are 11 years or older; this figure equals 22% of the entire population, assuming those respondents who replied "Don't Know" follow the same distribution as those respondents who reported an age (Table 3-46) Given that it is common for water heaters to be warranted for seven years, even more than 22% may be good candidates for early replacement.

Table 3-46: Age of Electric Water Heater
(Base –Respondents with an electric hot water heater)

Age of electric hot water heater	Percent of respondents with electric water heaters	Percent of all respondents
0 to 5 years	31%	16%
6 to 10 years	20%	11%
11 to 15 years	24%	13%
16 to 20 years	8%	4%
More than 20 years	7%	4%
Don't know	11%	6%
Number of respondents	75	142

Room Air Conditioners. Forty-eight percent of respondents have room air conditioners in their homes. (Table 3-47)

Table 3-47: Presence of Room Air Conditioners in Home
(Base – All Respondents)

Room air conditioners in home	Percent
Yes	48%
No	51%
Don't know	1%
Number of respondents	142

The mean number of room air conditioners for those respondents with room air conditioners in their home is about 1.5, with 57% having one and 40% having two. (Table 3-48)

Table 3-48: Number of Room Air Conditioners in Home
(Base – Respondents with room air conditioners in home)

Number of room air conditioners	Percent of respondents with room air conditioners	Percent of all respondents
One	57%	27%
Two	40%	19%
Three	1%	1%
Four	1%	1%
Mean	1.5	0.7
Number of respondents	68	142

Room air conditioners tend to be relatively new, with 77% five years old or younger, according to survey respondents. (Table 3-49) Only 4% are over ten years in age.

Table 3-49: Approximate Age of Room Air Conditioners in Home
(Base – Respondents with room air conditioners in home)

Age of room air conditioners	Percent of respondents with room air conditioners	Percent of all respondents
0 to 5 years	77%	37%
6 to 10 years	24%	11%
11 to 15 years	2%	1%
16 to 20 years	2%	1%
Don't know	6%	3%
Number of respondents	68	142

Dehumidifiers. Only 20% of respondents have dehumidifiers in their homes. (Table 3-50)

Table 3-50: Presence of Dehumidifiers in Home
(Base – All Respondents)

Dehumidifiers in home	Percent
Yes	20%
No	80%
Don't know	1%
Number of respondents	142

Dehumidifiers, like room air conditioners, tend to be relatively new with 61% five years old or younger. (Table 3-51) However, 18% of dehumidifiers are more than 20 years old.

Table 3-51: Approximate Age of Dehumidifiers in Home
(Base – Respondents with dehumidifiers in home)

Age of dehumidifiers	Percent of respondents with dehumidifiers	Percent of all respondents
0 to 5 years	61%	12%
6 to 10 years	11%	2%
11 to 15 years	4%	1%
16 to 20 years	4%	1%
More than 20 years	18%	4%
Don't know	4%	1%
Number of respondents	28	142

Nightlights. Thirty nine percent of respondents use nightlights at home. (Table 3-52)

Table 3-52: Use of Nightlights in Home
(Base – All Respondents)

Use nightlights	Percent
Yes	39%
No	61%
Don't know	1%
Number of respondents	142

The average number of night lights for those respondents with night lights in their home is 1.7. (Table 3-53) Respondents use their night lights for an average of 8.8 hours per night.

Table 3-53: Number of Night Lights in Home
(Base – Respondents with night lights in home)

Number of night lights	Percent of respondents with night lights in their homes	Percent of all respondents
One	56%	34%
Two	24%	15%
Three	15%	9%
Four	5%	3%
Mean number of night lights	1.7	1.0
Mean daily hours of use	8.8	5.3
Number of respondents	86	142

According to survey respondents, one-half of their night lights use incandescent bulbs, followed by light sensitive lights (14%), compact fluorescents and LEDs (7% each). (Table 3-54)

Table 3-54: Types of Night Lights in Home
(Base – Respondents with night lights in home)

Type of bulb	Percent of respondents with night lights in their homes	Percent of all respondents
Incandescent	50%	30%
Light sensitive	14%	8%
Compact fluorescent	7%	4%
LED	7%	4%
Don't know	26%	15%
Number of respondents	86	142

3.7 Demographics

We asked survey respondents a short series of demographic questions to better understand who has participated in the LIARP. The survey respondents' self-reported demographic characteristics are compared to the demographic characteristics of households in the state of Maine as reported in the 2006 American Community Survey (ACS) implemented by the U.S. Bureau of the Census. Since the LIARP serves customers who enroll in the LIHEAP program[20], we expect that program participants will earn lower-incomes than Maine residents as a whole. Since the program requires participants to own the refrigerator and pay their electric bill, we also would expect them to mostly be homeowners.

[20] Note that demographic data for LIHEAP participants from the state of Maine was not available, which would have provided a more relevant group for demographic comparisons.

As expected, compared to the general population in Maine, more LIARP participants (89%) own their own homes (Table 3-55).

Table 3-55: Homeownership Status

Homeownership	LIARP	ACS 2006
Own	89%	73%
Rent	10%	27%
Other	1%	n/a
Number of respondents	142	548,247

Seventy-three percent of respondents live in single family homes and 25% live in mobile homes. In comparison, 68% of households from the ACS survey live in single-family homes and only 9% live in mobile homes (Table 3-56). As expected, a higher proportion of the general population (12%) than respondents (2%) live in multifamily buildings, which are more likely to be rental units whose tenants tend be ineligible for the program.

Table 3-56: Type of Residence

Residence Type	LIARP	ACS 2006
Single family home	73%	68%
Duplex or two family home[a]	1%	6%
Apartment or condo in a 2-4 unit building[b]	1%	6%
Mobile home, house trailer	25%	9%
Number of respondents	139	691,164
Number of respondents refusing	3	

[a] 2 units for ACS data
[b] 3 to 4 units for ACS data

Over one-half of all respondents (55%) live in single person households compared to just 27% of the general population.[21] (Table 3-57) Respondents report smaller average household sizes than are found in the general population—1.8 compared to 2.3 persons.

Table 3-57: Size of Household

Household Size	LIARP	2000 Census
One person	55%	27%
Two people	27%	37%
Three people	7%	16%
Four people	6%	13%
Five people	4%	5%
Six or more people	1%	2%
Average number	1.8	2.3
Number of respondents	142	518,200

Program participants tend to be older than the general population, with 81% being older than 55 years of age, compared to 36% of the general population (Table 3-58). Because the program primarily serves homeowners, the participants tend to be older.

Table 3-58: Age of Respondent or Householder

Age Category	LIARP	ACS 2006
18 to 24 years[a]	0%	8%
25 to 34 years	4%	15%
35 to 44 years	6%	19%
45 to 54 years	9%	22%
55 to 64 years	23%	17%
65 or more years	58%	19%
Number of respondents	141	1,005,316[b]
Number of respondents refusing	1	

[a] Age 20-24 years for ACS data
[b] Population 20 years and older for ACS data

[21] The ACS does not report household size data, so data from the 2000 Census was used for this comparison

Program participants tend to have less formal education than the general population. Twelve percent of program participants have a college degree or beyond, compared to 26% of the general population (Table 3-59).

Table 3-59: Educational Attainment

Formal Schooling Completed	LIARP	ACS 2006
Less than high school	22%	11%
High school graduate	43%	37%
Technical or trade school graduate	1%	n/a
Some college	15%	18%
Two-year college graduate	8%	9%
Four-year college graduate	8%	17%
Some graduate or professional school	1%	n/a
Graduate or professional degree	3%	9%
Number of Respondents	141	923,328 [a]
Number of respondents refusing	1	

[a] population 25 years of age or older for ACS data

As may be expected, program participants have substantially lower incomes than the general population. (Table 3-60) Eighty-five percent of program participants report having household incomes of less than $20,000, compared to 15% in the general population.

Table 3-60: Reported Annual Household Income

Reported Household Income	LIARP	ACS 2006
Less than $10,000	28%	8%
$10,000 - $19,999[a]	57%	7%
$20,000 - $29,999 [b]	11%	13%
$30,000 - $39,999 [c]	4%	12%
$40,000 plus[d]	0%	59%
Number of Respondents	135	548,247
Number of respondents refusing	17	n/a

[a] $10,000 to 14,999 for ACS data
[b] $15,000 to $24,999 for ACS data
[c] $25,000 to $34,999 for ACS data
[d] $35,000 or more for ACS data

Program participants are much more likely to be female as 83% of respondents are female, while the general population is almost evenly split in terms of male-to-female ratio. (Table 3-61)

Table 3-61: Gender of Respondent

Gender	LIARP	ACS 2006 [a]
Male	28%	49%
Female	83%	51%
Number of Respondents	135	1,321,574 [a]
Number of respondents refusing	7	

[a] Because ACS data is not segmented by age, the gender figures encompasses the entire population, including children.

4. Onsite Inspection Results

This section presents the results of the on-site visits to the homes of 40 program participants.

4.1 Refrigerators

The metered data from the refrigerator loggers were used to determine the annual consumption of each sampled new unit. Table 4-1 presents metered data results by refrigerator size along with the tracking system estimate of the consumption of the removed unit (Column B) and the tracking system estimate of the program installed refrigerator consumption (Column C). While we are unsure of how the baseline consumption was estimated, the installed refrigerator consumption appears to be consistent with that found on the ENERGY STAR website.

In comparing the new unit consumption estimates from the tracking data (Column C) to the metered consumption (Column D), the metered data are determined to be 85% of the tracking data. In researching this issue, we have found another Northeast refrigerator metering study that found the actual consumption of energy efficient refrigerators to be around 10% less than their rated usage.[22] In calculating the energy savings between the metered consumption and the tracking baseline consumption, we estimate that the overall savings among the metered units is 45,158 kWh as compared to the tracking estimate of 43,079 kWh. The average annual energy savings per unit is 1,390 kWh per the tracking data and 1,456 kWh per metering. This represents a 104.8% realization rate with a calculated precision of 9.7% at the 80% confidence level.

Table 4-1: Estimated Refrigerator Energy Consumption and Savings

	A	B	C	D	E	F
Size (CuFt)	Number of Models	Old Unit Usage from Tracking Data (avg kWh)	New Unit Usage from Tracking Data (avg kWh)	New Unit Usage from Metering (avg kWh)	Annual Savings from Tracking Data (sum kWh)	Annual Savings from Metering (sum kWh)
15	6	2,385	398	309	11,919	12,456
16	3	1,831	409	299	4,268	4,598
17	7	1,663	453	332	8,476	9,322
18	10	1,641	422	387	12,184	12,531
19	1	1,575	488	365	1,087	1,210
21	3	1,911	511	539	4,200	4,115
22	1	1,395	448	468	947	926
Total	31	1,824	435	368	43,079	45,158

[22] 2004 ACEEE Summer Study conference proceedings, "Statewide Refrigerator Monitoring and Verification Study and Results", Teague and Blasnik, pp. 11:188 – 11:198.

Table 4-2 below presents coincident energy factors for use in determining demand impacts between 1 and 4 pm and 5 and 7 pm on a weekday. These values were derived by taking the average hourly demand profile during the metering period and normalizing it to each unit's annual energy consumption. This provides hourly energy factors, which are then used with energy savings estimates to determine the demand impact across the specified performance hours.

The summer coincident energy factor is 0.0001349 with a relative precision of ±3.5% at the 80% confidence level while the winter coincident energy factor is 0.0001319 with a relative precision of ±4.0% at the 80% confidence level (Table 4-2). The coefficient of variation calculated for each value were very low (0.15 summer, 0.17 winter) and suggests that the operation of the refrigeration units during the hours of interest were very similar and did not vary by the size of the unit. As such, we believe both the summer and winter factors can be used to determine coincident demand impacts for all refrigerator sizes and types installed through the program.

Table 4-2: Estimated Refrigerator Coincident Energy Factors

Factor	Summer	Winter
Average	0.0001349	0.0001319
Standard Deviation	0.0000205	0.0000229
Relative Precision	±3.5%	±4.0%
Coefficient of Variation	0.152077	0.173517

In order to calculate the coincident demand impact values, the coincident energy factor is multiplied by the difference in annual energy consumption between the retrofit and baseline refrigerators. As an example, if an old refrigerator with annual consumption of 1,800 kWh was replaced with a refrigerator with an annual consumption of 430 kWh, the summer coincident demand reduction would be calculated as (1,800 – 430) * 0.0001349 = 0.184 kW and the winter coincident demand reduction would be calculated as (1,800 – 430) * 0.0001319 = 0.180 kW.

4.2 Compact Fluorescent Light Bulbs

According to the program tracking system, the 40 customers in the on-site sample received 328 CFLs through the program in 2006. The persistence rates as determined from the on-site survey are expressed in (Table 4-3). The table shows the totals for all program CFLs based on the following categories, according to on-site observations and customer reporting:

1) Installed in the customers' homes,
2) Never installed,
3) Installed outside of the customers' homes,
4) Plans to install,
5) Installed and removed, and
6) Not purchased.

At the time of the on-sites, approximately 83.5% (with ±3.1% sampling error and 80% confidence) of the program CFLs were installed. The primary reason for non-installation of CFLs was that the customer did not recall receiving them and the evaluation auditor was unable to find them installed in the home or in storage for future use.

Table 4-3: On-Site CFL Installation and Removal Rates

Currently Installed in Maine	
Installed in Customer's Home	265
Installed in Other Home in Maine	9
Total Installed in Maine	274
Percent Installed	83.5%
Not Currently Installed in Maine	
Not Installed	54
Customer Did Not Receive	44.4%
Installed and Removed	33.3%
Customer Plans to Install to Replace Existing Incandescents	11.1%
Customer plans to Install to Replace Existing CFLs	9.3%
Gave Away to Someone Outside of Maine	1.9%
Total Sample	**328**

Table 4-4 presents the reported duration between receipt and installation of CFLs among participants. Almost all (94.9%) installations occurred immediately after the bulbs were received.

Table 4-4: Duration until Installation for CFLs

Time Between Receipt and Installation	**Total # of CFLs**	**% of Total Installed**
Immediately	260	94.9%
Three Days	2	0.7%
Five Days	5	1.8%
One Month	3	1.1%
Two Weeks	3	1.1%
Two Months	1	0.4%
Total	**274**	**100.0%**

Table 4-5 shows where customers installed the CFLs that they received through the program. Almost half (48.7%) of these installations were in living rooms and kitchens, which are also among the most frequently occupied rooms.

Table 4-5: Breakdown of CFL Installations by Room Type

Room	# of Bulbs Installed	Avg. Hours	Avg. Hrs/Day
Kitchen	68	1,556.4	4.3
Living Room	61	1,055.7	2.9
Bedroom	52	220.2	0.6
Bathroom	30	555.2	1.5
Hallway	13	279.2	0.8
Dining Room	10	1,137.9	3.1
Laundry Room	6	923.5	2.5
Den	6	361.8	1.0
Basement	5	362.3	1.0
Exterior	4	3,767.1	10.3
Attic	2	1,341.7	3.7
Foyer	1	750.9	2.1
Garage	1	6.1	0.0
Closet	1	1.8	0.0
Total	**265**	**920.6**	**2.5**

Table 4-6 below illustrates the logger-informed average daily hours of CFL use. While the tracking system assumed 3.4 hours per day on average for the bulbs in the sample, the lighting loggers found that the average installed program CFL operates for approximately 2.5 hours per day or 921 hours per year with sampling error of ±9.8% and 80% confidence.

Table 4-6: Average Daily Hours of Use for CFLs

Average Hours of Use	CFLs (n=274)
Result	2.5
80% Confidence Level	*±9.8%*

Displaced Wattage/Connected Demand Reduction Results. Table 4-7 illustrates the on-site observed inputs for wattage displaced by the CFLs installed through the program. The average displaced wattage in the sample is 46.9 watts with sampling error of ±2.4% and 80% confidence. This is also considered the average reduction in connected demand for each CFL installed through the program.

Table 4-7: Average Displaced Wattage Results

Average Displaced Wattage	CFLs (n=274)
Result	46.9
80% Confidence Level	*±2.4%*

Table 4-8 compares the program's current baseline wattage assumptions with the customer-reported replaced wattages from the on-site visits. Regardless of wattage, most program CFLs replaced 60-watt incandescent bulbs.

Table 4-8: Comparison of Program and On-Site Replaced CFL Wattages

CFL Wattage	Avg. Tracking System Wattage Replaced	n	On-Site Wattage Replaced	On-Site Wattage Displaced
9	40.0	1	70.0	61.0
10	43.4	11	56.4	46.4
11	40.0	0	-	-
13	65.4	51	63.9	50.9
14	60.3	74	60.5	46.5
15	60.3	56	56.9	41.9
18	73.1	0	-	-
20	72.1	45	62.9	42.9
23	100.0	6	82.5	59.5
25	85.0	17	91.5	66.5
26	89.8	12	63.8	37.8
32	150.0	0	-	-
35	-	1	60.0	25.0
Total		**274**	**63.2**	**46.9**

Lighting Gross Savings Impacts. The program impact parameters provided in the sections above generate the per-unit savings estimates provided in Table 4-9. The average program CFL saves 35.7 kWh per year with sampling error of ±11.3% and 80% confidence.

Table 4-9: Average Annual Energy CFL Savings

Average kWh Savings	CFLs (n=274)
Result	35.7
80% Confidence Level	*±11.3%*

Table 4-10 compares the current program savings assumptions to the savings calculated for each of the program CFL wattages found installed during the on-sites. In calculating the savings below, the following formula and values were used:

*Displaced Wattage * Hours of Use/Day * 365 * Installation Rate/1,000*

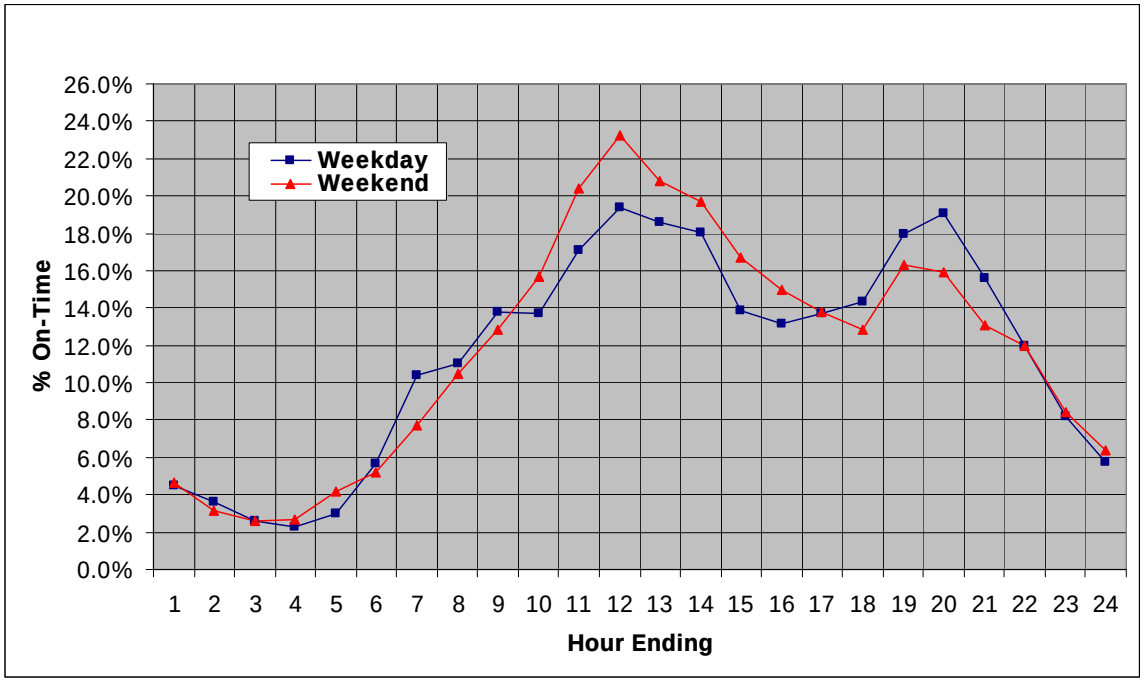
*Displaced Wattage * 2.5 * 365 * 83.5% / 1,000*

Table 4-10: Comparison of Program and On-site CFL Savings by Wattage

On-Site CFL Wattage	Tracking System Annual Savings Assumption (kWh)	n	On-Site Annual Savings (kWh)
9	45.3	1	46.5
10	37.8	11	35.3
11	52.0	-	-
13	50.6	51	38.8
14	50.1	74	35.4
15	65.9	56	31.9
18	90.6	-	-
20	49.5	45	32.7
23	66.5	6	45.3
25	67.2	17	50.6
26	45.3	12	28.8
32	37.8	-	-
35	52.0	1	19.0
Total		**274**	**35.7**

Figure 4-1 displays the weighted (by connected lighting Watts) averages of monitored on-times for all 180 loggers that were utilized for this project. It is important to recognize that the metering for this study was conducted in October, so that these usage patterns reflect 'shoulder' months of daylight hours. Also, it is important to remember that these load shapes do not represent typical lighting load shapes for a typical home with all lights considered; rather it is the load shape for CFLs installed in low income homes through the program.

Figure 4-1: Sampled Lighting Logger Profiles for the Average Weekday and Weekend



The percent on time calculated from the average of the four hours from 1 to 5 PM during a typical weekday in the monitoring period was found by RLW to be 14.7%. This result has a relative precision of +/-11.9% at the 80% confidence level. The percent on time calculated from the average of the two hours from 5 to 7 PM during a typical weekday in the monitoring period was found by RLW to be 16.2%. This result has a relative precision of +/-13.0% at the 80% confidence level.

4.3 Appliance Saturation

As mentioned previously, the on-site survey included a section that was designed to gather information on various types of appliances that were being used by participants at the time of the on-site visit. One customer would not allow the auditor to gather this information. Therefore, the results are based on the information gathered at the other 39 homes.

Clothes Washers & Dryers. Almost all (92.3%) of the customers in the sample had a clothes washer at the time of the on-site visit. Three-quarters of these units were classified by the

auditor as being in 'good' condition and the average customer-estimated age is 8.3 years. The majority (91.7%) of the customers that have clothes washers also have dryers. All but two of these (93.9%) are electric dryers.

Room Air Conditioners. Only 31% of the sample used room air conditioners in their homes, with two customers using two units each. The average room air conditioner is 7,720 Btu in size, serves approximately 300 square feet of space, and is three years old according to customer reports. The auditor rated three of these units as being in 'fair' condition, with the remaining nine units rated as being in 'good' condition. Because the visits were conducted in October, some of the units may have already been removed.

Dehumidifiers. Only six customers (15.4%) used dehumidifiers in their homes, with one customer using two units. The average dehumidifier is 4.3 gallons in size and is approximately four years old. The auditor rated all seven units as being in 'good' condition.

Hot Water Heaters. Almost all (92.3%) of the sample had hot water heaters at the time of the on-site visits. The majority (72.4%) of these units use electricity, while 17.2% are oil, and 10.3% are gas. The average tank is approximately 37 gallons in size and 8.2 years in age (Table 4-11). The auditor rated 83.3% of these hot water heaters as being in 'good' condition and the remainder as being in 'fair' condition.

Table 4-11: Water Heater Summary

Fuel Used	Avg. Age	Condition	
		Good	Fair
Electric	6.9	19	2
Oil	12.3	4	1
Gas	10.3	1	2
Overall	8.2	24	5

Night Lights. Only two customers (5.1%) use night lights in their home, but each customer uses two night lights. The night lights are located in the bathroom, bedroom, kitchen, and hallway. Three of these night lights use seven-watt incandescent bulbs, while the other uses a 0.5-watt LED bulb. The customers reported using the night lights an average of 10.5 hours per day.

Additional Opportunities. Table 4-12 compares the average ages of the appliances summarized above to the average life expectancy of each appliance. Based on the data collected, the average clothes washer may be in need of replacement within the next two or three years.

Table 4-12: Study Average vs. Life Expectancy

Appliance	Life Expectancy (in years)[23]	Study Avg. Age (in years)
Clothes Washer	11	8.3
Room Air Conditioner	10	3.1
Dehumidifier	11	3.9
Electric DHW	12	6.9
Gas/Oil DHW	9	11.6

For measures not explicitly targeted in the additional opportunities assessment presented above, new windows were most often needed by study participants. Eleven of the homes in the sample had windows that customers reported were very drafty. The auditors found these windows to be single-paned, wood framed, or having sweat between the panes.

4.4 Customer Demographics

This section summarizes the participant demographics as gathered in the on-site survey. Thirty-five of the forty customers in the sample own their home; the remaining five rent their home but pay for the electricity.

Almost three-quarters (72.5%) of the sample live in homes that are over twenty years old, while only 17.5% live in homes that are between 10 and 20 years old. The remaining customers did not know how old their home was. Most (70.0%) of the homes in the sample are less than 1,500 square feet in size. Another 17.5% are between 1,500 and 2,000 square feet, while the remaining homes are larger than 2,000 square feet.

Only five of the participants in the sample claimed that they changed how they used their lights since receiving the program CFLs. Three reported a decrease in the use of these lights compared to the other lighting in their homes; one reported an increase, while the other reported using some more and some less.

The sampled participants are generally pleased with the program as they gave it an average rating of 9.6 on a scale of 0 (not at all satisfied) to 10 (extremely satisfied). When asked to rate their satisfaction with the CFLs and refrigerator they received on a scale of 0 (not at all satisfied) to 5 (extremely satisfied), customers provided an average rating of 4.4 for CFLs and 4.6 for refrigerators.

[23] US Department of Energy, 2007 Buildings Energy Data Book:http://buildingsdatabook.eere.energy.gov/docs/5.10.19.xls.

5. Overall Program Impacts

This section presents findings on the impacts of the program regarding gross energy and demand savings, spillover, and net energy and demand savings.

5.1 Gross Energy and Demand Savings

Table 5-1 displays the number of refrigerators and CFLs provided the LIARP in 2006, as well as the average displaced wattage, daily hours of use, in-service rate, and the gross first-year energy savings. We rely on the on-site inspections, rather than the telephone surveys, for the estimates of displaced wattage, hours of use, and in-service rate.

The gross energy savings for refrigerators was calculated directly from the metering data. In order to calculate the gross savings for CFLs, the following formula was used:

Gross Energy Savings	=	*Displaced Wattage*	** Hours of Use/day*	** Days per Year*	** In-service rate*	*Divided by 1000 watts/kW*

The gross first-year energy savings per refrigerator is estimated to be 1,361 kWh; this figure is calculated by adjusting the 1,299 annual kWh figure from the tracking database (see Table 1-3) by the 104.8% realization rate (see Table 4-1) estimated for refrigerators. The annual energy savings per CFL of 35.7 kWh is derived from the on-site results (see Table 4-10). The overall gross first-year energy savings for the 2006 program year is estimated to be 4,874 MWh.

In order to estimate measure life, we refer to other studies. According to program tracking data, the average age of refrigerators upon replacement was 21 years (see Table 1-3). We assume that these refrigerators would have remained in use for an additional five years before being replaced by a refrigerator that meets the federal energy efficiency standards. According to a recent study conducted in Massachusetts, the average age of refrigerators upon replacement was 20 years;[24] thus we assume the new program refrigerators remain in use for 20 years. In addition, we assume that CFLs have an effective useful life of 8,000 hours, which is consistent with the lifetime assumptions from the impact evaluation of the Efficiency Maine lighting program.[25] We estimate a lifetime of 8.8 years by dividing the 8,000 hours assumption by the average daily hours of use (2.5) and the number of days per year (365). The gross lifetime energy savings for the 2006 program year, which assumes each program refrigerator and CFL remains installed for the full assumed lifetime, is estimated to be 33,409 MWh.

[24] 2004 ACEEE Summer Study conference proceedings, "Statewide Refrigerator Monitoring and Verification Study and Results," Teague and Blasnik, pp. 11:188 – 11:198.
[25] *Process and Impact Evaluation of the Efficiency Maine Residential Lighting Program.* Nexus Market Research and RLW Analytics, 2007.

Table 5-1: Gross Energy Savings, 2006 Program Year

Parameter	Refrigerators	CFLs	Total	Source
Number of Units	2,799	29,804		Program records
Displaced Wattage per Unit (watts)	190.5	46.9		Onsite inspections
Hours of Use per Day	n/a	2.5		Onsite inspections
In-service Rate	100%	84%		Onsite inspections
Gross First-Year Energy Savings per Unit (kWh)	1,361	35.7		
Gross First-Year Energy Savings Total (MWh)	3,809	1,065	4,874	
Assumed Lifetime (years)	20.0	8.8		Estimated
Gross Lifetime Energy Savings per Unit (kWh)	8,600	313		
Gross Lifetime Energy Savings (MWh)	24,071	9,337	33,409	

Gross Demand Savings. The demand savings for refrigerators is calculated by multiplying the gross annual energy savings by the coincident energy factors (Table 4-2). The maximum coincident energy factor, used in estimating potential gross demand savings, is estimated to be .00014. For CFLs, we use the total number of CFLs provided by the program, the in-service rate, and the average displaced wattage, and then are able to calculate potential gross demand savings with the following formula:

Potential Gross Demand Savings	=	*Number of CFLs*	** In-service rate*	** Displaced Wattage*	*Divided by 1000 watts/kW*

In order to calculate the winter or summer peak demand reduction for CFLs, the following equation can be used:

*Seasonal Peak Demand Reduction = Potential Demand Savings * Peak Demand Coincidence Factor*

As discussed in Section 4.2, the peak coincidence factor for CFLs is estimated to be 14.7% during the summer peak period (1pm-5pm) and 16.2% during the winter peak period (5pm-7pm). However, it is important to recognize that the metering for this study was conducted in October, so that these usage patterns reflect 'shoulder' months of daylight hours. A recent lighting logger study conducted in Maine estimated that the weighted winter weekday peak demand factor (between 5pm-7pm) for CFLs was 33.6% ±11.2% at the 90% confidence level.[26] In addition, a study conducted in 2004 in New England[27] estimated the weighted winter coincident factor to be 25.3% ±9.9% and the weighted summer coincident factor to be 12.1% ±19.6%. For this

[26] Process and Impact Evaluation of the Efficiency Maine Lighting Program. NMR and RLW. 2007.

[27] Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs. NMR and RLW. 2004.

analysis, we assume the winter peak coincidence factor is 33.6% and the summer peak coincidence factor is 14.7%.

The potential gross demand savings for the 2006 program is estimated at 1,700 kW (Table 5-2). The peak gross demand savings is estimated to be 895 kW in winter and 685 kW in summer.

Table 5-2: Gross Demand Savings, 2006 Program Year

	Refrigerators	CFLs	Total	Source
Number of Units	2,799	29,804		Program records
Displaced Wattage per Unit (watts)	190.5	46.9		Onsite Inspections
In-service Rate	100%	84%		Onsite Inspections
Potential Gross Demand Savings (kW)	533	1,167	1,700	
Winter Peak Gross Demand Savings (kW)[a]	502	392	895	
Summer Peak Gross Demand Savings (kW)[a]	514	172	685	

[a] Seasonal peak demand savings equals potential demand savings multiplied by the seasonal peak coincidence factor.

5.2 Net Energy and Demand Savings

Net energy savings are estimated from gross energy savings after adjusting for spillover, based on the telephone survey results from program participants. Freeridership, defined as program purchases that participants claim they would have made on their own in the absence of the program, was assumed to be zero because the refrigerators and CFLs were provided free of charge. Non-participant spillover is *not* included in these estimates, nor are snapback, snapforward, or persistence.[28] Because the program does not actively market nor influence the stocking or promotional practices of retail stores that sell refrigerators or CFLs, it is reasonable to assume that non-participant spillover is zero.

[28] It may be appropriate to examine this assumption through inclusion of the standard freeridership questions in surveys of LIARP participants in the future. Thirty nine percent (39%) of LIARP respondents in this study report having purchased CFLs on their own, prior to the program.

Participant Spillover. For refrigerators, participant spillover was assumed to be zero because the customers would have no rationale to purchase an additional refrigerator. For CFLs, participant spillover is calculated as the proportion of CFLs that participants purchased outside the program as a result of having participated in the program, based on the telephone survey results from program participants.

In order to determine spillover rates, only those customers who say that the program influenced their decision to purchase additional CFLs are considered. Spillover purchases are defined as:

- CFLs purchased since program participation
- CFLs purchased at the standard price without any incentives[29]
- Respondent reports being influenced by the experience of their program participation to make the additional purchases

Table 5-3 displays the percentage of respondents who purchased CFLs before the program audit and since the audit. Nearly four in ten respondents (39%) reported purchasing CFLs before the audit and nearly a third (32%) have purchased bulbs since the audit.

Table 5-3: CFL Purchases by Program Participants

(Base - All respondents)

Purchased CFLs	Yes (percent)	Number of Respondents
Before the program audit	39%	142
Since the program audit	32%	142

[29] Estimates of spillover for these programs are complicated by the presence of the instant coupons and the markdown component of the Efficiency Maine CFL program. Customers can purchase CFLs using instant coupons at many stores or at a reduced price at Hannafords or Shaws without using an instant coupon (and apparently, BJs or Sams Club too, though this was not known at the time the survey was designed).

Table 5-4 reports the number of CFLs purchased since the program audit and estimated spillover. Because the Efficiency Maine CFL program incentivized CFLs sold at Hannafords and Shaws through a markdown campaign, we calculated spillover excluding those bulbs purchased at Hannafords and Shaws. The number of spillover bulbs is divided by the total number of bulbs provided by the program, which results in a spillover estimate of 6.4%.

Table 5-4: Spillover Calculation
(Base - All respondents)

Number of CFLs	Number of CFLs	Number of Respondents
Provided by Program	1,208	142
Purchased since the program audit	210	45
Purchased using an instant rebate coupon	106	20
Purchased at Hannafords or Shaws	16	4
Not influenced by the program to purchase	11	3
Influenced by the program to purchase	77	20
Spillover rate, excluding purchases at Hannafords or Shaws	**6.4%**	

Net Energy Savings. Net energy savings for the LIARP is defined as gross energy savings adjusted for participant spillover and freeridership:

Net energy savings = Gross energy savings x (1 + participant spillover rate – freeridership rate)

Table 5-5 displays the freeridership rate, spillover rate, net-to-gross ratio, net first-year energy savings, and net lifetime energy savings. The only adjustment to the gross energy savings is due to the 6% spillover rate for CFLs, as freeridership is assumed to equal zero.

Table 5-5: Net Energy Savings, 2006 Program Year
(gross savings adjusted for behavioral influences)

Parameter	Refrigerators	CFLs	Total	Source
Number of Products	2,799	29,804		Program records
Gross First-Year Energy Savings (MWh)	3,809	1,065		(See Table 5-1)
Freeridership Rate	0%	0%		Assumption
Spillover Rate	0%	6%		Assumption; Telephone Surveys
Net-to-Gross ratio (1 + SO – FR)	100%	106%		
Net First-Year Energy Savings (MWh)	3,809	1,129	4,938	
Assumed Lifetime (years)	20.0	8.8		Estimated
Net Lifetime Energy Savings per Unit (kWh)	8,600	332		
Net Lifetime Energy Savings (MWh)	24,071	9,898	33,969	

Net Demand Savings. Potential net demand savings is equal to gross demand savings multiplied by the Net-to-Gross ratio (Table 5-6).

Table 5-6: Net Demand Savings, 2006 Program Year
(gross savings adjusted for behavioral influences)

	Refrigerators	CFLs	Total	Source
Potential Gross Demand Savings (kW)	533	1,167	1,700	(See Table 5-2)
Winter Peak Gross Demand Savings (kW)[a]	502	392	895	(See Table 5-2)
Summer Peak Gross Demand Savings (kW)[a]	514	172	685	(See Table 5-2)
Net-to-Gross ratio	1.0	1.06		Telephone Surveys
Potential Net Demand Savings (kW)	533	1,237	1,771	
Winter Peak Net Demand Savings (kW)[a]	502	416	918	
Summer Peak Net Demand Savings (kW)[a]	514	182	696	

[a] Seasonal peak demand savings equals potential demand savings multiplied by the seasonal peak coincidence factor.

5.3 Comparison to Other Studies

This section of the evaluation provides a review of selected findings from other refrigerator and CFL program evaluation studies conducted over the past several years.

Refrigerators. Two prior studies provide meter-based estimates of refrigerator energy consumption and savings; the first study was done for the Massachusetts sponsors[30] regarding refrigerators eligible for replacement through a home energy audit program and the second study was completed for Southern California Edison.[31] Note that neither of these programs focuses on providing services to low-income customers. Table 5-7 finds that the annual energy savings estimate for the LIARP is slightly greater than the Massachusetts estimate, and substantially lower than the California estimate.

Table 5-7: Comparison of Refrigerator Annual Energy Savings

Source	Estimated Annual Energy Savings (kWh)
Maine LIARP	1,457
Massachusetts, 2004	*1,383*
Southern California Edison, 2004	*1,946*

[30] Blasnik, Michael "Measurement and Verification of Residential Refrigerator Energy Use: Final Report 2003-2004 Metering Study." Submitted to NSTAR Electric, National Grid, and Northeast Utilities on July 29, 2004.
[31] KEMA- Xenergy (2004) "Final Report: Measurement and Evaluation Study of 2002 Statewide Residential Appliance Recycling Program." Submitted to Southern California Edison on February 13, 2004.

CFLs. We have selected two studies for comparison that estimate impact parameters for New England retail-based instant coupon programs – from the 2007 Efficiency Maine Residential Lighting program evaluation and the 2004 study of programs in Massachusetts, Rhode Island, and Vermont. In addition, we present the impact parameter estimates from one low-income program, the We Energies Low-Income study, which delivered CFLs to low-income customers through existing social service agencies. Where available, the study results are based on the results of on-site surveys. Below is a brief description of the methodology used in each study. The following studies were reviewed:

- *Process and Impact Evaluation of the Efficiency Maine Residential Lighting Program.* NMR and RLW Analytics, 2007. This study consisted of 170 telephone surveys and 25 on-site visits.
- *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs.* NMR and RLW Analytics, 2004. This study consisted of 823 telephone surveys and 128 on-site visits.
- *Evaluation Report for the Low-Income/Hard-to-Reach CFL Distribution Program of the We Energies 55 MW Energy Efficiency Procurement Plan.* Itron and Shel Feldman Management Consulting, 2007. This study consisted of 150 verification visits conducted by social service agencies and 15 site visits by evaluation contractors.

Table 5-8 compares the in-service rates calculated from the current study to those produced in the other studies. The in-service rate estimated for the program (83.5%) is significantly higher than the results of the three comparison studies, which range from 58% to 66%. This is likely due to the fact that a program auditor installed the CFLs in the home; for the two comparison studies which are based on retail coupon programs, the customer themselves would install the bulbs.

At 46.9 watts, the wattage reduction for the LIARP is similar to the estimates from the comparison studies, which range from 45.5 to 48.7 watts. In addition, the daily hours of use estimate of 2.5 hours is similar but slightly less than the estimates from the other studies, which range from 2.7 to 3.2. This result seems reasonable, given that the LIARP provides participants with a substantial number of CFLs (an average of 8.5 for each telephone survey respondent); some of these CFLs are likely to be installed in low-usage locations.

At 6%, the spillover rate is lower than the 22%-30% estimates from the Maine lighting program and the MA/RI/VT study. However, this result also seems reasonable due to the substantial number of CFLs provided to participants; most participants would not be expected to need more CFLs in their home. In addition, the LIARP serves low-income customers, who may be less able to afford purchasing CFLs than the typical customer who participates in a retail coupon program.

Table 5-8: CFL Impact Parameter Comparison

Study	In-Service Rate	Average Wattage Reduction (Watts)	Average Daily Hours of Use	Average Gross Annual Energy Savings per CFL (kWh)	Participant Spillover rate	Source[a]
Maine LIARP Results	83.5%	46.9	2.5	35.7	6%	Onsite Inspections
Maine RLP Study	*66%*	*45.5*	*3.2*	*35.1*	*30%*	*Onsite Inspections*
MA/RI/VT Study	*62%*	*48.7*	*2.7*	*29.8*	*22%*	*Onsite Inspections*
We Energies Low-Income	*58%*	*46.4*	*n/a*	*n/a*	*n/a*	*Telephone Surveys*

[a] This column indicates the source for estimates of in-service rate, wattage reduction, and hours of use. Spillover is usually estimated from telephone surveys.