**General Approaches for**

**Estimating Key Parameters for the**

**Retail Plug-Load Portfolio Program**

**Submitted by**

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# **Introduction**

## The Retail Plug-Load Portfolio Program

On November 1, 2013, a trial run (the Trial) of the Retail Plug Load Portfolio (RPP) Program concept was launched by Pacific Gas and Electric Company (PG&E) in collaboration with one retailer, Kmart, and the Sacramento Municipal Utilities District (SMUD). The RPP program is a midstream design whereby a portfolio of consumer energy efficiency measures is delivered through retail channel partners. The retail channel, particularly large retailers who are significant players in this channel,[[1]](#footnote-1) is ideally suited to assist PG&E in transforming the market for the most energy efficient products. Because the intervention is aimed at primarily midstream market actors, it is considered to be a market transformation program. A market transformation program is one that is specifically designed and fielded for the purpose of changing the way a market operates over a long-term basis so that energy savings are achieved *at a market level*.

The advantages of such a midstream program are:

* Incentives are attractive to retailers even though similarly-sized incentives are less likely to motivate changes to end-user behavior when offered through downstream programs because they represent a small percentage of the average selling price of the rebated item,
* The utility program administration costs are minimized,[[2]](#footnote-2)
* Such programs can leverage Energy Star branding,
* Midstream models enable energy efficiency program sponsors to take advantage of retailers’ marketing strengths and abilities to shape customer experience, and
* Such programs can influence manufacturers’ product features when retailers select their product assortments.[[3]](#footnote-3)

A midstream program design is also attractive to PG&E given that more than $10 billion of energy-consuming consumer products are sold through retailers in PG&E’s service territory. Moreover McKinsey estimates that products sold through the retail channel may account for nearly 30 percent of the future energy savings potential.[[4]](#footnote-4) The *2013 Potential and Goals Study[[5]](#footnote-5)* is reasonably consistent with this forecast noting:

*There are many new appliance plug measures that are coming into the market and modeled in this study. The results show that these new appliance plug measures [computers, power strips, vending machine controllers, TVs, clothes washers, dishwashers] have a significant impact on energy savings potential and make up nearly a quarter of the [market] potential savings in 2020. (p. 138)*

In addition, the U.S. Department of Energy’s Energy Information Administration (DOE/EIA) estimated that “other” electricity consumption, combined with televisions and office equipment, represented about 29% of U.S. residential annual electricity consumption in 2006 and will grow to approximately 36% in 2020. EIA forecasts that the “plug load” annual consumption will increase by 31% over the same period, on a per household basis (TIAX LLC, 2008). Drexler (2013) underscored the importance of midstream interventions:

*The goal of midstream programs is to transform markets by motivating retailers to stock and sell qualifying high-efficiency products. It stands to reason then that successful midstream programs can rapidly transform markets because retailers that are effective at moving high efficiency products off the shelves can quickly saturate markets. In turn, utilities will need to provide incentives for more-efficient technologies in step with market changes to sustain their programs. (p. 3)*

In summary, the RPP Program is a holistic, multi-product intervention that uses retailer engagement to increase the retailer demand for, and the supply of, more energy efficient home appliance and consumer electronic products. Retailers have been chosen as the point of intervention because of their ability to impact the entire value chain. Retailers work with manufacturers early in product development to determine feature sets and consumer demands. Retailers work with consumers late in the value chain when they sell the products to the end customers in the physical and virtual locations where they make purchases on a regular basis. Retailers’ ability to drive these multiple points makes them one of the more effective market actors in the creation of sustainable market effects. This approach allows retailers to do what they do best: sell program-qualified products using their own proven strategies.

Each product category has its own technical challenges, development timeline, supply chain, end-users, barriers, and opportunities. Although there are similarities across product types, programs should treat each product individually when designing an implementation strategy. It is not advisable to treat a diverse group of retailers offering a diverse portfolio of product categories as if a single strategy can address this collection of unique challenges.

The Trial is the first test of an innovative intervention designed to address the problem of growing plug load at the retail store level and is scheduled to run through December 2014. In 2015, it is expected that the RPP will be scaled to include three or four additional retailers.

## Report Objective

The objective of this brief report is to describe, in general, the various approaches to estimating three key parameters for use in planning the RPP Program and to recommend methods, in rank order of preference, for estimating values for each of the product categories. The three parameters are:

* Net-to-gross ratio (NTGR)
* Effective useful life (EUL)
* Incremental measure cost (IMC)

Because the RPP Program is primarily a market transformation program, these inputs must consider the:

* Time frame of the cost,
* Time frame of the benefits, and
* Approaches for inputting the fraction of the naturally occurring savings and costs that would have happened without the initiative. (Prahl and Keating, 2014)

The approaches outlined in this report are based on the following observation of Prahl and Keating (2014):

*Avoid seeking a fundamentally different cost-benefit analysis approach for market transformation initiatives than for resource acquisition programs. Rather, recognize the need for limited changes in the way the CPUC’s TRC test and cost-effectiveness calculator handle some inputs. The single most important change would be a lengthening of the time-frame covered by the analysis, specifically the handling of up-front costs and delayed benefits. (p. 6)*

Prahl and Keating go on to note:

*Our three main associated recommendations for adjusting the inputs to the cost-effectiveness calculator would entail:*

1. *Inputting the gross savings values as the total of the stream of savings for all of the measures adoption forecasts over the projected term of the initiative times the effective useful lives of the measures.*
2. *For TRC costs, inputting the stream of administrative and incremental measure costs that match the time frame of the savings impacts. If appropriate, the incremental measure cost forecast for measures adopted due to program influence should reflect any reductions below the forecast baseline incremental cost due to competition and economies of scale resulting from the increased market for the measure resulting from the program.*
3. *As the appropriate net to gross input for the calculator, using the ratio of forecast total market change minus the forecast of the baseline changes divided by the total market change for the same time period used for both the costs and savings. (p. 23)*

Whenever possible, we will rely on DEER for EULs and IMCs. When the RPP measures are not in DEER, other sources of data will be identified. Also, because the NTGRs in DEER do not apply to market transformation programs, other approaches that have been identified in such documents as *A Framework for Planning and Assessing Publicly Funded Energy Efficiency* (Sebold et al, 2001) are recommended.

# **Net-to-Gross Ratios (NTGRs)**

The net-to-gross ratio is factor representing net program load impacts divided by gross program load impacts that is applied to gross program load impacts to convert them into net program load impacts. This factor is also sometimes used to convert gross measure costs to net measure costs. We have identified three basic approaches to estimating NTGRs for market transformation programs: analogic diffusion models, Delphi panels, and a combination of these two. Each is discussed below.

## Analogic Diffusion Models

Our preferred approach to estimating NTGRs is the one suggested by Sebold et al., (2001) as well as Prahl and Keating (2014) that involves long-term forecasting:

*A third potential issue is the need to provide a surrogate for net to gross ratios used in the cost-effectiveness calculator. With market transformation, the gross market changes observed over the time horizon of a market transformation initiative are not all linked to the utility or other public policy intervention. Some of it is naturally occurring – even a slow growing product, if it is moving into the market will have an increasing penetration, even without a strategic market transformation intervention. This equates to the non-net portion of a resource acquisition.*

*For market transformation initiatives, naturally occurring growth must be forecast into the future and debited from the overall cumulative impact of the initiative. Naturally occurring growth may occur in a nonlinear fashion, starting from close to zero in many cases, but not forecast to stay that way. It may be necessary to compute an overall cost and benefit reduction over the time horizon within the calculator, or to select an average annual net to gross adjustment. (p. 45)*

NTGRs would be calculated for each RPP product category and the RPP Program as a whole. The NTGR would be based on forecasts of the RPP share with and without the RPP Program. The RPP share is defined as the proportion of all models purchased in participating retailer stores that are program-qualified.

For a Bass diffusion model, three key inputs are required when forecasting the RPP share for a particular product category:

* Market potential
* Coefficient of innovation
* Coefficient of imitation

Once the market potential is estimated, a number of diffusion scenarios will be estimated that describe the penetration of the product until the market potential is achieved. In the Bass diffusion models, potential buyers are divided into two major classes: innovators and imitators. Innovators (Ino) are viewed as the first buyers to enter a market during a given period of time. Their purchases are assumed to be motivated by commercial or external sources of communication over the planning period. Imitators (Imi) are assumed to purchase on the basis of interpersonal influence processes within a market. The diffusion model is formulated as:

Adpt = Ino (Pot – Cumt) + Imi (Cumt/Pot)(Pot – Cumt) (1)

where

Adpt = The number of adopters at time *t*

Ino = Coefficient of innovation

Imi = Coefficient of imitation

Pot = Market potential

Cumt = Cumulative number of adopters by time *t*

Typically, the Ino and Imi parameters are estimated with a multiple regression analysis based on a product’s historical sales data, which is then used to predict the penetration of market potential. However, this approach would not work in this current situation where there is insufficient historical data. Consequently, an analogical diffusion model will be explored. Analogical diffusion models follow the structure of Equation 1. The literature will be reviewed to identify estimates of the two parameters (Ino and Imi) that were estimated from the historical data of existing product analogies, market studies, and published data. Recent literature on Bass diffusion models will also be reviewed to insure that the most appropriate model specifications are identified.

It is essential to underscore that for the RPP product categories there is a fair amount of uncertainty regarding these parameters and their diffusion. For example, the size of the advertising budget for the RPP Program, future funding from the California for energy efficiency programs, the price of electricity, or the health of the economy cannot be predicted. While there is some information regarding the current penetration and even market share for some of energy of some of the product categories, such data are not available for all. Having said this, for each product category, two sets of diffusion parameters will be developed that define two basic scenarios. One set of parameters will represent the current situation without the RPP Program. The second set will represent a situation with the RPP Program. The intention here is to set the bounds within which families of possible diffusion curves may exist.

A forecast of the long-term savings was done for a hypothetical product category using the Bass diffusion model. The NTGR was based on two forecasts of the RPP share. The RPP share model was estimated *with* and *without* the program, with the difference being the net savings and the NTGR calculated as net savings divided by gross savings. Figure 1 illustrates these two forecasts for a hypothetical product category for which a NTGR of 0.75 was calculated. Once done for all product categories, the results of the RPP NTGRs could be aggregated to form the program-level NTGR and net savings.

**Figure 1.** Forecasts of Vendor Share With and Without RPP Program



## Delphi Panel

If the quality of the data is insufficient to support the use of diffusion models to estimate NTGRs, then a consensus estimation approach, or a Delphi panel, may be a reasonable alternative. Since its design at the RAND Corporation over 40 years ago, the Delphi technique has become a widely used tool for measuring and aiding forecasting and decision making in a variety of disciplines. The Delphi technique is an approach based on expert judgment. As Rowe and Wright (1999) note:

*Delphi is not a procedure intended to challenge statistical or model-based procedures, against which human judgment is generally shown to be inferior: it is intended for use in judgment and forecasting situations in which pure model-based statistical methods are not practical or possible because of the lack of appropriate historical/ economic/ technical data, and thus where some form of human judgment is necessary (e.g., Wright, Lawrence and Collopy, 1996). Such input needs to be used as efficiently as possible, and for this purpose the Delphi technique might serve a role. (p. 354)*

Four key features are necessary for the Delphi approach:

1. Anonymity
2. Iteration
3. Controlled feedback
4. Statistical aggregation of group response

Delphi panels could be formed that address one or more product categories. These panels would be composed of experts with respect to the RPP product categories and their respective markets. They would be presented with relevant information regarding each product category including the following:

* Characterization of each market
* Current assessment of each market
* Market potential in terms of future adoptions as well as energy and demand impacts
* The RPP Program theory, logic model, and indicators
* Program budget over the expected duration of the program
* Detailed information about each product category
* Current market share and saturation

Participants would be told that the objective is to forecast the market share of program-qualified products and the adoption of program-qualified units over the next 15 years. Three forecast are required: best, most likely, and worst. They would also be asked to provide the assumptions and rationale for each of these three forecasts.

Depending on the availability of data, more complex models could be estimated, which involve the use of Bass diffusion models combined with discrete choice models.

## Mixed Approach

If affordable, a somewhat more costly mixed approach would combine the diffusion forecasts with the Delphi approach. This method would take the Delphi approach described above and make available the diffusion forecasts as additional information for Delphi participants’ consideration.

# **Incremental Measure Cost (IMC)**

Incremental measure cost (IMC) is defined as the difference in the cost of an efficient measure and a baseline measure attributable to the difference in efficiency. For refrigerators, freezers, and other measures in DEER, the IMC values in DEER would be used. For the remaining product categories, one or more of the following methods could be used for estimating the IMCs.

## WebCrawler

A WebCrawler is an [Internet bot](http://en.wikipedia.org/wiki/Internet_bot)[[6]](#footnote-6) that systematically browses the [World Wide Web](http://en.wikipedia.org/wiki/World_Wide_Web) and copies all the pages it visits for later processing by a search engine that [indexes](http://en.wikipedia.org/wiki/Index_(search_engine)) the downloaded pages so that [users](http://en.wikipedia.org/wiki/User_(computing)) can search them much more quickly. Our preferred approach for estimating IMCs is to develop and deploy a WebCrawler for each product category within the RPP portfolio since this method offers the potential to yield the most current, affordable, and credible estimates of IMC. For each product category, we could develop a WebCrawler application that collects product data from retail websites. This could include both online-only and brick-and-mortar retailers with online retail presence. For each product, we would identify key product features, including retail price and Energy Star qualification status. Determining exactly which product features we'd like to include would be an important part of the process. Based on the data points, we could develop a regression analysis (hedonic price models) to estimate the incremental cost of an energy efficient product. Setting up a WebCrawler for each product category requires some initial customization to identify specific features and data points to collect. However, once the process is set up, there is a very low incremental cost to collect this data on an ongoing basis. Targeted in-store shelf studies[[7]](#footnote-7) could be useful in correlating in-store data with online values on a one-off basis, but in general the shelf studies have limited value due to the fact that RPP will likely utilize a dynamic product mix that is expected to change over time. Note that because the WebCrawler approach is relatively untested, we also propose a second approach for estimating IMCs that is discussed below.

## Retailer Price Analyses

If, for some products, the WebCrawler fails to provide credible estimates of the IMC, a second approach will be used that relies on an analysis of sales price data, supplied by each retailer, for each model sold within each product category. The calculation of the incremental cost within each product category would be the sales-weighted price of non-program-qualified models minus the sales-weighted price of program-qualified models. If sufficient information on model characteristics were available, hedonic price models could be estimated to isolate the price difference attributable to higher efficiency.[[8]](#footnote-8) One important caveat of this approach is whether we will be able to obtain a sufficient amount of timely retailer price data to pursue this approach.

## Targeted In-Store Shelf Surveys

The most expensive approach would be in-store shelf surveys. Such surveys involve the selection of a representative sample of stores and within each sampled store a systematic in-store survey of specific products including their characteristics and prices is conducted. These data are then used to estimate hedonic price models to estimate IMCs. However, as noted above, in general the shelf studies have very limited value, especially since RPP is based on a dynamic product mix that is expected to change over time.

## Declining IMCs

As Prahl and Keating note, if one is forecasting over a longer horizon, the fact that IMCs decrease over time must somehow be taken into account. Determining the appropriate decline in the IMC for each product category will be based on a review the historical declines observed in other product categories such as CFLs, TVs, and air conditioners.

# **Estimated Useful Life (EUL)**

The effective useful life (EUL) is an estimate of the median number of years that a measure installed under a program is still in place and operable. For refrigerators, freezers, and other measures in DEER, the EUL values in DEER would be used. For the other product categories, reviews of manufacturer data, a Delphi panel, or a combination of the two could be used.

## Available Research Data

For products that are federally-regulated, EUL should be based on research data used in the standards proceeding. In cases where this is not a federal standard, we will use best available research. This may include data from EPA, manufacturers, or other research on EULs. This may include data from market studies, IRS depreciation tables, and/or financial institutions.

## Delphi Panel

In cases where credible research data for the EUL might not be available, we would employ a Delphi panel (an approach was successfully employed in California during the 1980s and 1990s) that would be structured along the same lines as described in Section 2.2 above. The only difference would be that the objective would be to estimate the EUL for each of the product categories. Perhaps many of the same experts used in the Delphi forecast could be used for estimating the EULs. Panelists would be provided with data available from published market research, laboratory studies, and other sources such as EPA, Energy Star, and Lawrence Berkeley Laboratory.

## Mixed Methods Approach

If affordable, a somewhat more costly mixed approach would combine the manufacturer data with the Delphi approach. This method would take the Delphi approach described above and make available the manufacturer data as additional information for their consideration.

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1. Best Buy, Costco, Home Depot, Lowes, Sears Holdings and Walmart Corporation: these retailers have more than 50% market share of any energy consuming product category (Appliances, Consumer Electronics, HVAC and Lighting) [↑](#footnote-ref-1)
2. For example, one rebate check is prepared once each month to each participating retailer rather the thousands of rebate checked prepared to thousands of end users. [↑](#footnote-ref-2)
3. Misra (2008) notes that assortment planning, where retailers decides which products to place on their store shelves, is one of the most fundamental decisions in retailing. Consumers view the assortment as an important category management service output that drives their decisions on where to shop (Kok and Fisher [2007]). Consistent with this view, in a recent meta-analysis, Pan and Zinkhan [2006] reviewed 14 papers all concluding that assortments are an important driver for consumers' purchase decisions. A recent survey by Nielsen found that store assortment is the second most important factor driving consumers' decisions (Nielsen, Dec 17, 2007). Moreover, category managers believe that their assortments are important competitive tools that allow them to differentiate. [↑](#footnote-ref-3)
4. Hannah Choi Granade, Jon Creyts, Anton Derksch, Philip Farese, Scott Nyquist, Ken Ostrowski, “Unlocking Energy Efficiency in the U.S. Economy,” McKinsey & Company, July 2009 [↑](#footnote-ref-4)
5. Note that there are other plug loads that were not specifically addressed in the Potential Study such as air cleaners, stereos, DVD/Blue-Ray players and home-theatre-in-a-box). [↑](#footnote-ref-5)
6. An Internet bot, also known as web robot, WWW robot or simply bot, is a software application that runs automated tasks over the Internet. Typically, bots perform tasks that are both simple and structurally repetitive, at a much higher rate than would be possible for a human alone to perform. [↑](#footnote-ref-6)
7. Such surveys involve the selection of a representative sample of stores and within each sampled store a systematic in-store survey of specific products including their characteristics and prices is conducted. These data are then used to estimate hedonic price models to estimate IMCs. [↑](#footnote-ref-7)
8. In [economics](http://en.wikipedia.org/wiki/Economics), hedonic regression or hedonic demand theory is a [revealed preference](http://en.wikipedia.org/wiki/Revealed_preference) method of estimating [demand](http://en.wikipedia.org/wiki/Demand) or [value](http://en.wikipedia.org/wiki/Value_(economics)). It decomposes the item being researched into its constituent characteristics, and obtains estimates of the contributory value of each characteristic (e.g., the level of energy efficiency). [↑](#footnote-ref-8)