EmPOWER Maryland Evaluation Plan

Residential Lighting & Appliances Program

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Section 1. Introduction

1.1 Summary of Changes to Initial M&V Plan

This is to be developed (TBD) together with utility-specific plans for PJM.

1.2 Program Description and Goals

The Residential Lighting and Appliance programs are designed to reduce energy consumption and peak demand by increasing the awareness and sales of ENERGY STAR qualified lighting and appliances. The programs provide all residential customers with the opportunity to purchase incentivized ENERGY STAR qualified lighting and appliances through retail sales channels.

All five utilities have some version of this Residential Lighting and Appliance Program, although it varies slightly from utility to utility. The programs focus on three distinct product segments: lighting, appliances, and domestic hot water heating equipment (PEPCO and Delmarva only). The CFL programs offer incentives to retailers/manufacturers to mark-down/buy-down the cost of CFLs to end-use customers.[1] Three utilities, Allegheny, BGE, and SMECO, include refrigerator and freezer recycling as part of their program and all utilities have varying appliances that qualify for rebates.

Table 1 outlines the incentives for the different utility appliance and recycling measures, and Table 2 outlines the measures incented as of first quarter 2010.

[1] Allegheny Power also offers mail-in rebates for the purchase of single ($1.50) and multi-pack ($3) CFLs.

Table 1. Incentive Amounts by Utility and Measure

Measure	Utility Incentive				
	BGE	SMECO	Allegheny	Delmarva	Pepco
Clothes Washer	$50	$50	$75		
Clothes Dryer			$25		
Dishwasher			$25		
Refrigerator	$50	$50	$50	$50	$50
Freezer			$25		
Room AC	$25	$25	$25	$25	$25
Hot Water Heater		$25		$20	$20
Programmable Thermostat			$25		
Recycled Freezer	$50	$50	$35		
Recycled Refrigerator	$50	$50	$35		
Recycled Room AC			$25		

Table 2. Rebated Measures by Utility and Measure
(through Q1 2010)

Measure	Utility Participation				
	BGE	SMECO	Allegheny	Delmarva	Pepco
Clothes Washer	14,196	280	759		
Clothes Dryer			739		
Dishwasher			377		
Refrigerator	11,182	143	63	174	364
Freezer	95		9		
Room AC	596	0	2	0	1
Hot Water Heater		0		5	4
Programmable Thermostat			316		
Recycled Freezer	924	38	47		
Recycled Refrigerator	3,954	125	222		
Recycled Room AC			65		

The EmPOWER MD Utilities Residential Lighting and Appliance programs are projected to save almost 500 GWh and 116 MW over the 3 year (36 month) period from 2009 to 2011, with the majority of the savings coming from lighting. Savings by utility ranges considerably, from 22.5 GWh for AP to about 344 GWh for BGE, largely reflecting the territory size. In total, these programs are projected to cost $37.7 million over the 36 month period, with individual utility program costs ranging from a cumulative of $0.5 million for Delmarva to $8.9 million for BGE.

Table 3. Lighting and Appliance Program Savings Goals

Program Segment	MWH	MW
Lighting	606,229	82.57
Appliances	47,737	12.59

1.3 Evaluation Objectives and Approach

The evaluation encompasses three overarching research objectives across all utilities:

1. Determine verified gross peak demand and annual energy savings, including verification of measure installation, for the population of measures installed as part of the program.
2. Determine the effectiveness of program design and process.
3. Provide estimates of net energy impacts including estimates of freeridership and spillover.

1.3.1 Impact Evaluation Objectives:

The primary objective of the impact evaluation is to provide verified estimates of gross program savings. Other key objectives of the impact evaluation include:

- Review the energy and demand savings values that were included in the program plans
- Verify that the claimed savings are consistent with the approved TRM values
- Assess, through a combination of primary and secondary data collection and analysis, the values for key parameters that are used to determine energy and demand (both utility and PJM defined) savings.
- Make recommendations for adjusted energy and demand savings values (i.e gross savings net of installation and NTG findings).

1.3.2 Process Evaluation Objectives:

Key objectives of the process evaluation include:

- To understand why programs are over- or under-performing, with an emphasis on providing recommendations to improve performance.
- To improve existing program designs, where possible, to ensure best-in-class programs are filed by the utilities for the 2012-2015 program cycle.

Our emphasis in the first year evaluation will include:

- Documenting the value of the programs in the market.
- Describing issues and providing recommendations for improving data tracking to help document program impacts.
- Exploring statewide integration issues, such as confusion over multiple program designs in the market.
- Examining marketing issues and providing recommendations to encourage additional participation.
- Examining areas of particular concern highlighted by utilities through their own observation of program start up and implementation activities and responses.

More details about the process evaluation goals and objectives are discussed in Section 3.

1.4 Other PJM Requirements

1.4.1 Energy Efficiency Application and Standards

Lighting

For lighting, the applicable baseline conditions to be gathered for this analysis are (1) the pre-existing wattage of the incandescent and (2) information as to whether there has been any change in the usage of the light since the conversion to CFLs.[2]

The programs offer incentives for ENERGY STAR rated CFLs, which use approximately 75% less energy than comparable incandescent bulbs. While there are currently no energy efficiency codes for residential lighting, the Energy Independence and Security Act (EISA) of 2007 mandates higher energy-efficiency levels in light bulbs sold in or imported into the United States beginning in 2012. As shown in Table 4, EISA's performance standards correspond to approximately 30% improvements in efficiencies (measured in lumens-per-watt) over current

[2] Participants in the upstream lighting program could either be replacing an incandescent bulb or a failed CFL. Given the lack of long standing programs in the EmPOWER service territory and the long life of CFLs, it is likely that the majority of purchasers are replacing incandescent bulbs. In addition, even households replacing a CFL could return to using an incandescent, so the assumed incandescent wattage is still the appropriate baseline.

incandescent technology. It is important to note that EISA is a performance-based standard; thus, the standards are "blind" to technology and do not ban incandescent bulbs.

A number of baseline lighting scenarios may develop in response to EISA, including the following:

- ***EISA Scenario***. While EISA will preclude current incandescent technology, advanced incandescent (particularly halogen bulbs) may meet EISA's minimum standards. Advanced incandescent bulbs use a variety of approaches to increase efficiency, and there are already a number of incandescent products (e.g., some bulbs from the Philips Halogena series) that meet the requirements. These bulbs, however, currently cost $4 to $8 each (substantially more than the cost of a comparable CFL), and it is unknown how much the price might drop in the next few years. [3] So, even though more products may become available, they also may cost more than CFLs, making CFLs both a lower cost and more efficient technology.
- ***CFL Baseline Scenario***. There is evidence that CFLs may become the new baseline technology. Advanced incandescent bulbs not only may cost more than CFLs, some manufacturers, such as General Electric, have abandoned efforts to develop an advanced incandescent and are focusing on improved CFLs and Light Emitting Diodes (LEDs).[4] Current CFL limitations regarding color rendering, dimmability, and warm-up period have limited consumer acceptance, so improvements in performance are needed to increase sales. Even with technological improvements, consumer concerns about the use of mercury could prove to be a significant deterrent.

Additional details regarding the assumptions for baseline conditions (i.e., delta watts) and how they impact the savings assumptions are discussed in Section 2.

Table 4. EISA Requirements for General Service Incandescent Lamps

Lumen Output	Typical Wattage: Current Incandescent Technology	EISA Requirements		
		Maximum Wattage	Minimum Lifetime (hours)	Effective Date
1490–2600	100	72	1,000	1/1/2012
1050–1489	75	53	1,000	1/1/2013
750–1049	60	43	1,000	1/1/2014
310–749	40	29	1,000	1/1/2014

[3] http://www.amazon.com/Philips-70-Watt-Halogena-Energy-2-Pack/dp/B001FA07UW and http://www.lutronstore.com/lutronproductsdetails.aspx?productid=151

[4] http://greeninc.blogs.nytimes.com/2009/05/29/can-incandescent-bulbs-be-made-efficient/?pagemode=print

Appliances & Recycling

The appliance measures included as part of the Lighting and Appliances program are described in the Evaluation Objectives and Approach section above, and outlined in further detail in Section 2.

For the appliance rebates, the savings is based on the assumption that the participant is already in the market for a new device, therefore the baseline is a new, standard efficiency model. For the appliance recycling program, the baseline will be the average energy use of the retired unit (i.e., early retirement). In both instances, we are not assuming any behavioral changes as a result of the new appliance.

1.4.2 Anticipated Savings

The anticipated energy and demand savings for the EmPOWER Residential Lighting and Appliance Program are outlined in Table 5.

Table 5. Residential Lighting and Appliance Programs Cumulative Annual Estimated Savings (2009-2011) *

	2009		2010		2011	
	Energy Savings (MWh)	Demand Reduction (MW)	Energy Savings (MWh)	Demand Reduction (MW)	Energy Savings (MWh)	Demand Reduction (MW)
Allegheny Power	2,298	1.4	10,306	5.6	22,512	11.2
BGE	91,049	20.7	210,892	47.9	344,368	78.2
Delmarva Power	8,613	2.0	18,108	4.0	28,562	6.0
PEPCO	23,616	5.0	49,650	11.0	78,313	17.0
SMECO	9,323	1.4	20,440	3.1	26,143	3.8
Total	134,899	30.5	309,396	71.6	499,898	116.2

* Source: Utility filed DSM Plans.

1.4.3 Anticipated M&V Costs

The anticipated cost to implement the impact evaluation is $908,000.

1.4.4 Location of EE Resource

Maryland EmPOWER areas, consisting of BGE, PEPCO, Delmarva Power, SMECO, and Allegheny Power service territories.

1.4.5 Anticipated Nominated EE Value of EE Resource

This is to be developed (TBD) together with utility-specific plans for PJM.

1.4.6 Schedule

Table 16 and Table 18 (in Section 5) provide a summary of the key evaluation milestones for Year 1.

Section 2. Approach to Verifying Gross Savings

Lighting

Gross savings from CFLs can be determined from a few key parameters. For example, gross annual energy savings is the product of the total program CFL sales, annual hours-of-use, and the change (delta) kilowatts from pre- to post-CFL installation:

*Annual kWh Savings =Program CFL Sales * Annual HOU * (Delta Watts/1000)*

Peak demand savings uses similar parameters, with the addition of the peak coincidence factor, or the percent of time the lights are used in the hour ending at 15:00 Eastern Prevailing Time (EPT) and the hour ending at 18:00 EPT during all the days from June 1 through August 31 in 2010, excluding weekends and federal holidays:

*Annual kW Savings = Program CFL Sales * Delta Watts/1000 * Coincidence Factor*

In addition, there are a number of other key parameters used to develop adjusted gross savings. These include:

- ***In-service Rate:*** Similar to incandescent bulbs, purchasers of CFLs may wait for working bulbs to burn out before installing the CFLs. The storage vs. in-service (installation) rate may be impacted by the price of the CFLs (i.e., lower cost CFLs may present an opportunity for people to "stock up" on CFLs), the program promotion of large multipacks, or other factors.
- ***Leakage (Spillage):*** Buy-down programs present a unique challenge in that the true program participant (who is paid the direct incentive) is a retailer or manufacturer. While retailers must be in the EmPOWER service territory, thus maximizing the likelihood that the discounted bulb will be purchased by one of the EmPOWER utility residential customers, there is still the distinct possibility that customers from neighboring utilities will purchase one of the program discounted bulbs. Because the EmPOWER utilities are surrounded by population centers served by other utilities, leakage will be examined as part of the evaluation activities.
- ***Residential vs. Nonresidential Purchases:*** Savings for the CFL programs are based on the assumption that the lighting product is installed in a residential application. Certain key parameters for gross savings, however, are typically markedly different for nonresidential applications. For example, CFLs are typically used for more hours per day, with a higher coincidence factor, for nonresidential applications, and thus savings will be higher than in residential applications.
- ***Interactive Effects:*** CFLs give off less heat than incandescent bulbs, and thus may require less cooling load in the summer (peak) months.

The approach for verifying each of the gross and adjusted gross key parameters is presented below (beginning in Section 2.3).

The evaluation team will also conduct an initial engineering review of the savings recorded in the program tracking system across all measures, for all utilities. This will include a review of the algorithms used to calculate savings, determining whether the algorithm is consistent with best engineering practice for the measure and whether it is consistent with or a viable alternative to the algorithm specified in the Mid-Atlantic Technical Reference Manual.[5] If the original algorithms are determined not to be suitable, the algorithms and/or variables will be adjusted to and rerun to calculate the measure savings. The tracking system database will be reviewed to assure that the required data for all variables are included, and that once the algorithm has been verified, the savings are accurately calculated. As discussed below, many of the assumed parameters will be assessed through this study, and will be updated as appropriate based on the findings from the research.

Appliances & Recycling

The evaluation team will verify gross savings realized from the appliance program measures by:

1. Completing a thorough engineering review of program-reported savings (for all utilities and all measures).
2. Conducting telephone surveys with a sample of appliance recycling program participants to verify participation

The findings from each of these efforts will be integrated into a single gross realization rate that calculates the proportion of program-reported savings being realized by each utility's residential appliance program based on the M&V research findings. More detail into the M&V approach is provided in Section 2.3.

2.1 Measurement Description

Lighting

As presented in Table 7, the evaluation will collect primary data on CFL hours-of-use, coincidence factor, and in-service rates. These are key parameters in estimating both energy and demand savings. Other parameters will be estimated based on secondary data.

Appliances & Recycling

Collectively, the programs provide prescriptive rebates for purchasing new, efficient home appliances or for recycling old ones. While there are some differences across the utilities regarding the specifications of program eligible measures and the incentive levels offered for these measures (see Table 1), the measures in the residential appliance programs can be generically categorized as:

[5] NEEP, Mid-Atlantic Technical Reference Manual, Version 1.0. May 2010

- Prescriptive Rebates of
  - ENERGY STAR Clothes Washers & Dryers
  - ENERGY STAR Refrigerators & Freezers
  - ENERGY STAR Room Air Conditioners
  - Efficient Hot Water Heaters, and
  - Programmable Thermostats.

- Rebates for Recycling Inefficient
  - Freezers
  - Refrigerators, and
  - Room AC Units.

2.2 *Equipment Specifications and Documentation*

Lighting

As discussed above in Section 1.4, the program assumes that CFLs replace incandescent bulbs of higher wattage. Lighting standards, however, will be changing beginning in 2012, with the phase-in of the 2007 EISA requirements. These requirements, while not impacting the first year savings estimates for the 2010 or 2011 programs, will have an impact on the lifetime savings assumptions for these program incented program bulbs.

Appliances & Recycling

Minimum equipment requirements to qualify for the appliance and recycling portions of program are presented in Table 6.

Table 6. Program Qualifying Equipment Minimum Specifications

Equipment Type	Qualifying Equipment Minimum Specifications
Clothes Washers	ENERGY STAR (MEF of 1.8 or higher with a WF less than or equal to 7.5) (Allegheny with MEF 2.0 or higher or with an annual energy use of 200 kWh or less per year).
Refrigerator	ENERGY STAR (At least 20% more energy efficient than the minimum federal government standard (NAECA).
Room AC	ENERGY STAR (At least 10% more energy efficient than the minimum federal government standards.) (Allegheny with a minimum EER of 10.8)
Water Heater	EF of 0.93 or greater (Pepco and Delmarva only)
Heat Pump Water Heater	ENERGY STAR (A maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water. Unit must have "integrated" or "drop-in" configuration.)
Dishwasher	ENERGY STAR (annual energy use of 324 kWh or less and uses less than or equal to 5.8 gallons per cycle)
Clothes Dryer	With a drum moisture sensor and associated moisture-sensing controls
Freezer	ENERGY STAR (At least 10% more energy efficient than the minimum federal government standard (NAECA)).
Electric Heat Pump Hot Water Heater	SEER 14.5 or higher and a programmable thermostat
Programmable Thermostat	ENERGY STAR

2.3 Measurement and Verification Approach

Lighting

To verify key evaluation parameters, the evaluation team will employ PJM's Option A (Partially Measured Retrofit Isolation/Stipulated Measurement). To meet Option A requirements, we will perform the evaluation activities listed in Table 7.

Table 7. Evaluation Activities

Research Area	Evaluation Activity	Evaluation Output
Gross Savings	Review sales data from participating retailers	Number of CFLs directly sold through the program
	Meter 60 homes, up to five CFLs per home/secondary data	Hours-of-use and Peak Coincidence Factor
	Review of wattage of incented bulbs/secondary data	Delta watts
Adjusted Gross	In-home audit of 80 homes	In-service rate; CFL awareness/penetration/saturation
	In-store intercepts at 40 stores (about 600 respondents)	Leakage; residential vs. nonresidential installations
	Review secondary data	Interactive effects

These activities, as relevant for each of the key parameters in the gross and adjusted gross savings estimates, are discussed below.

2.3.1 Program CFL Sales

Participating retailers are required to provide program-incented sales data. These data will serve as the basis for the gross number of CFLs incented through the program.[6] In addition, the evaluation team will review the data to ensure that there are no errors in aggregation or reporting (e.g., that the sum of sales by store matches the total reported number of sales). The evaluation team will also investigate the data for reasonableness (e.g., examining sales by store to check for gross outliers that might be due to data entry errors).

2.3.2 Annual HOU and Coincidence Factor

The data for annual hours-of-use and coincidence factor will be collected through both a metering study of 60 EmPOWER households and through analysis of the recent California CFL metering study of over 1,200 residential customers.

Extrapolation of Hours-of-use and Peak Coincidence Data from California

The KEMA baseline study proposes reanalysis of data from the recent evaluation of the California Upstream Lighting Program (ULP). That study included a metering sample of approximately 1,200 residential customers. These data would be reanalyzed and applied to EmPOWER by adjusting the model (with actual EmPOWER data) to estimate the hours-of-use and coincidence factor to account for parameters that impact hours-of-use, such as CFL

[6] The number of coupon based bulbs will also be considered for Allegheny Power.

saturation, household size, presence of children, and other factors. Note that although the California data has not been released publically yet, it is currently expected to be released by August of 2010. The existing models are currently public and could be applied to Maryland by using the same coefficients with updated inputs derived from the RASS baseline study and CFL saturation study. For the peak coincidence factor, the same approach would be used, although the coefficient estimates would be re-estimated by using different values for peak (utility and PJM) in the dependent variable of the regression model.

One limitation of the KEMA baseline study approach is that it does not include any primary data collection for hours-of-use with Maryland households. Given that the CFL program represents over 50% of the claimed demand impacts, it would be valuable to increase the rigor of the evaluation effort by including lighting logger data for Maryland residences. The evaluation team therefore proposes to conduct a metering study to serve as a validation sample on the application of California residential lighting meter data for Maryland.

In other words, actual metered hours-of-use from the primary data collection sample will be compared to the forecasted hours-of-use – for the same households – based on the application of the California metering study. If no significant differences are identified, the California data will be used to estimate the hours-of-use and coincidence factor for the entire residential population. If significant differences are identified, adjustment factors will be developed so that the analysis accounts for potential differences in the Maryland customer population.

2.3.3 Meter Participant Recruitment Methodology

Metering participants will be identified through either a random digit dial recruitment process or through the use of customer contact information. During a three-week time period, EmPOWER customers will be called to identify their interest in participating in the meter study. Customers will be screened to ensure they have a minimum of one CFL currently installed in their home. The evaluation team plans to meter both single-family and multifamily homes, and utility customers from all five EmPOWER utilities will be represented in the sample.

2.3.4 Sample Size

Calculating sample size for the lighting metering study is dependent on what parameters are being measured. For example, peak demand impacts are a function of not only hours-of-use during peak periods (the coincidence factor), but also the delta watts, in-service rate, and interactive effects. For the purposes of the sample size calculations, we have assumed that the coefficient of variation (CV, or the standard deviation divided by the mean) for the annual hours-of-use and peak demand savings estimate is 0.5.

Assuming a desired measurement for annual hours-of-use and peak demand savings with 90% confidence with 10% precision, a one-tailed test would require a sample size of 41. Although there will be multiple loggers in homes with more than one CFL - likely a large part of the sample - it would still be prudent to meter at least 41 homes for to allow for maximum

variability in the mix of saturation levels, room types, and housing type. In order to allow for data cleaning and additional stratification, we are recruiting and logging 60 households for the study (and expect to generate data from approximately 250 loggers).

2.3.5 Delta Watts

The change in watts from pre- to post-CFL installation represents the third key parameter in estimating gross savings. While the actual CFL wattage will be available from the program data tracking, the pre-installation wattage must be determined through other methods. The evaluation team, therefore, proposes to assess delta watts through the two approaches outlined below.

2.3.6 Utilizing the Stated Incandescent Equivalent

Most new CFL packaging prominently displays the incandescent equivalent wattage. As shown in Figure 1, many brands use a far larger font for the incandescent equivalent than for the actual wattage of the bulb. The evaluation team will therefore assign each CFL in the tracking database with an equivalent incandescent wattage, and will use a sales-weighted approach to determine the overall delta-watts for the program.

2.3.7 Assessment of Overall Incandescent-to-CFL Wattage Ratios

Although manufacturers have recommended a 4:1 ratio for incandescent-to-CFL wattage, there are a number of Websites suggesting that a 3:1 ratio might provide a higher consumer satisfaction with the quantity of light.[7] In addition, recent evaluations of the California Upstream Lighting Program, which examined the average wattage of installed CFLs to equivalent incandescent in the same home, found a ratio of approximately 3.6. This ratio has remained steady in the evaluations of both the 2004-2005 program cycle and the 2006-2008 program cycle, suggesting that the delta watts – unlike the hours-of-use – has not changed as saturation increases.

After calculating the sales-weighted delta watts, the evaluation team will also compare the overall ratio of incandescent-to-CFL wattage. If the manufacturer's suggested ratio is 4:1, the evaluation team will assess all the available secondary data, and will consider "de-rating" the ratio to account for the fact that consumers may select higher wattage CFL equivalent (e.g., use a 100 watt equivalent CFL to replace a 75 watt incandescent).

[7] See recent Websites for both Consumer Reports (http://www.consumerreports.org/cro/magazine-archive/october-2009/home-garden/compact-fluorescents/how-to-choose/compact-fluorescents-how-to-choose.htm) and Flex Your Power (http://www.fypower.org/res/tools/products_results.html?id=100195).

Figure 1. Example of CFL Packaging with Equivalent Incandescent

2.3.8 In-Service Rate

As noted above, the availability of low-cost, multi-pack CFLs may encourage consumers to stockpile bulbs, thus some program bulbs may not be initially installed. However, the recent evaluation of the California Upstream Lighting Program conducted a trajectory analysis and determined that nearly all (98%) of program bulbs will be installed within three years of purchase. The California findings strongly suggest that nearly all program CFLs will be installed, so the research question is to determine when – not if – to claim savings.

In order to calculate the in-service rate, the evaluation team will utilize the findings from the in-home audits. The audits will determine the total number of CFLs per household, including those installed and in storage. In addition, the survey conducted at the time of the audit will determine which CFLs have been purchased in the last 18 months, and whether those CFLs are installed or in storage.

The storage rates from this research will then be compared to those in California, and the California data will be adjusted accordingly to develop an installation rate by year that is tailored to Maryland.

2.3.9 Leakage (Spillage)

In order to assess leakage, the evaluation team will conduct in-store intercepts to determine whether the customers are also EmPOWER utility customers. The in-store intercepts will be conducted in 40 stores. The stores selected for intercepts will be stratified between urban (e.g., Baltimore) and rural (areas near electricity co-ops and mini-utilities) in order to assess differences in leakage across the service territories, as well as between stores that are at low risk

(far from the utility borders) and high risk (closer to utility borders). Assuming an average of 15 intercepts per store, the evaluation team expects to collect data from over 600 customers, collectively generating service territory-wide results in excess of 95% confidence and 5% precision.[8]

2.3.10 Residential vs. Nonresidential Purchases

The allocation of sales between residential and non-residential customers will be assessed based on the following factors:

- ***Customer intercepts.*** During the intercepts consumers will be asked if the purchase is for residential or non-residential applications;
- ***Interviews with participating retailers.*** During the process interviews participating retailers will be asked to assess the allocation of sales between the sectors; and
- ***Secondary data from studies such as the recent California evaluation.*** These data will be assessed based on differences that could vary in Maryland. For example, the California program promoted a substantial number of bulbs through dollar stores, which may have lower sales to non-residential customers compared to "do-it-yourself" stores such as Home Depot.

2.3.11 Interactive Effects

Most CFL programs have selected not to claim interactive effects, due to both the difficulty in estimating them and the possibility that they can be offsetting in some climates (i.e., decreased cooling load may be offset by increased heating load). However, there have been some studies suggesting that interactive effects can exist, particularly in extreme climates, and the California Public Utilities Commission recently accepted interactive effects as part of the evaluation of the 2006-2008 Upstream Lighting Program.[9] The evaluation team will therefore conduct a thorough review of all secondary data sources to assess if, and how, interactive effects should be included in the EmPOWER CFL programs.

Appliances & Recycling

The evaluation team will verify gross savings realized from the appliance program measures by:

1. Completing a thorough engineering review of program-reported savings (for all utilities and all measures); and

[8] While we plan on stratifying by these variables and coming up with utility specific leakage rates, the Evaluation Team needs to see the final distribution of participating stores by utility to determine if intra-utility transfers can be calculated. With the current sample size we do not think we will have the required sample to get intra-utility estimates, and – if these data are required – may need to increase the sample size.

[9] "Do CFLs Save Whole –House Energy?" Home Energy Magazine, November/December 2008.

2. Conducting telephone surveys with a sample of recycling program participants to verify participation.

The findings from each of these efforts will be integrated into a single gross realization rate that calculates the proportion of claimed savings being realized by each utility's residential appliance program based on the M&V research findings.

Table 8. Evaluation Activities

Evaluation Activity	Evaluation Output
Review Program Tracking Data	Number and efficiency of appliances directly sold through the program; baseline efficiency for appliance recycling
Engineering Review	Savings calculations
Phone Survey*	Verify program participation; Program attribution

* For appliance recycling.

These activities, as relevant for each of the key parameters in the gross and adjusted gross savings estimates, are discussed below.

2.3.12 Review of Program Tracking Data

The utility data will serve as the basis for the gross number of appliances incented through the program. In addition, the evaluation team will review the data to ensure that there are no errors in aggregation or reporting and investigate the data for reasonableness (e.g., examining sales by store to check for gross outliers that might be due to data entry errors). In addition, the evaluation team will review the appliance recycling program database to establish reasonable baseline efficiencies for recycled units by considering the age, style (e.g., top freezer) and other factors that impact energy use.

2.3.13 Engineering Review

The evaluation team will conduct an engineering review of the savings recorded in the program tracking system across all measures, for all utilities. This will include a review of the algorithms used to calculate savings, determining whether the algorithm is consistent with best engineering practice for the measure and whether it is consistent with or a viable alternative to the algorithm specified in the Mid-Atlantic Technical Reference Manual.[10] If the original algorithms are determined not to be suitable, the algorithms and/or variables will be adjusted to and rerun to calculate the measure savings. The tracking system database will be reviewed to

[10] NEEP, Mid-Atlantic Technical Reference Manual, Version 1.0. May 2010

assure that the required data for all variables are included, and that once the algorithm has been verified, the savings are accurately calculated.

For the appliance recycling programs, the evaluation team recommends calculating the energy and demand savings by applying the results of a robust metering study developed as part of the most recent statewide appliance recycling program in California.[11] In addition, the evaluation team recommends the application of the California values be validated through a bottom-up engineering analysis of the actual appliances recycled by EmPower programs. To conduct this validation, the evaluation team will develop a database detailing the per-unit savings associated with the retirement of every combination of the following appliance characteristics:

- Appliance Type (Refrigerator, Freezer)
- Appliance Configuration (Top Freezer, Side-by-Side, etc.)
- Appliance Age
- Appliance Size (Internal Cubic Feet)

The information needed to populate this database will be industry databases detailing the Department of Energy tested energy consumption of units at the time of their manufacturer. Since energy consumption increases over time as the appliance degrades, an annual degradation factor will be applied to approximate energy consumption at the time of retirement. Additional adjustment to account for weather will also be applied.

2.3.14 Phone Survey

The telephone survey effort will be coordinated with the process evaluation surveys of participants whenever practical. The objective is to verify that customers recorded in the tracking system were accurate, to determine the frequency of use of recycled appliance (primary or secondary unit and an estimate of "part use" during the year), location of the unit within the home (conditioned vs. unconditioned space), as well as estimate program attribution (net-to-gross ratio). Net to gross ratio will be determined through a standard self report net to gross battery of questions.

2.3.15 Sample Size

For the purposes of the sample size calculations for the high impact appliance recycling measures, the evaluation team proposes to conduct 120 surveys with participants in the refrigerator recycling program and 120 participants in the freezer recycling program (or 240 total participant surveys, Table 9). Based on our experience with similar recycling programs, this sample size should provide final estimates of energy and demand savings at 90% confidence with 10% precision after accounting for the variance in the NTG, part-use factor, and

[11] Residential Retrofit High Impact Measure Report, Prepared for the California Public Utilities Commission, February 8, 2010 (www.energydataweb.com/cpuc)

energy/demand modeling parameters that feed into the final savings estimates. The survey will include a proportional sample for each the three utilities (BGE, SMECO, and Alleghany) that run refrigerator and freezer recycling programs.

Table 9. Proposed Participant Surveys

Measure	2010	2011
Recycled Refrigerator	120	120
Recycled Freezer	120	120

2.3.16 Optional Survey Activities

The recycled refrigerators and freezers were selected for telephone surveys because they typically represent the highest proportion of savings in appliance programs. However, if further review of the program database reveals that the recycled room ACs or new appliance rebates represent a significantly higher proportion of savings, the evaluation team may revise the evaluation plan accordingly.

In addition, our research with retailers/haulers and non-participants in utility areas throughout the U.S. has shown little regional variation in recycling trends, as many "big box" stores have consistent policies throughout the U.S. (e.g., dispose of any refrigerators over 15 years old). The evaluation team, therefore, believes that secondary data will be adequate to estimate recycling rates. However, should the appliance recycling program savings increase dramatically (above the currently forecasted savings percent), the evaluation team may also revise the plan to include retailer/hauler interviews and non-participant end user surveys in year 2 of the evaluation to validate this assumption.

2.3.17 Gross Realization Rate

The gross realization rate for the recycled refrigerator portion of the program will be developed by applying the energy and demand model developed as part of the California ARP program, calibrated based on the actual refrigerator characteristics of the units recycled through the program. Gross energy and demand savings for recycled freezers and room ACs, as well as rebated appliances, will rely on a review of secondary data and engineering calculations.

2.4 Assumptions

Lighting

Many of the key parameters for assessing the gross and adjusted gross savings will be collected through either primary data collection or a combination of primary and secondary data. Certain parameters, however, either cannot be captured (e.g., actual pre-CFL wattage) or are cost-prohibitive to conduct as part of this study (e.g., interactive effects).

As the CFL programs are upstream and use a buy-down approach for promotion, there is no feasible way to measure pre-program conditions regarding wattage and/or hours-of-use. As such, the study assumes that these parameters can be assessed from other sources. For example, pre-CFL wattage will be assessed both on manufacturer and secondary data, while hours-of-use will be assessed through post-installation metering – thus assuming no increase (take back) or decrease in hours-of-use and secondary data.

In addition, due to the small presence of specialty bulbs (e.g., covered A-lamps, dimmables, 3-ways), the evaluation of gross and adjusted gross savings also assumes a similar approach for both standard twisters and specialty bulbs. For example, identical values will be developed for hours-of-use, leakage, in-service rates, residential vs. nonresidential, and interactive effects. Delta watts, however, will be developed based on wattage rating of the incented CFLs, and could differ between standard twisters and specialty bulbs. Due to the differences in sales, separate net-to-gross (NTG) values will developed for the standard twisters and specialty bulbs. The approach to NTG is discussed in Section 4.

Appliances & Recycling

The appliances and recycling portions of the appliance program include a number of assumptions, including:

- That the efficient appliance rebate participant is already in the market to purchase a new appliance, so that the baseline is a new, standard efficiency appliance;
- For the recycling program that the recycled appliance would have continued to have been used in the participant home or in a nonparticipant home, and thus the savings represents the full use of the unit (i.e., early replacement).

2.5 Measurement and Verification Activities: Baseline Period

As noted above, the nature of the upstream CFL program does not allow for data collection during the baseline period. Similarly, the nature of the appliances programs does not readily allow for data collection of baseline appliances or data during the baseline period.[12] These parameters, therefore, will be estimated through engineering reviews.

2.6 Measurement and Verification Activities: Post-Installation Period

Lighting

Research activities during the post-installation period include:

[12] Note that these data can be collected, as members of the evaluation team did collect baseline data as part of the CPUC study. "Intercepting" program participants and conducting in situ metering, however, is extremely expensive, and the evaluation team believes that the models developed as part of the recently completed California study can be extrapolated to Maryland.

- Meter the hours-of-use for CFLs. The metering sample will include 60 homes, with up to five CFLs per home.
- Conduct an in-home audit on approximately 80 homes, collecting information on CFL awareness, penetration (percent of homes with one or more CFLs), saturation (percentage of sockets with CFLs), as well as satisfaction and program awareness.
- Conduct intercept surveys at 40 participating retailer location, with approximately 600 end-use customers, to collect information on leakage and residential versus non-residential sales.
- Review secondary research materials, such as research conducted in California and elsewhere, for information on delta watts, leakage, and residential versus non-residential installations.
- Utilize the Maryland baseline project to identify housing characteristics that will impact extrapolation of primary or secondary data collection activities.

Appliances & Recycling

Research activities during the post-installation period include:

- Conduct participant telephone surveys as discussed above
- Review secondary research materials, such as research conducted in California and elsewhere, for information on standard (baseline) efficiencies and net to gross ratios. This information will inform the baseline and allow us to compare measure savings with that of similar programs.

2.7 Calculations and Adjustments

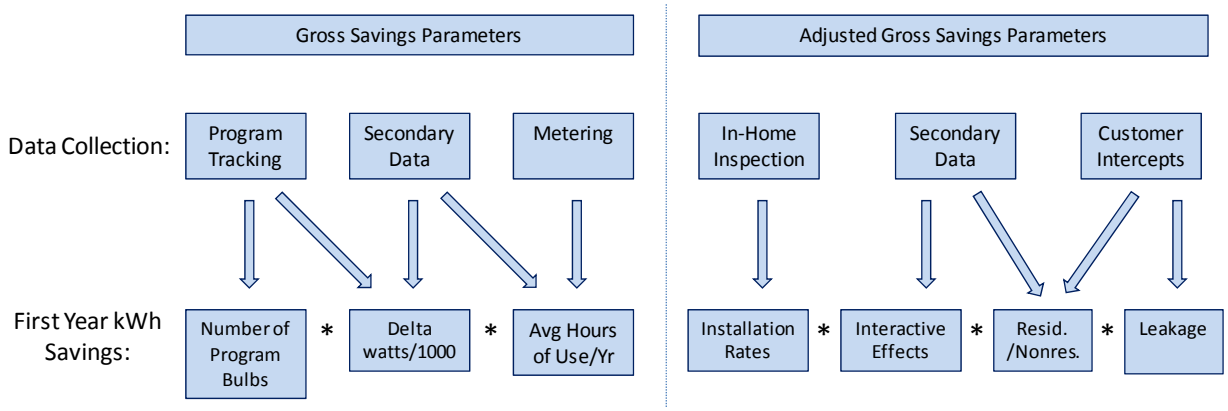
Lighting

As shown in Figure 2, the key gross and adjusted gross evaluation parameters come from a number of primary and secondary data sources. Additional information regarding the sample sizes/approach is presented above in Table 7.

Two additional parameters – expected useful life (EUL) and incremental cost – are needed to calculate the cost-effectiveness of the program. Estimating these parameters can be quite costly, however. For example, although CFLs typically include the rated useful life (in hours) on the packaging, actual lifetime can differ based on switch rates (the frequency bulbs are turned on and off), the type of fixture bulbs are installed in (closed fixtures may result in shorter lifetimes), or the presence of lighting controls (most CFLs are not meant for dimmer switches). Measuring these parameters – and the impact they have on actual lifetime – requires a long-term, multiyear field or lab test that is outside the scope of work for this project. Similarly, estimating incremental cost requires a comprehensive shelf-stocking study with pricing data collected both on CFLs and the many varieties of incandescent lamps that are available, and collecting these data can take one to two days at a single store, plus getting approval to collect these data can be

quite challenging. EUL and incremental cost, therefore, will be estimated based on secondary data sources.

Figure 2. Mapping of Evaluation Parameters and Data Sources



Appliances & Recycling

The savings estimates for rebated appliances will be calculated based on a review of secondary data and engineering calculations. For recycled refrigerators and freezers, the evaluation team will collect primary data to assess NTG and part use. For recycled refrigerators the evaluation team will apply the energy and demand model developed as part of the California ARP program, calibrated based on the actual refrigerator characteristics of the units recycled through the program. Gross energy and demand savings for recycled freezers and room ACs, however, will rely on a review of secondary data and engineering calculations.

2.8 Metering Plan

Metering will take place for the lighting segment of this program, and no metering is planned for the appliances program evaluation.

2.8.1 Equipment

Data will be collected through Dent data loggers, which record the change of state (e.g., on or off) with date/time stamps. The advantage of these loggers is that every use of the light – even for short intervals – is accurately captured. In addition, our field staff are equipped with fiber optic attachments that allow us to meter all lights, even external fixtures.[13]

2.8.2 Sampling

During the site visit, the evaluation team will install up to five light loggers. The loggers will be in place from July through September, and will collect hourly run-time information. This

[13] http://www.dentinstruments.com/media/TOU-L_Fiber_Optic_Attachment_Note.pdf

information is imperative for understanding household energy habits during peak energy usage times as well as annual hours-of-use, and will allow for a more accurate estimate of demand savings during the PJM designated months.

Information will be collected to determine the total number of fixture groups as well as the number of fixture groups containing CFLs. A "fixture group" refers to all fixtures controlled by the same switch. If both CFLs and non-CFLs are used within the same fixture group, that fixture group will be considered CFL.

The protocols require installing meters on up to five CFL fixture groups. If a home does not have five CFL fixture groups, then the meters will be installed on all CFL groups in that home. If it is determined technically infeasible to install meters on any fixture group this protocol prescribes for metering, the surveyor will fully document the technical conditions precluding meter installation. If the site contact objects to the surveyor installing meters on any prescribed fixture group, the surveyor will fully document the reasons the site contact provides. Four examples for identifying fixture groups are shown in Table 10.

Table 10. Example of Identifying Fixture Groups

Site	Number of CFL Fixture Groups	Comments
Site 1	3	Only three meters installed because dwelling only had three CFL fixture groups.
Site 2	5	All meters installed per the protocol.
Site 3	4	A meter could not be installed on one CFL fixture group because it was located by the living room window.
Site 4	4	A meter could not be installed on one CFL fixture group because the customer refused. An extra meter was installed on a non-CFL fixture group, per the protocol.

Surveyors will also use a protocol to determine which specific fixture groups to meter, ensuring meters are installed randomly. Each site will be assigned a random start number, based on a range of possible fixture groups present at the site. The surveyor will count from that point a predetermined number of fixture groups (e.g., every 4th fixture group); meters will then be installed according to the protocol. Table 11 summarizes the protocol for selecting CFL fixture groups for metering.

Table 11. Fixture Selection Protocol

Number of Total Fixture Groups at Site	Random Start Number (CFL)	Meter Every (CFL)
1-5	1	1st
6-10	1-5	2nd
11-15	1-10	3rd
16-20	1-15	4th
21-25	1-20	5th
26-30	1-25	6th
More than 30	1-30	7th

For example, if a site has 21 to 25 fixture groups, the surveyor will look up the random start number for that site and fixture group category. If the random start number is 7, the surveyor will go to the Lighting Inventory Form and identify the seventh CFL fixture group. Per the protocol, the surveyor will then count CFL fixture groups from the seventh CFL fixture group until he/she gets to the fifth CFL fixture group past the random start assignment. A meter will be installed on this fixture group; the surveyor will then count again until the next fifth CFL fixture group is identified.

2.8.3 Quality Control

All field staff will undergo training for installing the lighting loggers and conducting the onsite audit. A copy of the training protocols are included in Attachment 2. Data entry errors will be minimized by the application of "rules" to the forms (limiting the entry of erroneous data). In addition, experienced engineers will conduct ride-along QC checks with all junior staff to ensure that the protocols are being properly implemented in the field.

As part of the analysis, all meter data will be checked for inconsistencies at two points in the process. First, data collection forms are checked for notes indicating possible tampering or damage to meters retrieved. If any such thing occurred, the data from the offending meter will be removed. Second, once data are formatted they are inspected for inconsistencies by running frequencies and means for all data fields (and spot checking for those outside of an acceptable range). If no variation in light level is indicated for the full duration that the meter is logging (which includes pre- and post-installation periods), then that data are discarded. This follows the assumption that light meters should have at least some variation in transport to the installation site. Meters which indicate that the observed fixture was on for the entire metering period will not necessarily be discarded, as this can be common for some types of common area lighting. In these cases, there would still be a short period of variation just prior to installation. The meter should then indicate the fixture being on until removal, at which point a small amount of variation would again be observed.

Section 3. Approach to Process/Market Evaluation

3.1 Process Evaluation Overview

For each utility's Residential Lighting and Appliances Program, the team will conduct a formative process evaluation that consists of collecting and analyzing data to uncover insights about the program design and operation which lead to useful program improvements. The process evaluations will investigate these research areas: (1) Program Participation; (2) Effectiveness of Program Design and Implementation; (3) Effectiveness of Program Processes; and (4) Opportunities for Program Improvement. The following types of questions will be investigated for each research area:

3.1.1 Program Participation

a. What does retailer/manufacturer participation look like? Which products were preferred?

b. Are retail customers aware of the program?

c. Does retailer/manufacturer participation meet expectations? If not, how different is participation from expectations, and why? What are the greatest factors in non-participation? What types of retailers/manufacturers are participating in the program? Does this meet program expectations?

d. Do sales/participation levels meet expectations? If not, how they different from expectations, and why?

3.1.2 Effectiveness of Program Design and Implementation

a. What are the key elements of the program including the ultimate goals; market barriers and associated market actors; and program activities, inputs, anticipated outputs/goals, and external influences?

b. Is the program design effective in meeting the goals? Are any design elements creating barriers to participation by retailers or manufacturers? Has the utility assigned sufficient resources to implement the program? Are the data collection and management tools effective?

c. What implementation challenges occurred and have they been overcome? If so, how? If not, why not? What is being done to address these challenges?

d. How well does data tracking work? Does the program implementer (if applicable) provide information in a timely fashion? Are all necessary data tracked and easily provided? Do the program managers have adequate internal data tracking mechanisms that give a comprehensive view of program status?

e. Does the program have adequate staffing levels to operate effectively?

3.1.3 Effectiveness of Program Processes

a. Are the program's outreach and marketing efforts increasing awareness of the program opportunities and desire to participate? Are they effective at motivating customers to purchase CFLs and energy efficient appliances, or to recycle used appliances?

b. Are the incentive levels and measure types sufficient to motivate participation?

c. Are participants satisfied with the program and its offerings?

d. Have the participation process and program requirements been clearly explained to participants? Is the application process onerous? Does the process present any barriers to program participation?

3.1.4 Opportunities for Program Improvement

a. What areas could the program improve to create a more effective platform for customers and retailers/manufacturers to increase energy and demand impacts?

b. How is the program addressing the economic downturn and how could it be modified to further assist customers in achieving energy savings?

We will coordinate the process evaluation where possible with the impact evaluation efforts, (i.e., we will incorporate process evaluation data collection efforts with the impact data collection efforts). Further, we will design the process evaluation results to inform the impact evaluation; for example, through contributing to the calculation of program net savings and providing supply-side research obtained through retailer and manufacturer interviews.

This evaluation is a two-year effort with the goal of providing draft process evaluation reports by March 1, 2011 and March 1, 2012. During the first year, the process evaluation will be heavily focused on recommending program design and strategy changes for the 2012-2015 program cycle and will make use of early feedback memos and interim reporting of select findings (e.g., preliminary results will be presented in the December 2010 report prepared by the evaluation team) to ensure timely input into the program planning process. The focus of the second year may change slightly depending on the first year findings.

3.2 Data Collection Tasks

In order to best answer the research questions outlined above for the Residential Lighting and Appliances Programs, we plan to conduct several data collection efforts. The data collection methods that will answer each research question are summarized Table 12 and discussed in more detail in the following sections.

Table 12. Process Evaluation Data Collection Methods

Research Area	Data Collection Method				
	Program Material Review	Program Staff Interviews	Customer Surveys[1]	Participating Lighting Retailer/ Manufacturer Surveys[2]	Non-Participating Lighting Retailer/ Manufacturer Surveys[2]
Program Participation	X	X	X	X	
Effectiveness of Design and Implementation	X	X		X	
Effectiveness of Program Processes	X	X		X	X
Opportunities for Improvement	X	X	X	X	X

[1] The evaluation team will conduct lighting surveys with 100 respondents in 2010 and 400 respondents in 2011. The team will also conduct surveys with 240 participants in the recycling program in both 2010 and 2011.

[2] For lighting, the evaluation team will conduct interviews with as many as 75 participating trade allies and 75 non-participating trade allies in both 2010 and 2011 (up to 75 interviews per year, or 150 total).

3.2.1 Program Material Review

Program materials communicate critical information to target audiences and back to the program managers. The objectives of program materials are to inform and market CFLs and energy efficient appliances, encourage participation, and collect needed participant information. The process evaluation team will examine program material visuals and content for adequacy, clarity, and effectiveness of messaging. For the database review, we will determine the number of participating retailers/manufacturers and the total number of CFLs sold through either buy-downs or coupons as well as the total number of appliances sold or recycled through the program. In addition, we will look at the effectiveness and quality control of data tracking including frequency, timeliness, and comprehensiveness.

In addition to our own expert review, where possible we will compare the utilities' materials with best practices as determined in previous evaluations of similar programs operating in other jurisdictions. We will also include questions about program materials in our interviews with retailers/manufacturers and our customer surveys, and will draw from all these sources to provide feedback and recommendations to utilities. We will make actionable recommendations as soon as possible to the utilities through interim feedback memos; the recommendations will all be summarized in our final report.

Our review of Residential Lighting and Appliances Program materials will include:

- Marketing materials from the general EmPOWER campaign and for the residential lighting programs in particular.
- Informational materials provided to retailers/manufacturers and customers.
- Printed material or Website pages used to inform customers about CFLs, efficient appliances and recycling of inefficient appliances.
- TV or radio scripts.
- Coupon forms (where applicable).
- Data tracking tools.

3.2.2 Program Staff Interviews

The evaluation team will conduct structured interviews with Residential Appliance and Lighting Program management and implementation staff at least once annually throughout the evaluation period. Table 13 provides an overview of the various implementation contractors who serve the utilities. In addition, we will conduct interviews with the appropriate subcontractors for the recycling portion of the programs (e.g. Jaco). We will communicate with all implementers on an as-needed basis to answer questions and discuss issues as they occur. Our structured interviews will focus on:

- Roles and responsibilities of all program staff;
- Program processes and procedures, training opportunities, and progress of educating retailers/manufacturers on program goals, including the effectiveness of the incentive mechanism;
- Perceived barriers to program participation and staff approaches for overcoming those barriers;
- Description of all program services, educational processes with outputs, and expected outcomes from each activity;
- Expected savings opportunities and market effects from each program element;
- Perceived successes and future challenges;
- Data resources, databases, and tracking system processes to secure the needed data; and
- Documentation for evaluation and key researchable issues for data collection and analysis.

Table 13: Lighting and Appliances Program Implementation Contractors

Utility	Implementer
Allegheny Power	None
BGE	ICF
Delmarva	Honeywell
PEPCO	Honeywell
SMECO	ICF

We will conduct up to 30 in-depth interviews with program managers and relevant implementation contractor staff across the five utilities. These interviews will help address the four research areas outlined previously. This discussion began during our initial process related interviews conducted in June 2010, and will continue with more focused interviews to answer our process questions and discuss the program theory. In cases where one contact from either the utility or the implementation contractor managers both the lighting and appliance portions of the program we may divide the interview into multiple sessions to avoid potential survey fatigue.

The evaluation team will seek to clarify specific elements of the program implementation process to identify strengths and potential areas of improvement. More specifically, these interviews will review the program design as a step towards developing program theory and logic models. The interviews will also address any implementation challenges that have occurred and any changes that may have been made to address these challenges. Further, we will review opportunities for program improvement for both existing resources within the utility and for broader economic conditions.

Table 14. Management and Staff Interviews

Utility	Type	PY 2010	PY 2011
Each Utility	Utility Management	2-3	2-3
	Implementation Staff	2-3	2-3

3.2.3 Trade Ally Interviews (Lighting only)

The evaluation team will work with each utility to identify and interview an appropriate number of participating and non-participating retailers and manufacturers (i.e., trade allies). We will begin with an interview protocol relevant to all lighting programs, and we will tailor these protocols to each utility's program and concerns.

We will conduct interviews or surveys as appropriate based on the number of participating and non-participating trade allies during the program evaluation period. The evaluation team will select retailers and manufacturers representing different levels of activity in the program, ensuring that we get a mix of retailer/manufacturer types (e.g., large home improvement stores, grocery stores, and club stores). We will purposefully identify large retailers and manufacturers not participating in the program, as well as a random sample of non-participating small to medium retailers and manufacturers. Participating trade allies will be drawn from the utility data tracking systems. Non-participating trade allies will be drawn from yellow page searches and program managers' knowledge of the residential lighting market. In addition, the retailer interviews will include a mix of store managers/lighting staff as well as corporate level respondents.

Interviews will cover the trade allies' program experiences, satisfaction level, and any changes they have made to stocking or recommendation practices as a result of program education and benefits. The interviews also will examine trade ally experiences in working with the target market, focusing on market and consumer barriers across housing groups (such as single-family and multifamily groups). Trade ally interviews will also inform the impact evaluation by providing self-reported inputs to the net-to-gross analysis.

Table 15. Lighting Trade Ally Interviews/Surveys[14]

Utility	Type	PY 2010	PY 2011
All Utilities	Participating trade allies	75	75
	Non-participating trade allies	75	75
PEPCO	Participating trade allies		
	Non-participating trade allies		
DPL	Participating trade allies		
	Non-participating trade allies		
BGE	Participating trade allies		
	Non-participating trade allies		
SMECO	Participating trade allies		
	Non-participating trade allies		
Allegheny	Participating trade allies		
	Non-participating trade allies		

[14] To be completed when population sizes are available.

3.2.4 Participant Surveys

Lighting

Because of the upstream focus of the CFL portion of the Residential Lighting and Appliance Programs, the participant (i.e., the entity receiving the incentive) is not the end-use customer, but retailers and manufacturers. End-use customers purchasing program bulbs are often not aware of buy-down programs. In a recent evaluation of the California Upstream Lighting Program, where over 75% of CFLs were purchased through the program, only 4% of CFL purchasers reported seeing the utility logo on the packaging (signaling a program discounted bulb).

Where incentives are received by the end-use customer, as in the case of the Allegheny coupon-based approach, the evaluation team will conduct telephone surveys with a sample large enough to provide 90% confidence/10% precision. Respondents will be asked about:

- Awareness of the program
- Prior experience with CFLs
- Satisfaction with CFLs
- Self-reported freeridership and spillover

Appliances and Recycling

The evaluation team will conduct a telephone survey with customers participating in the programs as of September 1, 2010.The surveys, which will explore both the process and impact evaluation topics, will include a sample size will be large enough to satisfy a 90 percent confidence level with a +/- 10 percent error across all utilities. We will base our final sample design and size on a review of PY1 participation data across all utilities. The survey questions will focus on process issues (e.g., how they became aware of the program and their program experiences) and initial barriers to participation (e.g., cost). The surveys will also include questions to allow program managers to understand the customers' decision making processes and the level to which program benefits influenced their decision to purchase the measure. These questions will be used to assess freeridership and spillover, which also will contribute to the development of a net-to-gross estimate.

3.2.5 Customer Surveys and In-home Audits (Lighting Only)

The evaluation team will also conduct surveys and in-home audits with a random sample of residential customers across all five utilities. The surveys and audits will be conducted in two rounds, the first in July 2010 as part of the recruitment process for the metering study (with a sample of approximately 100 respondents), and the second in July 2011 (with approximately 400 telephone survey respondents and 100 onsite audits). The surveys and in-home audits will be used to feed into the net-to-gross analysis, discussed in the next section, but will also assess:

- CFL awareness
- CFL satisfaction
- Household penetration (percent of homes with one or more CFLs)
- Household saturation (percent of sockets with CFLs)
- Storage rates
- Program awareness
- Environmental attitudes
- Demographic and household characteristics

3.3 Process Evaluation Deliverables

3.3.1 Logic Models

The evaluation team will work with program managers and implementation contractors to develop program theory and logic models for the lighting, appliances and recycling programs. A program theory provides the underlying rationale for the cause and effect relationships of a program. A logic model is the graphical representation of a program theory, showing the flow between the activities and outputs, as well as the short-term, intermediate, and long-term outcomes.

Program theory and logic models help to determine why program activities are expected to create specified outputs and outcomes, particularly for new programs as they tend to have untested cause and effect relationships. Logic models are also used to develop performance indicators that can be monitored over time. At the same time, these models can be used to identify high priority research opportunities, such as the effectiveness of key program elements or additional market research, which can further inform the design and delivery of the program activities.

We will develop and deliver a three program-wide theory and logic models – one each for lighting, rebated appliances, and recycled appliances – to the utilities by December 2010. This model will be finalized upon an iterative review by program managers and other relevant staff. The model will delineate any utility-specific activities as needed. During this process, the evaluation team will develop, and the utilities will review, key performance metrics and success criteria associated with the programs.

3.3.2 Reporting

The evaluation team will conduct a formative process evaluation for the lighting, appliances and recycling programs. We will collect and analyze data from the various data collection efforts to formulate conclusions regarding program design and implementation. Our conclusions will provide actionable recommendations for improvement, focusing on the four research areas identified above, and will take into consideration the utility needs and priorities. To meet the utilities' desire for feedback as early as possible, the team will deliver early program feedback memos and interim reports in addition to a final annual report.

The early program feedback memos will provide key insights and information from the initial data collection tasks. These include program material review, program staff interviews, and participating and non-participating retailer/manufacturer interviews. The evaluation team will provide these interim memos outlining findings specific to each utility. These memos will provide each utility with timely feedback regarding process-related findings that can serve as input to program design and delivery. The memos will be provided to each utility as they become available.

Interim process evaluation results will be presented in the December 1, 2010 report prepared by the evaluation team. This report will focus primarily on impact evaluation findings; however, interim process findings will also be included to the extent they are available. The draft comprehensive process evaluation report will be submitted on March 1, 2011 and the final process evaluation report will be submitted on or about May 1, 2011. This schedule will allow the evaluation team to complete the requisite data collection tasks and develop actionable recommendations to support the 2012-2015 program cycle.

During the first year, the process evaluation report will focus on recommending program design and strategy changes for the 2012-2015 program cycle. During the second year, the focus may remain the same or change slightly depending on the first year findings. These reports will include a net savings analysis as well as process findings derived from our data collection efforts. The process team will also provide information that will serve to inform initial impact analysis.

Section 4. Net Savings Analysis

4.1 Net Savings Analysis - Lighting

Residential upstream lighting programs are a cost-effective approach to administer, promote, and influence consumers to purchase and install CFLs. This approach has been very effective in selling large quantities of CFLs, but makes it difficult to evaluate net impacts of the program. Reasons for this difficulty include:

- The upstream approach is invisible to the consumer and it is nearly impossible to distinguish program participants. Studies have shown that a high percentage of end-use customers are not aware that they are even a participant in a program. For example, a recent California CFL-user survey determined that less than 4% of recent CFL purchasers remember seeing the utility logo on the packaging, despite the fact that program bulbs represented approximately three-quarters of all program sales.
- The marketing and outreach components of the program are expected to lead not only to program CFL sales, but also to a potentially large number of non-program CFL sales. These sales can occur both at participating retailers (either during or outside the program promotions) and at non-participating retailers. Limiting the NTG analysis to only those few respondents who recall purchasing a program bulb would significantly underestimate the program impacts. In fact, studies conducted in Wisconsin, Massachusetts, and Vermont in 2005 and 2006 found NTG values exceeding 1.0 due to the influence they exerted on the overall CFL market.

To address these challenges, the evaluation team has developed an approach which estimates baseline CFL sales that would have occurred in the absence of any program activity. Rather than the standard program self-report method of calculating NTG values based on identifying program participants via a tracking database and asking a random sample about the influence the program had on their decision to purchase the energy efficient measure, the approach relies on a multivariate regression model to determine the hypothetical baseline.

4.1.1 Modeling Approach and Activities

Through primary data collection activities, the multistate model estimates the sales of CFLs from states and areas with no programs; states and areas with new or recently expanded programs; and states and areas with long-standing programs. As of August 2010, the multistate model effort will include survey data from (1) ten sponsors in states that run programs, including Massachusetts (MA collaborative), Rhode Island (NGrid), Michigan (Consumers Energy), New York (NYSERDA), Missouri (AmerenUE), Illinois (ComEd and Ameren IL), Arizona (SRP), and Ohio (DP&L); and from (2) baseline regions without program activity, including Kansas, Indiana, Texas (Houston), and South Dakota.

Having respondent data from states varying on the continuum of program activity as well as demographic and economic characteristics will assist with assessing the effects of individual

program activity on CFL sales. In addition, the advantage of a statistical model is that it controls for many variables (income, education, access to big-box stores, energy prices, etc.) that can impact CFL sales, plus the model utilizes thousands of records, providing more statistical power.

CFL sales are estimated through both random digit dial (RDD) telephone surveys and onsite lighting audits. The phone surveys attempt to interview the person responsible for lighting purchase and recruit onsite participants. A trained technician performs the onsite audits, capturing every CFL throughout the home including the manufacturer, model number, and any specialty features. The technician also inquires about when CFLs were purchased and counts CFLs in storage, thus providing a verified, reliable estimate of both CFL sales and saturation.

After capturing sales data, the evaluation team will develop a regression on CFL purchases, controlling for other factors that impact CFL sales. An example of the final model might include:

$$CFL\ Purchases\ per\ Household = b_0 + b_1 Program\ Characteristics + b_2 Demographic\ factors + b_3 Household\ Characteristics + b_4 Environmental\ Opinions + b_5 Other\ CFL\ related\ factors + e$$

Where:

- Program Characteristics = History/magnitude of the program[15]
- Demographic factors = Matrix of demographic variables including income and education of respondent
- Household Characteristics = Matrix of household characteristics including the home size and ownership status
- Environmental Opinions = Matrix of attitudes towards environment/climate change
- Other CFL related factors = Matrix of other factors that may impact CFL sales, such as utility rates and presence of big box stores
- *E* = Error term

The model, therefore, isolates the effect of the program on sales and establishes a modeled baseline of CFL purchases in the absence of the utility program. The "lift" in purchases, as

[15] Based only on objective data (e.g., dollars spent per customer), no subjective measurement of program effectiveness will be included in the model.

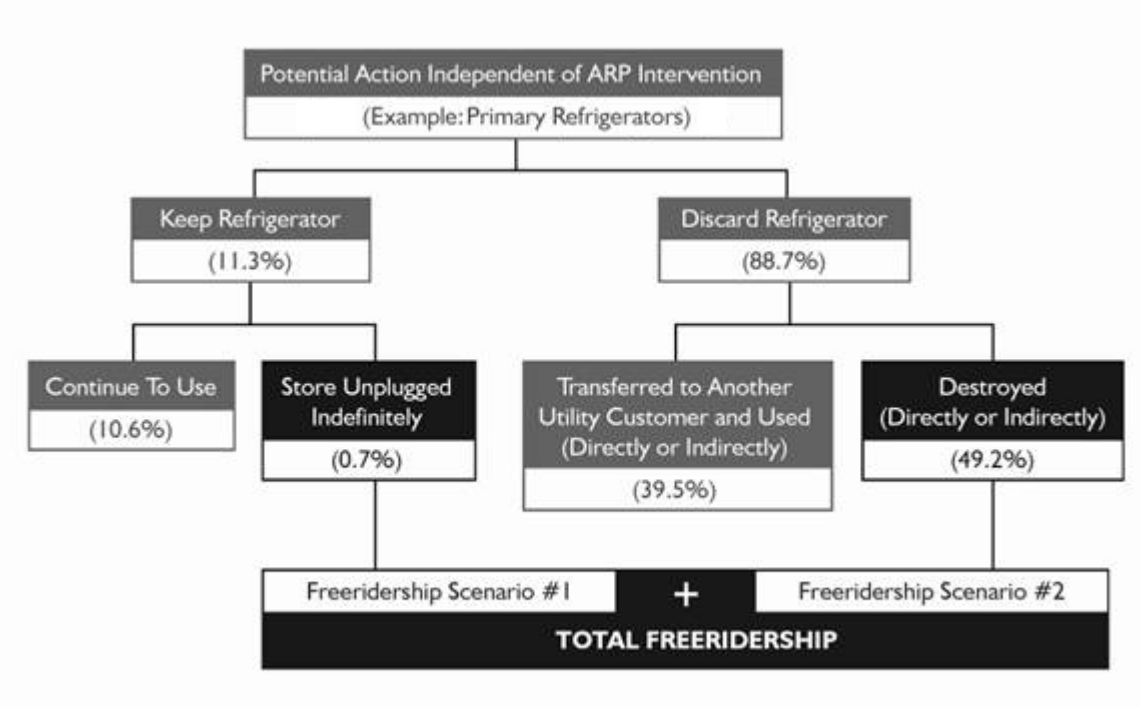
indicated by the program variable, is the effect that is attributable to the program activities.[16] It is important to note that the uncertainty and variability in the CFL market over the last few years make estimating the NTG quite difficult. If the model does not effectively determine program effects, the evaluation team will rely on the NTG collected through the upstream interviews.

4.2 Net Savings Analysis – Appliances Recycling

While freeridership typically estimates the percentage of a measure that would have been installed in absence of a program, recycling program are unique in that freeridership is really based on units that either were not used at all or would have been taken out of use even in absence of the program. A schematic of the approach is presented in Figure 3, with the telephone surveys with refrigerator and freezer participants serving as the primary data source, supplemented by secondary data sources.

Net savings for all other appliance measures will be estimated based on secondary data research.

Figure 3. Appliance Recycling NTG Methodology



[16] The evaluation in California found no difference in non-program price in CA and prices in non-program states, thus price is co-linear with the program variable, so is deliberately left out of the model. The program variable, in other words, will pick up the presence of lower priced CFLs.

Section 5. Schedule and Budget Summary

The total two-year budget for the Lighting and Appliances evaluation is $1,185,000, of which $908,000 is allocated to the impact evaluation and $277,000 is allocated to the process evaluation.

Lighting

The total two-year budget for the Lighting portion of this evaluation is $1,010,000. Table 16 shows the key milestones for the Year-1 evaluation of the Lighting portion, while Table 17 shows the targeted sample sizes for each data collection activity.

Table 16. Key Lighting Milestones for Year 1 Evaluation

Milestone Description	Timing
Preliminary high level interviews with program staff	Early/Mid June 2010
Collection of meter data on residential lighting	July – October 2010
Customer surveys and in-home audits	July-August 2010
Program staff interviews	August 2010
Program material review	August 2010
Program theory and logic models	August – September 2010
Retailer/manufacturer interviews	September-October 2010
Customer intercept surveys	September-October 2010
Engineering review results memo	October 2010
Participant surveys	October 2010
Review of secondary data (delta watts/interactive effects)	October 2010
Analysis of results and report writing	November 2010
Final report (covering activity through Q3 2010) – Will include interim process evaluation and net effects findings	December 1, 2010
Evaluation draft for the multistate lighting study	December 2010
Update memo (true-up of verified savings applying RRs calculated based on activity through Q3 2010, but applied to the total year's reported savings).	January 30, 2010
Draft comprehensive process evaluation report	March 1, 2011
Final comprehensive process evaluation report	May 1, 2011

Table 17. Lighting Tasks and Sample Sizes by Year

Task Description	2010	2011
Collection of meter data	60	
Customer surveys	100	400
In-home audits (Nested sample)	80	100
Program staff interviews	15	15
Program material review	✓	✓
Program theory and logic models	✓	✓
Retailer/manufacturer interviews	150	150
Customer intercept surveys	600	
Engineering review results memo	✓	✓
Participant surveys (AP only)	70	70

Appliances

The total two-year budget for the Appliances portion of this evaluation is $175,000. Table 18 shows the key milestones for the Year-1 evaluation of the Lighting portion, while Table 19 shows the targeted sample sizes for each data collection activity.

Table 18. Key Appliance and Recycling Milestones for Year 1 Evaluation

Milestone Description	Timing
Preliminary high level interviews with program staff	Early/Mid June 2010
Customer surveys	August 2010
Program staff interviews	August 2010
Program material review	August 2010
Program theory and logic models	August – September 2010
Retailer/manufacturer interviews	September-October 2010
Engineering review results memo	October 2010
Participant surveys	October 2010
Review of secondary data	October 2010
Analysis of results and report writing	November 2010
Final report (covering activity through Q3 2010) – Will include interim process evaluation and net effects findings	December 1, 2010
Update memo (true-up of verified savings applying RRs calculated based on activity through Q3 2010, but applied to the total year's reported savings).	January 30, 2010
Draft comprehensive process evaluation report	March 1, 2011
Final comprehensive process evaluation report	May 1, 2011

Table 19. Appliance and Recycling Tasks and Sample Sizes by Year

Task Description	2010	2011
Appliance Recycling Customer surveys	240	240
Program staff interviews	15	15
Program material review	✓	✓
Engineering review results memo	✓	✓
Program theory and logic models	✓	✓

Section 6. Attachments

Attachment 1: Lighting Audit Onsite Data Collection Instruments

Attachment 2: Training Protocols for Lighting Field Staff