**Work Paper PGECOALL107**

**Home Energy Reports**

**Revision # 1**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Home Energy Reports**

**Measure Codes – Procedural work paper**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** |  |
| **Measure Description:** | Home Energy Reports is a residential information-based measure that provides usage feedback and comparisons of energy usage to similar residences. Information is provided via printed or email reports sent to residential customers. The measure is implemented through successive experiments (also named waves). These experiments use a randomized control trial whereby a subset of the whole eligible population defined by multiple eligibility criteria is randomly assigned either to receive reports (“treatment condition”) or not (“control condition”). The treatment is defined as receiving reports containing usage feedback and comparisons. Due to the unique composition of each experiment, savings for this measure must be estimated for each experiment separately using the associated control group as the Base Case energy consumption (acting as counterfactual or baseline), on an *ex-post* basis. |
| **Energy Impact Common Units:** | kWh, kW, Therms per household |
| **Base Case Description:** | PG&E: Customers that are assigned to the control condition for any given experiment. |
| **Base Case Energy Consumption:** | PG&E: The Base Case energy consumption is that of the average of residential customers assigned to the control condition for a given experiment. Since savings are estimated by comparing usage between treatment and control conditions for every experiment separately, there is not a single numerical Base Case. Control groups show indeed different characteristics from each other because the characteristics of the sample frame (i.e. the set of eligible residential customers to receive the treatment) evolve over time and are function of wave-specific exclusions, and because random assignments to each control group are done at different times (experiments are launched successively, not simultaneously). However, each control group is representative of its corresponding treatment group and is assumed to accurately predict what would have been the energy usage and demand for treated customers if they had not experienced the treatment. These control groups serve as counterfactuals in order to assess the treatment effect, defined as savings impact. |
| **Measure Energy Consumption:** | PG&E: The Measure Case assumes that customers receiving home energy reports would act during the time they continue to receive them and after. Energy consumptions of the treatment and the control group are recorded from billing data and compared to each other. Savings due to other rebate programs is subtracted from the Measure Case for attribution purposes to avoid the risk of double counting savings. There may indeed be savings overlaps between the HER program and other energy efficiency programs. |
| **Energy Savings**  **(Base Case – Measure):** | PG&E: The energy and peak demand savings from the HER program is estimated by comparing usage between each treatment condition (households that are randomly assigned to receive reports) and its corresponding control condition (households that are randomly assigned to not receive the reports) using statistical methods (fixed effects panel regression model or lagged dependent variable model) based on difference-in-difference estimates. |
| **Costs Common Units:** | $ per household |
| **Base Case Equipment Cost ($/unit):** | PG&E: There is no action required for the Base Case, hence no cost. |
| **Measure Equipment Cost ($/unit):** | PG&E: This is not a “widget-based” measure. The changes in customer behavior resulting in energy savings and peak demand reduction have no identifiable cost. PG&E and program evaluators are conducting rebate records analyses, home inventories, and online surveys to identify whether specific HER-induced purchased equipment has concomitantly been rebated and claimed by other measures. The estimated savings overlaps – when they exist – are subtracted from the HER savings claims to avoid double counting in the energy efficiency portfolio. |
| **Gross Measure Cost ($/unit)** | Since the savings of the program is posited to be changes in customer behavior and PG&E is accounting for rebate related activity, the Measure Cost is zero (0). |
| **Measure Incremental Cost ($/unit):** | PG&E: These measures are considered replace on burnout (ROB) since this depends on customer behavioral action. Incremental Cost is zero. PG&E and program evaluators are conducting rebate records analyses, home inventories, and online surveys to identify whether specific HER-induced purchased equipment has concomitantly been rebated and claimed by other measures. The estimated savings overlaps – when they exist – are subtracted from the HER savings claims to avoid double counting in the energy efficiency portfolio. |
| **Effective Useful Life (years):** | PG&E: The Effective Useful Life is assumed to be one (1) year. The length of the program measure life may be longer though because of the possibility of savings persistence. PG&E will estimate a more accurate measure life based on the results of on-going persistence studies. |
| **Measure Application Type:** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratios:** | PG&E: Since (1) these measures are implemented as randomized control trials (RCTs), (2) potential savings overlaps with other programs are subtracted from HER savings claims, and (3) comparative energy usage and demand are based on *ex-post* data (billing data for energy ; interval meter data for demand), the unique impact of the measures is isolated during the evaluation. Therefore, net-to-gross (NTG) is built into the experimental design. Each control group is indeed assumed to accurately predict what would have been the energy usage and peak demand for treated customers if they had not experienced the treatment. These control groups serve as counterfactuals in order to assess the program savings.  Given this methodology, and the attribution analysis using utility rebate records for downstream measures, and home inventories and surveys for upstream measures to avoid double-counting, NTG equals 1.0. |
| **Important Comments:** |  |

# Work Paper Approvals

The following Manager(s) approved this work paper through the PG&E Electronic Data Routing System under Routing Requisition # 2013-15423

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| --- |
|  |
| **Grant Brohard**  Manager, Engineering Services |
| **Aaron Berndt**  Manager, Core EMS and Information Products |

# Document Revision History

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| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| **Revision 0** | **03/01/2013** | **Home Energy Reports original work paper.** | **Steve Blanc, Brian Smith, Jim Wyatt (PG&E)** |
| **Revision 1** | **03/02/2017** | **EUL, calculations, load shape** | **Guillaume Calas, Henry Liu, Brian Smith, Jim Wyatt (PG&E)** |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description***

The purpose of the Home Energy Reports (HER) program is to reduce energy consumption by motivating no-cost energy conservation actions and self-installation of low cost energy savings measures. The HER program operates on the principle that, by providing information that compares a household’s energy use to that of similar households, customers modify their behavior and/or make minor purchases which lead to savings that can be observed at the meter. The HER program employs randomized control trials (RCTs) which are considered as the most effective way to establish causality between a treatment and its effect. This experimental design indeed isolates the unique impact of the comparative usage and leads to a net-to-gross (NTG) ratio for savings of one (1). The estimation of savings is achieved via statistical analysis of billing and interval meter data by comparing energy use and peak demand between the treatment and control groups for each experiment independently.

PG&E has engaged the vendor OPOWER – currently the largest and best established vendor in this domain – to produce and deliver the home energy reports. PG&E has also engaged Nexant (formerly Freeman, Sullivan and Company) to assist in the experimental design and data analysis. Nexant is an acknowledged expert in the design of information feedback experiments. The key objectives of this research initiative are as follows:

1. Estimate changes in residential energy consumption and peak demand resulting from exposure to home energy reports for a wide range of PG&E residential customers with different characteristics;
2. Assess persistence of savings over a period of at least two years;
3. Estimate the impact of relative frequency of report delivery on energy consumption;
4. Modify program design to increase cost-effectiveness.

**Program Restrictions and Guidelines**

This program is an “opt-out” program whereby selected households are sent the reports without explicitly requesting them. Since the household characteristics that define the sample frame are specific of each experiment (e.g., climate zone, fuel type, energy usage, time since account was established), each experiment requires its own analysis of energy and peak demand savings. This is why each experiment has its own control group, which serves as Base Case, also known as baseline or counterfactual.

**Terms and Conditions:** These are the actual rules for the specific measure(s) described in this work paper. These form the basis of the savings and cost calculations for the measures. They must be presented EXACTLY as stated in the product catalog and customer materials.

**Market Applicability:** The target for this program is residential customers that meet experiment-specific eligibility criteria determined by PG&E and OPOWER at the time of sampling. An initial description is provided in PG&E Home Energy Reports Initiative Sampling Plan. This document contains the background and initial plan for the Home Energy Reports program as submitted to Energy Division of the California Public Utilities Commission in May 2011. The sampling plan for each experiment is based on this initial plan, but may present subtle differences around sample size, sample frame, treatment communication channel or frequency…

## 1.2 Product Technical Description

The Home Energy Report (HER) program operates on the principle that customers in the treatment condition that are provided periodic reports with energy use feedback and comparisons of energy use of similar neighbors reduce energy consumption and shift demand compared to customers in the control condition who are not provided these reports. The impact of such HER experiments on savings has been demonstrated in many jurisdictions (including California) through statistical analyses conducted by multiple evaluation firms, including DNV GL contracted by the Energy Division of the CPUC (see impact evaluations for 2010-2012, 2013, and 2014). The usage feedback that is the core of the reports is accompanied by tips on saving energy and suggestions to purchase more energy efficient equipment. The HER program employs a randomized control design whereby a homogeneous group of residential customers defined by key usage and demographic characteristics are randomly assigned to either receive the reports (the treatment group) or not (the control group). Random assignment ensures that the treatment and control groups are equivalent from a statistical standpoint. Other than the fact that the treatment group receives the reports, households in the treatment and control groups indeed show similar characteristics (e.g., pre-treatment energy usage, household size and age, occupant characteristics) and are treated in the same fashion with respect to all other utility interactions. Therefore, the experimental design can test the hypothesis whether the reports cause energy savings and peak demand reduction in the treatment group. The randomized control trial methodology provides a comparison group so that the effectiveness of the treatment can be determined with precision. Since the set of household’s characteristics of each control group is unique, savings for each experiment must be calculated independently and on an *ex-post* basis.

A number of independent evaluations of comparative usage programs around the country provide evidence of their effectiveness in reducing energy use and peak demand. A meta-analysis of HER programs conducted by the Environmental Defense Fund demonstrates that households receiving the reports reduce energy demand by 1.8% on average, with the effectiveness of individual programs ranging from 0.9% to 2.9%.

The HER experiments are keyed to accounts and premises, not meters, so that attrition among participants can be taken into account. Attrition has two origins:

1. “Opt-outs”, i.e. households requesting not to receive the reports any longer. The HER experiments are indeed run on an opt-out basis. A group of eligible residential customers is randomly assigned to either treatment or control conditions without their prior knowledge or approval. However, they are allowed to opt-out when desired (i.e. reports are stopped being sent). As of February 2017, a total of about half a percent (0.5%) of treatment households had opted-out since the inception of the program. Since households opting out of the program have received at least one report, they are considered to have been treated. Therefore, they are retained in the experiment and are included in the treatment group for the *ex-post* billing analysis until they move away from their residence (“move-outs”);
2. General attrition is based on customers that move away from their residence (e.g., moving, change of utility billing address). The observed annual attrition rate of the treatment group in PG&E’s experiments is between 7% and 13% per year and is consistent with the U.S. Department of the Census data. Attrition rate depends on the precise customer characteristics that define each experiment. Experiments targeting electric-only customers show higher attrition rate when compared with experiments targeting dual-fuel households. This may be partly explained by the greater proportion of renters in the electric-only customer segment. Attriting accounts are kept in the experiment until the meter is “stopped” at account closing. Existing studies have shown that: (1) the home energy reports do not cause attrition and (2) control and treatment groups keep similar characteristics over time.

The HER program may increase rebate activity in other PG&E’s energy efficiency programs. To ensure that the energy and peak demand savings claimed by the HER program is not duplicative of savings claimed by other programs, it is essential to estimate savings overlaps and subtract these joint-savings from the HER savings claims in order to avoid double counting. It is important to note that these joint-savings are an added benefit of the HER program and the subtraction of the savings overlaps is to ensure that these joint-savings are only reported once. The simplest and most common approach is to remove all joint-savings from the HER program rather than remove program-specific joint savings from all of the associated rebate programs.

Two analyses are undertaken to estimate joint-savings and calculate adjusted savings[[1]](#footnote-1): These estimates have been verified by the CPUC-managed impact evaluator. Beginning with the 2015 impact evaluation, these estimates will be incorporated into the CPUC-managed impact evaluations.

1. Assessment of participation in direct rebate programs (“downstream” measures). A comparison of the relative uptake of downstream measures between treatment and control groups using PG&E’s rebate program tracking databases is undertaken to determine whether the HER program has an impact on participation in these programs. To estimate joint-savings, the deemed annual savings values are transformed into realistic day-to-day savings values upon the installation of that measure, the daily share of annual savings being determined by using hourly 2011DEER load shapes. These load shapes indeed indicate when a measure is used during the year and, by proxy, when efficiency savings would occur. A more detailed description is presented in PG&E’s impact evaluations;
2. Assessment of participation in manufacturer and reseller rebate programs (“upstream” measures).The main upstream program considered is the Upstream Lighting Program (ULP), which rebates compact fluorescent lamps (CFLs) and light emitting diodes (LEDs). The methodology to estimate the lighting savings overlap between the HER program and the ULP is described in a study published by TRC Energy Services[[2]](#endnote-1) and was applied during subsequent impact evaluations of PG&E’s HER program. The estimation is based on the following equations:

* Equation 1: kWh attributable to the HER program and the ULP per household for CFLs:

= CFLs installed due to HER x Years CFLs have been installed x (Rebated CFLs / Total CFLs) x (CFLs attributable to ULP / Rebated CFLs) x Installation Rate x Savings per CFL per year

* Equation 2: kWh attributable to the HER program and the ULP per household for LEDs

= LEDs installed due to HERs x Years LEDs have been installed x (Rebated LEDs / Total LEDs) x (LEDs attributable to ULP / Rebated LEDs) x Installation Rate x Savings per LED per year

* Equation 3: Lighting Savings Overlap for each Treatment group (GWh/yr)

= Number of households in the Treatment group of an experiment x (kWh attributable to HER program and ULP per household for CFLs + kWh attributable to HER program and ULP per household for LEDs) x 1 GWh/106 kWh

TRC Energy Services obtained many of the values for the abovementioned parameters from PG&E’s 2010-12 ULP impact evaluation. Estimates for excess efficient lamps (CFLs and LEDs) are based on results of the 2012 home inventory survey [[3]](#endnote-2) done for the 2012 HER program evaluation, as well as results from the 2014 phone survey conducted for the 2014 Puget Sound Energy’s evaluation.

During the 2012 home inventory, evaluators surveyed 702 homes (approximately half in treatment and half in control conditions). This on-site survey found that HER treatment households had installed an average of 0.95 more CFLs than the control group. This value of 0.95 CFL had large confidence intervals that included zero – i.e., there may have been no statistical difference in CFL installations between HER and non-HER households. In addition, the 2014 phone survey of HER treatment households (n = 1,649) and control households (n = 857) found there was no statistical difference in customer self-reported responses to the question of whether they had replaced incandescent lamps with CFLs; control and treatment households responded almost identically[[4]](#endnote-3). The latter study estimated 0.95, 0.4, 0.15, and 0.08 excess lamps for the 1st, 2nd, 3rd, and 4th year of HER treatment, respectively.

For the 2011-2013 evaluation, TRC Energy Services assumed that all excess lamps were CFLs. For 2014, TRC assumed that excess lamps were a mix of CFLs and LEDs, reflecting the overall residential market purchases of CFLs and LEDs in 2014. The excess lamp estimate is to be updated for PG&E’s 2015 impact evaluation based on an online survey to all HER participants who have been treated during two years or more.

Since program inception, the energy and demand savings overlaps with downstream and upstream programs have been limited. Recent estimations show a significant reduction of joint-savings, below 6% of unadjusted savings during the 2014 evaluation (Table 1). This trend mainly comes from a reduction in upstream joint-savings and is consistent with PG&E’s upstream lighting program being scaled down.

Table 1 Savings overlap estimates between the HER program and downstream/upstream measures as a percentage of unadjusted electric savings

|  |  |  |  |
| --- | --- | --- | --- |
| **% of Unadjusted electric Savings** | **2010-2012** | **2013** | **2014** |
| Downstream Joint-Savings | 0.4% | 0.4% | 1.2% |
| Upstream Joint-Savings | 11.6% | 10.9% | 4.5% |
| Total Joint-Savings | 12.0% | 11.3% | 5.7% |

For the purposes of this work paper, we characterize savings based on kWh, kW or Therms per household. This provides the regulators and others with a value for the program consistent with DEER. A more thorough explanation of the design approaches and research techniques can be found in Neenan and Robinson (EPRI) and State and Local Energy Efficiency Action Network (SEE Action).

Decision 09-09-047 (p. 304)[[5]](#endnote-4) authorizes the investor-owned utilities (IOUs) to make savings claims for interventions that use a “neighbor comparison” approach and a randomized control test (whereby customers are assigned to either treatment or control conditions). The decision determining EM&V processes for the 2010-2012 portfolio (D. 10-04-029) provides for savings claims for behavior-based programs based on experimental design (pp. 40-42, see Conclusion of Law 18; OP 13)[[6]](#endnote-5). Based on these decisions, PG&E makes *ex-post* savings claims for the HER program.

## 1.3 Measure Application Type

The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls*, defines the terms as follows:

Table 2 Measure Application Type[[7]](#endnote-6)

*Identifies the measure application type in the Measure Implementation table in DEER2011.*

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ER | Early retirement | *measure applied while existing equipment still viable, or retrofit of existing equipment* |
| ROB | Replace on Burnout | *measure applied when existing equipment fails or maintenance requires replacement* |
| NC | New Construction | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

We are observing that residential customers, on the basis of reports and recommendations sent to their homes, change their operation of energy using devices in their homes and/or change to more efficient ones absent participation in PG&E programs aimed at rebating such transactions. This program group of measures being defined as behavioral responses has no corollary in the DEER transaction types. We would go so far as to say that we would require that CPUC develop a behavior modification transaction type to fit this class of measures. For the purposes of this work paper, we are using the ROB designation as it is the only existing transaction type that approximates the circumstances of these measures.

## 1.4 Product Base Case and Measure Case Data

## 1.4.1 DEER Base Case and Measure Case Information

The DEER Use / Technology Table has no reference that would correctly categorize these program measures. These program measures are being counted as *ex-post* savings pursuant to the guidance. Consequently, the relevance of DEER impacts is moot. However, for the purpose of this document, we address these issues to clarify the difference between this program and an *ex-ante* work paper measure.

*DEER Values: Measure-specific values found in the database for energy efficient resources*

*(DEER) including net-to-gross (NTG), estimated useful life (EUL) and unit energy savings (UES) are not applicable to comparative usage programs*[[8]](#endnote-7).

The HER program is a set of measures based on altering customer behavior through a periodic reporting system. It does not involve savings from any installed piece of equipment, control system or building feature. Consequently, the DEER data do not contain the appropriate information for this (these) measure(s).

* ***Net-to-Gross Assumption: See 1.4.3.2***
* ***Effective Useful Life: See 1.4.3.2***
* ***In-service rate/first year installation rate: See 1.4.3.2***

## 1.4.2 Codes & Standards Requirements Base Case and Measure Information

The HER program is a set of measures based on altering customer behavior through a periodic reporting system. It does not involve savings from any installed piece of equipment, control system or building feature. Consequently:

* ***Title 20:*** These measures do not fall under Title 20 of the California Energy Regulations.
* ***Title 24:*** These measures do not fall under Title 24 of the California Energy Regulations.
* ***Federal Standards:*** These measures do not fall under Federal DOE or EPA Energy Regulations***.***

## 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

***1.4.3.1 PG&E Home Energy Reports Initiative* *Sampling Plan******[[9]](#endnote-8)***

This document describes the proposed sample frames for PG&E’s two initial experiments (Wave Beta and Wave Gamma). It presents the stratification variables (baseline territory, historical household energy consumption) used during sampling and also details how sample size influences statistical power and precision. The minimum treatment and control group size to have sufficient statistical power was calculated using a sample design procedure known as “bootstrapping”. It uses Monte Carlo simulations to iteratively solve for the sample size that produces a desired level of statistical precision in model parameter estimates. A typical precision goal is to estimate the savings impacts with a 90% confidence interval of +/- 0.5%. After adjusting for anticipated attrition, the minimum sample size was estimated around 15,000 households.

***1.4.3.2 IOU Proposal for Reporting Energy Savings for Comparative Usage Energy Efficiency Programs*** ***May 18, 2012[[10]](#endnote-9)***

**This document proposes utility reporting schemes for behavior-based programs and sets the parameters for reporting savings and other inputs to CPUC.**

Impacts of comparative energy usage programs can be assessed using experimental design whereby a target group of similar households is randomly assigned to receive the reports (“treatment”) or not (“control”). The random assignment ensures that the treatment and control groups are equivalent from a statistical standpoint such that the experimental design establishes whether the desired effects are more likely to occur in the intervention (or treatment) group due to the program. Households in the treatment and control groups are treated in the same fashion with respect to utility interactions outside of this particular intervention (such as exposure to marketing programs and recruitment to demand response programs).

**How Energy Savings and Peak Demand Reduction Result from Comparative Usage Programs**

The impacts of home energy reports have been tested in several jurisdictions across the nation by independent evaluators. These findings are based on the results of randomized controlled trial (RCT) experiments which are considered as the most effective way to establish causality between a treatment and its effect. This experimental design indeed isolates the unique impact of the comparative usage. To reduce sampling error and thereby improve the representativeness of the sample of each of these experiments, PG&E created stratified sample frames for each PG&E baseline territory (akin to climate zones) and by energy usage quartile. More detail is provided in the “*PG&E Home Energy Reports Initiative Sampling Plan*”8.

Savings from the HER program results from a myriad of actions that vary from household to household. They may be divided into three types of actions:

1. Behavioral changes or practices that affect equipment use (e.g., switching off lights, unplugging unused appliances, and adjusting thermostat settings to limit heating and cooling);
2. Behavioral changes in the purchase and installation of equipment not rebated by PG&E’s energy efficiency incentives programs;
3. Behavioral changes in the purchase and installation of energy efficient equipment rebated by PG&E’s energy efficiency incentive programs.

Since households have large variations in energy usage and savings are small (between 1.0% and 3.0% for electricity and between 0.5% and 1.5% for natural gas), large treatment and control groups are necessary to produce an un-biased savings estimate with a high level of statistical precision. Because the set of household’s characteristics for each experiment is unique, savings is calculated on an *ex-post* basis using billing analysis and demand response impact assessment. Regression models are based on the “difference-in-difference” (DID) approach, whereby the average change in energy consumption between pre- and post-periods among the treatment group is subtracted to the average change in energy consumption between pre- and post-periods among the control group.

**How Energy Savings and Peak Demand are Reported**

Per agreement with the Energy Division of the CPUC, PG&E has been reporting savings on a quarter to quarter basis for all experiments in the program. The savings is *ex-ante* and based on forecasts from OPOWER and include agreed upon holdbacks of 20% for electric and demand savings and 10% for gas savings. The final savings amounts are then trued-up during the *ex-post* evaluation.

**Base Case Costs and Measure Case Costs**

**Costs DEER Version and Impact Ids**

* The [Base Case / Measure Case / Incremental] Costs were derived from “*IOU Proposal for Reporting Energy Savings for Comparative Usage Energy Efficiency Programs*” study directly, they match the intended measures for climate zones and building types and ages.
  + - Incremental Measure Costs (IMC) and Negative Therm Interactive Effects. As is detailed above, comparative usage programs cause savings through behavior change and/or equipment purchases. IMCs and negative Therms interactive effects are treated in the following manner for each class of savings as detailed below. Energy savings and peak demand reduction resulting from:
  + Behavioral changes (such as adjustment of thermostat and water heater settings) have no IMCs or known interactive effects, so none are reported;
  + Equipment purchases that, as determined by utility records (for downstream measures) and by home inventories and surveys (for upstream measures), have been claimed through another utility program and are omitted from savings claims for comparative usage programs to avoid double-counting. Since savings claims for comparative usage programs do not include energy savings and peak demand reduction attributable to these types of purchases, IMCs and negative Therm effects are reported through the savings claims for those equipment purchases[[11]](#endnote-10).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Costs ($)** | | |  |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Base Case** | **Measure Case** | **IMC** | **Specific study reference** |
| **RES** | **ALL** | **ALL** | **0** | **0** | **0** | **See Study.** |

**Effective Useful Life:**

* The Effective Useful Life (EUL) estimates were downloaded from the “*IOU Proposal for Reporting Energy Savings for Comparative Usage Energy Efficiency Programs*” study directly; they match the intended measures for climate zones and building types and vintages.

EUL is the estimate of the median number of years that the measures installed under an energy efficiency program are still in place and operable (retained). The intent of comparative usage programs is to affect behavioral change, and studies in multiple jurisdictions have confirmed that savings continues for as long as comparative usage reports are provided to households. This is the so-called ‘savings durability’. Some recent studies indicate that there are residual effects from these programs that continue after cessation of report deliveries. PG&E claims savings for the duration that the reports are sent. PG&E is undertaking studies to understand how the treatment effect decays over time should a particular program or measure be terminated**[[12]](#endnote-11)**.

The EUL is set to 1 year for each experiment from the start of report deliveries. The program measure life may be longer because of evidence of savings persistence. PG&E will estimate a more accurate measure life based on the results of persistence studies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **EUL (yrs)** | **RUL (yrs)** | **DEER Version** | **Impact IDs** |
| **RES** | **ALL** | **ALL** | **1** | **DNA** | **From Study** | **From Study** |

**Net-to-Gross Assumption:**

The net-to-gross (NTG) Ratio assumptions are noted below. Because of the nature of the program and the method of analysis, any further application of NTG is considered redundant.

Table 2 below summarizes all applicable NTG ratios for programs that may be used by this measure.

Table 3 Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Program Approach** | **NTG** | **Study Reference** |
| Home Energy Reports | 1.0 | See Below |

* Net-to-Gross (NTG). NTG is an adjustment made so that only energy efficiency gains that are a direct result of an energy efficiency program are reflected. We propose that NTG be treated for each of the types of savings resulting from behavioral programs:
  + Behavioral changes in practices and equipment installations only resulting from the treatment are reported without additional NTG adjustment. By definition, randomized control trials isolate the unique impact of the comparative usage program to the treatment group, so the reported results are “net” impacts;
  + Equipment purchases that have been rebated and claimed by another utility program are not included in the savings claim, so any NTG adjustment would be made through the savings claims for those measures rather than through savings claims for behavioral programs. Consequently no NTG adjustment would be applicable[[13]](#endnote-12).

**In-service rate/first year installation rate**:

* The in-service rates are not relevant to this particular set of measures since savings is derived from actions taken as the result of the communications with the customer. ISR equals 1.0

***1.4.3.3 Evaluation, Measurement and Verification (EM&V) of Residential Behavior-Based* *Energy Efficiency Programs[[14]](#endnote-13)***

This report provides guidance and recommendations on methodologies that can be used for estimating energy savings and peak demand reduction impacts resulting from residential behavior-based efficiency programs. Regulators, program administrators, and stakeholders can have a high degree of confidence in the validity of energy savings and peak demand reduction estimates from behavior-based programs if the evaluation methods that are recommended in this report are followed.

The document discusses techniques for ensuring that the estimated savings impacts for a behavior-based energy efficiency program are valid for a given program participant population and a given time frame (the first year[s] of the program); this is commonly referred to as internal validity. Methods for ensuring internal validity are well established and are being utilized by several behavior-based programs.

It also discusses several evaluation design and analysis factors that affect the internal validity of the estimated savings impact: the evaluation design, the length of historical data collection, the estimation method, potential evaluator conflicts of interest, and the exclusion of data from households that opt out of a program or close accounts during the study period. It also discusses methods for avoiding the double counting of energy and peak demand savings.

The contribution of this document is the derivation and definition of the operative mathematical models underlying this series of program interventions. The models presented in Section 2.1 have been directly influenced by this work.

## 1.4.4 Assumptions and Calculations from other sources – Base and Measure Cases

There are no further data or calculations provided for the support of the measures in this work paper.

***1.4.5 Time-of-Use Adjustment Factor***

We are required by CPUC decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since HER removes savings attributable to uptake of rebated residential A/C measures, no adjustment is applicable and the TOU adjustment factor is 0.

The specific values and results are summarized below:

Table 4 TOU Adjustment Factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | ***kWAC*** | ***kWTotal*** | **%** |
| AC unit etc. | 0 | 0 | 0 |

## 1.5 Summary of Inputs for Savings Calculations

The following table provides references to sections that document the inputs for calculation:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | SFm only | N/A | N/A | *ex post* | *Section 1.4.3.2* |
| **Gas Savings** | SFm only | N/A | N/A | *ex post* | *Section 1.4.3.2* |
| **Peak Demand Savings** | SFm only | N/A | N/A | *ex post* | *Section 1.4.3.2* |
| **Hours of operation** | SFm only | N/A | N/A | N/A | *Section 1.4.3.2* |
| **Full Cost** | SFm only | N/A | N/A | 0 | *Section 1.4.3.2* |
| **Incremental Cost** | SFm only | N/A | N/A | 0 | *Section 1.4.3.2* |
| **EUL /RUL** | SFm only | N/A | N/A | 1 year | *Section 1.4.3.2* |
| **NTG** | One | N/A | N/A | 1.0 | *Section 1.4.3.2* |
| **ISR** | Applies --No | N/A | N/A | 1.0 | *Section 1.4.3.2* |
| **TOU Factor** | *A/C projects only* | N/A | N/A | **0.0** | *Section 1.4.5* |

# Section 2. Calculation Methods

## 2.1 Electric Savings Estimation Methodologies

* This section describes the overall *ex-post* analysis technique for estimating savings resulting from the HER program. There is no *ex-ante* value calculated as the result of this section.
* This measure includes HVAC interactive effects savings, as noted in 1.4.3.2
* This measure is not an Early Retirement measure.

The electric and gas savings are estimated via an econometric model which compares billing data collected on the members of each of the control and treatment groups for each experiment as described in sections 1.2 and 1.4. The statistical analysis of the data requires the following assumptions:

1. The estimation of savings derives from a panel-based regression analysis whereby the aggregate energy use of the control group and that of the treatment group are compared over a period of time. This is discussed in Section 1.4.3.3 and other References (see Reference List). The beginning and ending billing aggregates are compared using regression analysis to determine a mean value of difference in the savings or increases in use;
2. The participants are counted based on rules set out in 1.2 and 1.4, opt-outs are continued to be counted while “move-outs” are not. The number of participants in each group constituting the control and treatment groups is counted as the participants in the group at the end of the test period.

The methodology used to estimate electric and gas savings resulting from the HER program is based on a fixed-effects panel regression model in which monthly energy consumption for treatment and control group customers is estimated using an indicator variable for month of the study, a treatment month indicator variable and a customer-level indicator variable. Such a model is the standard for evaluating behavioral programs. It produces a “difference-in-difference” calculation by comparing the pre- to post-treatment difference for the treatment group to the pre- to post-treatment difference for the control group.

The change that occurs in the treatment group is adjusted to reflect any change that occurred in the control group, in order to isolate changes attributable to the program. The fixed-effects equation is:

𝐸𝑖𝑡 = 𝜇𝑖 + 𝜆𝑡 + 𝛽𝑃𝑖𝑡 + 𝜀𝑖𝑡

Where:

* 𝐸𝑖𝑡 = Average daily energy consumption for account 𝑖 during month 𝑡
* 𝑃𝑖𝑡 = Binary variable: one for households in the treatment group in the post period month *t*, zero otherwise
* 𝜆𝑡 = Binary variable: one for a specific month/year, zero otherwise
* 𝜇𝑖 = Account level fixed effect
* 𝜀𝑖𝑡 = Regression residual

This model produces estimates of average monthly savings using the following equation:

𝑡 = 𝑡

Where:

* 𝑡 = Average treatment related consumption reduction during month 𝑡
* 𝑡 = Estimated parameter measuring the treatment group difference in the post period month *t*

The model also includes site-specific and month/year fixed effects. The site-specific effects control for mean differences between the treatment and control groups that do not change over time. The month/year fixed effects control for change over time that is common to both treatment and control groups. The monthly post-program dummy variables pick up the average monthly effects of the treatment. The total savings are a sum of the monthly average savings combined with the count of households still eligible for the program in that month.

Since our intent for the purposes of this work paper is to define the process of calculating the savings for the *ex-post* analysis of the program and as noted in 1.2 and various sections of 1.4, this includes the effects of opt-outs, “move-outs” and other statistical variances during the treatment period. Since we are using billing data for randomly selected user quartiles and weather areas, these variables are also considered to be accounted for. The further analysis of rebate records, home inventories, and online surveys accounts for the participation in PG&E’s rebate programs and prevent from double counting savings. Interactive effects are built in due to the use of billing data.

This model is consistent with best practices as delineated in State and Local Energy Efficiency Action Network’s (SEEAction) Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.

## 2.2. Demand Reduction Estimation Methodologies

Reductions in demand at peak times that result from program participation can be estimated through a variety of approaches. During prior impact evaluations, DNV GL contracted by the Energy Division of the CPUC used the peak period definition provided by the Database for Energy Efficiency Resources (DEER). This definition takes into account the average temperature, average afternoon temperature (12 p.m.–6 p.m.), and maximum temperature over the course of three-day heatwave candidates. Each candidate is a combination of three consecutive non-holiday weekdays occurring between June 1 and September 30. Using this definition, the optimal heatwave (HW) for each climate zone is ultimately selected by choosing the single candidate three-day-period with the highest peak score (Score𝑘) among all possible candidates.

The mathematical expression is given by:

=

=

Where:

* 𝐻𝑊 = Zone-specific set of three consecutive non-holiday weekdays that has the highest value of Scorek for heat wave candidate 𝑘 across all possible candidates 𝐾
* Score𝑘 = The summation of maximum temperature, average daily, and afternoon average temperature
* temp𝑑,𝑘 = The hourly temperature value across all hours on day d, for heat wave candidate k
* 𝑑𝑎𝑖𝑙𝑦\_𝑚𝑒𝑎𝑛𝑑,𝑘 = The average hourly temperature across all hours on day d, for heat wave candidate k
* 𝑎𝑓𝑡𝑒𝑟𝑛𝑜𝑜𝑛\_𝑎𝑣𝑔𝑑,𝑘 = The average hourly temperature between 12 and 6 PM on day d, for heat wave candidate

Statistical differences in demand between treatment and control groups can be done using 15-minute and 60-minute interval meter data (also named Advanced Metering Infrastructure [AMI] data), and consumption during the hours of 2 p.m. and 5 p.m. of the most common heat wave.

Since the HER program is built as a RCT, the simplest approach is to calculate the difference in average hourly load between treatment and control households during peak periods. This is referred to as a “post-only” framework as it employs only data that is observed after the launch date of the program and does not make use of any pre-program period data.

The general equation for the post-only approach is given below:

savings = -

Where:

* *savings* = Average demand reductions during the peak period
* ̅ = Average hourly load of the control group during the peak period in the post period being evaluated
* = Average hourly load of the treatment group during the peak period in the post period being evaluated

Another methodology is more suitable when pre-existing differences exist between average treatment and control load. A difference-in-differences approach would then be a more appropriate method for controlling the differences in demand from pre- to post-period to avoid biased estimates of demand reduction.

## 2.3. Gas Savings Estimation Methodologies

* This section describes the overall *ex-post* analysis technique for estimating savings resulting from the HER program. There is no *ex-ante* values calculated as the result of this section.
* This measure includes HVAC interactive effects savings, as noted in 1.4.3.2
* This measure is not an Early Retirement measure.

The gas energy savings for each measure follow the same process as do the electric savings except they utilize gas billing data rather than electric billing data for the affected households.

# Section 3. Load Shapes

The load shape for this program should be determined by actual interval meter data.

The previous version of this work paper (Revision # 0, 3/1/2013) was produced prior to the analysis of the differences between the hourly energy use of customers assigned to HER treatment and HER control groups. Because no calculation of the avoided energy use was available, the HER work paper specified a conservative DEER Load Profile, Res. Refrigerator–Freezer Monthly (DEER:RefgFrzr\_HighEff), acting as a “strawman” suitable for initial valuation of the program.

As of summer 2016, the majority of customers assigned to HER treatment groups have been treated for about two years or more. For those experiments, the average household’s savings has decelerated and grows marginally over time (as seen in most HER programs). This steady state was an appropriate time to calculate the actual load shape of avoided energy use by comparing the average usage of treated customers to that of control customers and generate the avoided cost load shape for PG&E’s HER program.

The process to generate this avoided cost load shape consisted of two steps:

1. Creating of hourly avoided energy use load shape for 2015, and
2. Matching this load shape to approved DEER residential load shapes using an Excel-based tool provided to PG&E by E3.

**Data Source for the Load Shape**

Hourly-level electric usage data from HER treatment and control customers was used to derive the shape of avoided energy use (“HER load shape”) for the most recent calendar year available (2015). Given that about two years of HER treatment are required to reach near-maximum household savings rates, usage data from treatment and control customers from the following HER experimental waves were included in this analysis:

* Beta Wave (launched in August 2011 with approximately 60,000 customers in treatment)
* Gamma Wave (launched in November 2011 with approximately 210,000 customers in treatment)
* Wave One (launched in February 2012 with approximately 400,000 customers in treatment, and
* Wave Two (launched in February 2013 with approximately 400,000 customers in treatment.

These experiments represented the majority of HER treatment households and savings in summer 2016. We do not expect that including other experiments would result in significant differences of load shape.

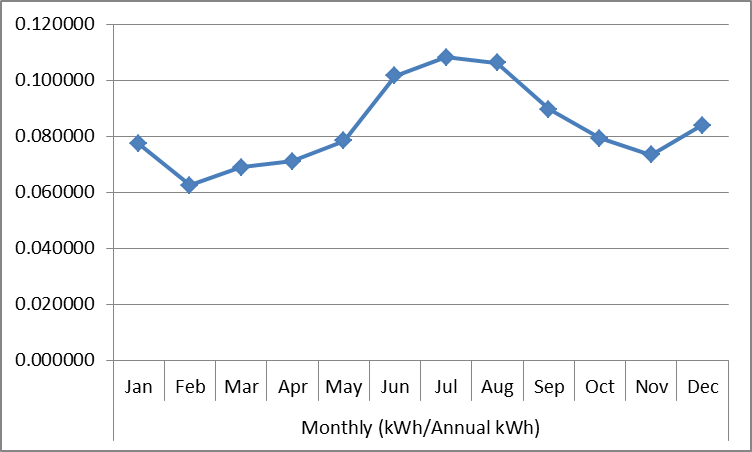
**Creation of the Hourly Avoided Energy Use Load Shape for 2015**

In September 2016, PG&E tasked HER vendor OPOWER to produce an avoided energy use load shape (expressed in kWh) for 2015 for PG&E customers who had been enrolled in HER experiments for approximately two years or more as described above.

OPOWER applied the following process to create the hourly avoided energy use load shape for 2015:

1. The difference between treatment and control average hourly usage within each experiment was computed for each hour of 2015. This produced an estimate of the average impact of the HER program on treatment usage in each experiment for each hour of 2015;
2. Multiplying the estimates of average savings per customer in each experiment and hour by the number of treatment customers active in that experiment on that date produced an estimate of total kWh saved for that experiment in each hour;
3. Adding up savings across experiments for each hour produced an estimate of savings for this set of experiments in each hour of 2015;
4. Dividing the savings in each hour by the total savings in 2015 for this set of experiments produced the hourly avoided energy use load shape for 2015.

This empirically-derived avoided energy use load shape is presented below (monthly values are provided in appendices):



**Matching the Hourly Load Shape to Approved DEER Load Shapes:**

The E3 Calculator and the Cost Effectiveness Tool (CET) are used to evaluate the cost effectiveness of energy efficiency measures and are based on a limited set of pre-determined energy efficiency impact shapes. 19 DEER-based impact shapes were selected to fit over 80 percent of the expected energy efficiency program savings. However, for those measures that were not a good fit with the pre-determined shapes, the user was generally left with the chore of selecting the least poor fit.

As more measures are deviating from the existing pre-determined shapes, E3 has developed a Proxy Tool to allow precise valuation of such measures. This Excel-based spreadsheet calculates a weighted average of two DEER shapes that can be used to equal the avoided cost benefits that would have been attributed to the measure if that measure impact shape were a selectable shape.

Using the Excel tool provided by E3 and the OPOWER savings load shape, PG&E engineering staff allocated the HER program annual kWh saved to a pair of DEER shapes. These load shapes are Res:DEER:RefgFrzr\_HighEff and Res:DEER:HVAC\_Eff\_AC.

This enables the E3 Calculator to attribute present value avoided cost benefits to the HER program that matches what the measure would have received if its actual shape were included among the official DEER shapes. More detail about the Proxy Tool is provided in the Appendices.

## 3.1 Base Case Load Shapes

As described in the introduction of Section 3, a pair of approved DEER residential load shapes is used to match the actual measure load shape derived from interval meter data, because there is no appropriate fit with pre-determined shapes. See Table 6 for a list of all Building Types and Load Shapes.

Table 5 Base Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Single Family Residence | RES | DEER:RefgFrzr\_HighEff |
| Single Family Residence | RES | DEER:HVAC\_Eff\_AC |

## 3.2 Measure Load Shapes

The Measure Load Shapes for this measure are the same as the base case due to the statistical and random nature of the savings generated by this program. They are shown in Table 6.

Table 6 Measure Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Single Family Residence | RES | DEER:RefgFrzr\_HighEff |
| Single Family Residence | RES | DEER:HVAC\_Eff\_AC |

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***NC (new construction)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ROB (replace on burnout)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ER (early retirement)*** | RUL/  EUL-RUL | Calculated as Full Gross Measure Cost | Calculated as Negative Full Gross Base Case Cost |

## 4.1 Base Case(s) Costs

The following Measure Application Type is appropriate to this program. The Base Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline**  ***(Control Group)*** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| *All* | ROB | *Existing Customer Behavior* | *0* | *0* | *0* | *0* |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Costs

The following Measure Application Type is appropriate to this program. The Measure Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Measure Usage**  **(Treatment Group)** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
|  | ROB | *Resulting Customer Behavior* | *0* | *0* | *0* | *0* |

*All costs are noted as $ per measure unit*

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Gross Measure Cost**  **(RUL Period/First Baseline)** | **Gross Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ROB | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |

# *4.3.1 Gross Measure Cost*

Gross Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

This Measure Application Type is **ROB**, so the Gross Measure Cost (GMC) is represented by the equation below:

GMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

\*Note: We assume that, unless stated otherwise, the measure case labor and base case labor are assumed to be the same value reducing the equation to the following:

GMC = Measure Equipment Cost – Base Case Equipment *Cost*

*GMC = $0.00 per (unit) - $ 0.00 per (unit) = $0.00 per unit*

# *4.3.2 Incremental Measure Costs*

Incremental Measure Cost (IMC) is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straightforward definition depending on the Measure Application type, the equation does vary.

This Measure Application Types is **ROB**, so the Incremental Measure Cost (IMC) is represented by the equation below:

IMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

\* Note: We assume that, unless stated otherwise, the measure case labor and base case labor are assumed to be the same value reducing the equation to the following:

IMC = Measure Equipment Cost – Base Case Equipment Cost

*IMC = $0.00 per (unit) - $ 0.00 per (unit) = $0.00 per unit*

**Summary Table for Section 4**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Measure Application Types** | **Base Case Total Cost** | **Measure Case Total Cost[[15]](#endnote-14)** | **Gross Measure Case Cost** | **Incremental Measure Cost** |
|  | ROB | **0** | **0** | **0** | **0** |

# Input Appendices

The spreadsheet below contains the PG&E HER program electric 8,760 values:



The monthly avoided energy use load shape for 2015 is presented below:

|  |  |
| --- | --- |
| **Monthly (kWh/ Annual kWh)** |  |
| Jan | 0.0772986 |
| Feb | 0.0623938 |
| Mar | 0.0689485 |
| Apr | 0.070993 |
| May | 0.0782812 |
| Jun | 0.1016216 |
| Jul | 0.1081705 |
| Aug | 0.1062156 |
| Sep | 0.0896876 |
| Oct | 0.0791887 |
| Nov | 0.073398 |
| Dec | 0.0838028 |

**E3 Proxy Tool Background**

The E3 Calculator is an Excel spreadsheet (to be replaced by a SQL tool referred to as the Cost Effectiveness Tool (CET) which has the same functionality) that is used to evaluate the cost effectiveness of energy efficiency measures for the three California investor owned utilities. The E3 Calculator was first developed in 2004 with a focus on simplifying the program submission and review process by using a limited set of pre-determined EE impact shapes. 19 DEER-based impact shapes currently included in the E3 Calculator were selected to fit over 80 percent of the expected EE program savings. However, for those measures that were not a good fit with the pre-determined shapes, the user was generally left with the chore of selecting the least bad fit.

E3 has provided the utilities with the “E3 Proxy” tool to allow precise valuation of such measures in the E3 Calculator (and in the CET). At its core, the E3 Calculator is a cost-effectiveness tool that determines the present value of lifecycle avoided cost benefits and lifecycle costs. When one assigns a DEER shape to a measure, that DEER shape determines the avoided cost benefits that will be attributed to the measure. The Proxy Tool simply calculates a weighted average of two DEER shapes that can be used to equal the avoided cost benefits that would have been attributed to the measure if that measure’s impact shape were a selectable shape.

For example, assume measure A saves 600kWh per year, has an EUL of 10 years, and has present value avoided cost benefits of $1000 per annual kWh. Further assume that we have DEER shape 1 with present value avoided cost benefits of $1400/annual kWh and DEER Shape 2 with $900/annual kWh.

* The standard approach would be to enter measure A as saving 600 kWh per year and mapped to DEER Shape 2. The resulting benefits would be $540,000 (600 \* 900) which is less than the actual $600,000 (600 \* 1000).
* The Proxy Tool method would enter measure A as saving 480kWh per year using DEER Shape 2 and 120kWh per year using DEER Shape 1. By modeling measure A using a blend of two existing DEER shapes, one can obtain the correct avoided cost benefits of $600,000 (480 \* 900 + 120 \* 1400)

**The Proxy Tool**

The Proxy Tool is an Excel spreadsheet that calculates the present value avoided cost benefits for a user-input hourly impact shape. This calculation is done using the same hourly avoided cost inputs that are used for the DEER shape “pre-processing”, and the same weighted average cost of capital (WACC) discount rate used in the E3 Calculator. The tool then compares the avoided cost benefits of the user-input impact shape to the avoided cost benefits for the official DEER shapes, and calculates allocation factors for any pair of DEER shapes. By splitting the measure’s annual kWh across the pair of DEER shapes using these allocation factors, the E3 Calculator will attribute present value avoided cost benefits to the measure that match what the measure would have received if its actual shape were included among the official DEER shapes.

Notes:

The Proxy Tool can calculate allocation factors for any pair of DEER measures. The choice of DEER measures to use will not affect the result, as the allocation factors will always result in the correct avoided costs, and will always sum to 100%, so the tracking of total annual kWh savings is not distorted. Certain pairings, however, will likely have more appeal from a pure optics perspective, and for this optics reason, one should probably try to avoid pairings that result in a negative share and a greater than 100% share (unless one is modeling a storage or load shifting measure).

The allocation shares are calculated assuming the measures are installed at the beginning of the user-entered calendar year, and that EUL is integer years. While the E3 Calculator tracks installation quarters and fractional EUL years, we do not believe that level of detail is necessary for determining allocation factors, as we do not expect the factors would change significantly with those modifications.

# References

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DNV GL – California Upstream and Residential Lighting Impact Evaluation Work Order 28 (WO28) Final Report ; 8/4/2014 ; Study ID: CPU0099.01

DNV GL – Review and Validation of 2014 Pacific Gas and Electric home energy reports Program impacts (Final Report) ; 4/1/2016 ; Study ID: CPU0123.01; ED\_D\_Res 3.1

Kema – Review of PG&E Home Energy Reports Initiative Evaluation; 5/31/2013 ; Study ID: CPU0064.01; WO027; KEMA027

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State and Local Energy Efficiency Action Network (SEE Action); *Evaluation, Measurement and Verification (EM&V) of Residential Behavior-Based* *Energy Efficiency Programs: Issues and Recommendations;* May 2012; [www.seeaction.gov](http://www.seeaction.gov)

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**Endnotes**

1. ‘Adjusted Savings’ are defined as ‘Unadjusted Saving’ (estimated by statistical analysis) minus ‘Joint-Savings’ (savings that have been claimed by other energy efficiency programs). [↑](#footnote-ref-1)
2. TRC Energy Services – Lighting Savings Overlap Estimate for 2014 IOU Home Energy Report Programs ; 6/27/2016 ; Study ID: PGE0383.01 [↑](#endnote-ref-1)
3. Freeman, Sullivan & Co. (FSC) – Evaluation of PG&E Home Energy Report Initiative for the 2010-2012 Program ; 04/25/ 2013, p. 39 ; CALMAC ID: ID PGE0329.01 [↑](#endnote-ref-2)
4. Smith B. and Arnot L. – Neighbor Comparison Reports Produce Savings, but HOW? ; ACEEE Summer Session 2014 [↑](#endnote-ref-3)
5. California Public Utilities Commission, Decision 09-09-047 September 24, 2009 -- Application of Southern California Edison Company (U338E) for Approval of its 2009-2011Energy Efficiency Program Plans and Associated Public Goods Charge (PGC) and Procurement Funding Requests, Date of Issuance 10/1/2009; pg. 304 [↑](#endnote-ref-4)
6. California Public Utilities Commission, Decision 10-04-029 April 8, 2010 -- Application of Southern California Edison Company (U338E) for Approval of its 2009-2011 Energy Efficiency Program Plans and Associated Public Goods Charge (PGC) and Procurement Funding Requests, Date of Issuance 4/21/2010, pp.40-42 [↑](#endnote-ref-5)
7. The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls.* [↑](#endnote-ref-6)
8. PG&E CES EM&V Dept.; *IOU Proposal for Reporting Energy Savings for Comparative Usage* *Energy Efficiency Programs,* May 8, 2012 Revision; page 4 [↑](#endnote-ref-7)
9. PG&E CES EM&V Dept. *PG&E Home Energy Reports Initiative* *Sampling Plan* May 17,2011 Revision [↑](#endnote-ref-8)
10. PG&E CES EM&V Dept.; *IOU Proposal for Reporting Energy Savings for Comparative Usage* *Energy Efficiency Programs,* May 8, 2012 Revision; page 4 [↑](#endnote-ref-9)
11. PG&E CES EM&V Dept.; *IOU Proposal for Reporting Energy Savings for Comparative Usage* *Energy Efficiency Programs,* May 8, 2012 Revision; page 4 [↑](#endnote-ref-10)
12. PG&E CES EM&V Dept.; *IOU Proposal for Reporting Energy Savings for Comparative Usage* *Energy Efficiency Programs,* May 8, 2012 Revision; page 4 [↑](#endnote-ref-11)
13. PG&E CES EM&V Dept.; *IOU Proposal for Reporting Energy Savings for Comparative Usage* *Energy Efficiency Programs,* May 8, 2012 Revision; page 4 [↑](#endnote-ref-12)
14. State and Local Energy Efficiency Action Network (SEE Action); *Evaluation, Measurement and Verification (EM&V) of Residential Behavior-Based* *Energy Efficiency Programs: Issues and Recommendations;* May 2012; [www.seeaction.gov](http://www.seeaction.gov) [↑](#endnote-ref-13)
15. SCE, Measure Cost Revision 5 revised for PG&E by S.L. Blanc 2012

    [↑](#endnote-ref-14)