Work Paper PGECOAPP128
Retail Products Platform
Revision # 2

Pacific Gas and Electric Company
Customer Energy Solutions

Retail Products Platform

1/31/2017

At-a-Glance Summary

	Retail Products Platform
Measure description	Incentives are given to participating retailers to sell larger volumes of more efficient appliances and consumer electronics.
Program delivery method	Midstream
Measure application type	ROB
Base case description	Non-ENERGY STAR certified products
Energy and demand impact common units	Each
Peak Demand Reduction (kW/unit)	Varies by product
Energy savings (Base case – Measure) (kWh/unit)	Varies by product
Gas savings (Base case – Measure) (therms/unit)	Varies by product
Full measure cost[1] ($/unit)	N/A
Incremental measure cost[2] ($/unit)	Varies by product
Effective useful life (years)	Varies by product Sources: DEER2017, available studies, EPA
Net-to-gross ratio(s)	Varies by product
Important comments	Revised per CPUC disposition issued December 15, 2015.

[1] Full measure cost = measure equipment cost + measure labor cost

[2] Incremental measure cost = Measure equipment cost – Baseline equipment cost

Document Revision History

Revision #	Revision Date	Section-by-Section Description of Revisions	Author (Name, PA)
0	12/29/2015	Revised UES and NTG values per CPUC disposition dated 12/15/2015. Revisions to UES calculations are as follows: - Freezers: revised to align with corrected values published in READI - Clothes Dryers: revised calculations to reflect use of remaining moisture content of minimum qualifying ENERGY STAR clothes washer. Revised interactive effects calculations to incorporate DEER internal gain fractions for vented electric clothes dryers. Revised peak demand reduction methodology to utilize CDF from Building America dryer usage profile. - Room air conditioners: revised with values from SCE workpaper SCE13HC001. - Room air cleaners: revised calculations to use minimum ENERGY STAR qualifying CADR/watt.	Jia Huang (PG&E) Andrea Salazar (EMI Consulting)
1	12/21/2016	Add new measures to RPP: ENERGY STAR Most Efficient clothes washers and refrigerators. Updated interactive effects for DEER 2017. Updated savings values to freezers in DEER 2017.	Jia Huang (PG&E)
2	1/31/2017	Added measure for CEE Tier 3 Clothes Washers, corrected calculation error in ESME Clothes Washers. Updated energy savings for dryers, air cleaners, and soundbars per new research results.	Jia Huang (PG&E)

Commission Staff Review and Comment History

Revision #	Date Submitted to Commission Staff	Date Comments Received	Commission Staff Comments
0	11/06/2015	12/15/2015	See CPUC disposition: “PGECOAPP128r0_RetailProductsPlatform_15Dec2015.docx”

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Section 1. General Measure and Baseline Data

1.1 Product Measures

General Description

The Retail Products Platform (RPP) Program responds to the call from the Long-Term Energy Efficiency Strategic Plan adopted by the California Public Utilities Commission (CPUC) on September 18, 2008 to develop comprehensive, innovative initiatives to reverse the growth of plug load energy consumption through technological and behavioral solutions[3] (California Public Utilities Commission, 2011). Rather than consisting of a single measure, the RPP Program is designed motivate retailers to change their business practices with the ultimate goal of reducing the growth of plug load electricity use. Unlike typical measures in PG&E's energy efficiency measure portfolio that are characterized as resource acquisition (RA) programs, the RPP Program is characterized as a market transformation (MT) program. The objective of the RPP Program is to accomplish long-term sustainable changes in the retail market to motivate consumers to adopt more efficient plug load and appliance products and to influence the supply chain to provide more efficient models over time.

The program will incent retailers for selling specific home appliance and consumer electronics models in targeted product categories that meet and/or exceed ENERGY STAR minimum efficiency requirements. The RPP Program is adopting a portfolio approach, which allows retailers and utilities to customize the product offerings on an ongoing basis based on a number of specific inputs for each product such as energy savings potential, product cost, market share, overall product sales volumes, etc.

The following measures are currently being considered for inclusion in the portfolio: freezers, electric clothes dryers, gas clothes dryers, room air cleaners, soundbars, room air conditioners, clothes washers, and refrigerators.

Technical Description

Freezer - a cabinet that is designed as a unit for the freezing and storage of food, beverages, or ice at temperatures of 0°F or below and that has a source of refrigeration requiring an energy input (Singh, Rider, & Babula, 2015).

Electric clothes dryer - a cabinet-like appliance that is designed to dry fabrics in a tumble-type drum with forced air circulation and that has a drum and a blower driven by an electric motor. Electric clothes dryer means a clothes dryer whose heat source is electricity (Singh, Rider, & Babula, 2015).

Gas clothes dryer - a cabinet-like appliance that is designed to dry fabrics in a tumble-type drum with forced air circulation and that has a drum and a blower driven by an electric motor. Gas clothes dryer means a clothes dryer whose heat source is gas and the drum and blower(s) are driven by an electric motor(s) (Singh, Rider, & Babula, 2015).

Room air cleaner – a portable, electric appliance that removes fine particles, such as dust and pollen, from indoor air (U.S. Environmental Protection Agency)

Soundbar - a special loudspeaker enclosure that creates a reasonable stereo effect from a single cabinet. They are much wider than they are tall, partly for acoustical reasons, but also so that they can be

[3] Reducing plug load energy consumption is highlighted as one of four strategic market transformation goals for the residential sector in the California Energy Efficiency Strategic Plan (see page 11).

mounted above or below a display device e.g. above a computer monitor or under a television or home theater screen. (Soundbar)

Room Air Conditioner - a factory-encased air conditioner that is designed (1) as a unit for mounting in a window, through a wall, or as a console, and (2) for delivery without ducts of conditioned air to an enclosed space (Singh, Rider, & Babula, 2015).

Clothes Washer - an appliance designed to clean clothes, utilizing a water solution of soap or detergent and mechanical agitation or other movement. (CEC Title 20)

Refrigerator - a cabinet that is designed for the refrigerated storage of food, including but not limited to solid food and wine, beer, and other beverages, at temperatures above 32°F, and that has a source of refrigeration requiring an energy input. It may include a compartment for the freezing and storage of food at temperatures below 32°F, but it does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures below 8°F. (CEC Title 20)

1.2 Program Implementation Overview

Implementation Methods

The Program is a mid-stream strategy (retailer-centered) that influences both upstream (manufacturer) and downstream (customer) actors. The fundamental program theory is that, with the right combination of incentives and engagement, market barriers for retailers, consumers and eventually manufacturers will be reduced.[4] This strategy involves the leveraging of retailer power (through stocking, assortment, pricing, and promotion practices) to influence consumer demand for energy-efficient products and using the retailer's market power with manufacturers to influence manufacturer supply. As a result, retailers will sell more models that meet and/or exceed ENERGY STAR specifications to more informed customers than retailers would have absent the program, thereby generating energy savings, and with sustained engagement, transforming the retail channel market in delivering energy efficient plug load products and appliances. A key metric that will be tracked over time is retailers' sales of program-qualified models as a percent of all models sold.

In the short term, the program is intended to motivate participating retailers through incentives to promote and sell more efficient models. Over time, other retailers, investor-owned utilities (IOUs), and administrators outside of PG&E's service territory (e.g., other investor-owned utilities, municipal utilities such as SMUD, and program administrators, such as NEEA) are expected to collaborate in this effort to incentivize retailers to regularly demand, stock, and promote the most efficient models available. Building scale through the participation of multiple utilities will be necessary because the market for these types of "plug-load" products is complex and world-wide and it would be extremely difficult for a single IOU to have sufficient influence on the market forces to affect how manufacturers and mid-stream players act. The program will require participation by a number of retailers and buying groups that have a significant market share to affect the demand for higher efficiency products. Once the RPP Program reaches full

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[4] Note that the RPP is not a lift program, which pays incentives only for the number of units sold that is greater than the forecasted number of units that would have been sold normally (in the absence of the program). That is, in lift programs incentives are paid only for the incremental, or net, units above a baseline forecast. Rather, in the RPP Program an incentive will be paid for every program-qualified unit in order to provide fair and balanced incentives to participating retailers. This incentive structure is no different than standard utility midstream incentive programs, which pay incentives for every qualified measure (e.g., a refrigerator). Some portion of program participants are always free riders, a proportion that is determined as part of an ex-post evaluation. To mitigate the risk of high free ridership, program implementers must incentivize energy-efficient measures that have relatively low market share, use less energy, are not readily available or promoted to customers, and may cost more than the standard efficient units. For a complete list of market barriers, see PG&E (2015). Program Theory and Logic Model for the PG&E Retail Products Platform(RPP) Program, pp. 14-15.

scale, the resulting increase in regional and/or national demand for higher efficiency models will cause their manufacturing partners to shift to production of these models permanently, thus transforming the markets for the targeted products and reversing the trend of increasing energy use due to plug loads and appliances. In cases where mandatory codes are adopted, the savings are irreversible. To the extent that retailer behavior is transformed permanently, the promotion of models that exceed current voluntary and mandatory efficiency codes will be sustainable. The program theory and logic model for the RPP Program, which includes program activities, expected outputs and short-, medium- and long-term outcomes is available upon request.

Program Restrictions and Guidelines

The program will provide incentives to retailers for selling specific models of targeted categories of home appliance and consumer electronics products that meet and/or exceed ENERGY STAR minimum efficiency requirements.

Measure Application Type

All purchases made through the RPP Program are assumed to be *replacement on burnout*. This assumption means that the baseline usage is the UEC for all non-program qualifying models rather than the UEC for all units that were replaced (which would require a separate baseline for early replacement).

Implementation Requirements

There are a number of components of the RPP Program that will help to ensure the reliability and persistence of the savings.

One of the challenges with MT programs is that the baselines used to estimate gross energy and demand impacts are dynamic, particularly in fast moving markets such as consumer electronics. To account for expected changes in baselines and ensure more reliable estimates of gross savings, the RPP Program will re-estimate UECs and UESs annually based on any updates to the data sources used to calculate the UESs adopted at the beginning of each program year. Other parameters such as NTGRs, EULs, installation rates, incentive levels, and load profiles will also be updated as new data are collected throughout the life of the program.

The persistence of the savings of each product is already captured in the product EUL. However, permanently changing retailer behavior with respect to the demand, sale and promotion of models that meet and/or exceed ENERGY STAR minimum efficiency requirements is the ultimate goal of the RPP Program. Put another way, the question of persistence of savings for this particular program becomes: once the RPP Program concludes, what are the chances that this changed retailer behavior will persist, i.e., become routine and sustainable? Of course, the program theory and logic model are designed to produce savings that persist after the program concludes. The fundamental program theory is that, with the right combination of incentives and engagement, market barriers for retailers, consumers and eventually manufacturers will be reduced. As a result, retailers will increase their sales of more energy-efficient models that meet and/or exceed ENERGY STAR specifications to customers than they would have absent the program, thereby generating energy savings, and with sustained engagement, transform the retail channel market by delivering energy-efficient plug load products and appliances.

More details how the design and delivery of the RPP Program are aimed at ensuring sustainable savings are provided in a more comprehensive program theory and logic model document that is available from PG&E upon request.

1.3 Level of Evaluation Rigor

Any measure that is expected to represent 1% or more of total IOU portfolio savings is referred to as a high impact measure (HIM). Evaluations aimed at estimating the savings for HIMs, due to their relative importance to the portfolio, are typically designed at a higher level of methodological rigor. The question is whether the savings associated with the RPP 2015 bundle of measures represent 1% or more of PG&E's estimated net savings. If not, is the bundle likely to achieve HIM status at some point in the future? Given that as of 2015, only four retailers are likely to engage with the RPP Program and that the RPP Program will incent initially only six products, achieving HIM status is highly unlikely in the immediate future. However, going forward, as more retailers engage with the RPP Program that will expand the number of products the Program covers, and the chances of achieving HIM status at some point in the future increases. Given this likelihood, the evaluation plan for the RPP Program (EMI Consulting, 2015) is set at the enhanced level of rigor. This represents a "no-regrets" evaluation design since PG&E wishes to avoid a situation in which the RPP Program eventually achieves HIM status but PG&E failed to establish baselines for key program performance and market transformation indicators.

1.4 Product Parameter Data

1.4.1 DEER Data

Unit Energy Savings (UES)

Table 1. DEER UES Difference Summary

DEER		Used in Workpaper Approach?				
	Freezers, Clothes Washers, Refrigerators	Electric Clothes Dryers	Gas Clothes Dryers	Room Air Cleaners	Soundbars	Room Air Conditioners
Modified DEER methodology	Yes	No	No	No	No	No
Scaled DEER measure	Yes	No	No	No	No	No
DEER base case used	Yes	No	No	No	No	No
DEER measure case used	Yes	No	No	No	No	No
DEER building types Used	Yes	No	No	No	No	No
DEER operating hours used	Yes	No	No	No	No	No
Reason for Deviation from DEER	N/A	There are no measure savings for Clothes Dryers in DEER.	There are no measure savings for Clothes Dryers in DEER.	There are no measure savings for Room Air Cleaners in DEER.	There are no measure savings for Soundbars in DEER.	There are no measure savings for Room ACs in DEER.
DEER Version	DEER2017	N/A	N/A	N/A	N/A	N/A

DEER ID and Measure Name (Sample)	Various	N/A	N/A	N/A	N/A	N/A

Net-to-Gross

Table 2. DEER Net-to-Gross Ratios

N/A

The net-to-gross ratio (NTGR) is a factor representing net program load impacts divided by gross program load impacts. The NTGR 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.

Estimating the NTGR for a market transformation (MT) program requires a different method than that which is commonly used for resource acquisition (RA) programs. Typically, the NTGRs in DEER are based on evaluations of RA programs, which are evaluated over a relatively short period of time — typically once every evaluation cycle. California IOUs have designed and implemented RA programs for over 30 years. Given this long history, forecasting a NTGR and a total resource cost (TRC) for a residential major appliance program that is scheduled to run for a three-year cycle, for example, is standard practice. During that cycle, the fact that the number of other interventions in the same market(s) and the number of social and economic factors are relatively few and change little contribute to the relative ease with which program attribution can be estimated.

MT programs, on the other hand, extend over a much longer period of time during which key parameters such as incremental cost can change dramatically and the number of interventions and social/economic factors are far more numerous and can change dramatically (i.e., The Great Recession). Prahl and Keating 2014 (Prahl & Keating, 2014) observed:

> 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. (pp. 45-46, see Appendix 1 – Supplemental Files for the full report)

Furthermore, there are limited CPUC-adopted guidance documents and CPUC decisions on MT evaluation policies, and limited experience among the California IOUs and across the United States in designing, implementing, and evaluating MT programs. Outside of California, while MT programs have been implemented more frequently, rigorous evaluations of these programs are rare (Ridge & Chen, 2012). The few exceptions, such as the evaluation of NYSERDA's 2010-2012 ENERGY STAR Product Program, have provided some valuable insights. However, since the RPP Program is being designed to avoid some of the program design problems identified in the NYSERDA evaluation, NYSERDA's estimated NTGR is not particularly relevant. The lack of relevant historical experience with MT programs combined with their greater complexity and duration creates enormous challenges in forecasting the NTGR for RPP products. For all these reasons, the DEER NTGR values that are available for RPP products were deemed not applicable. For nearly all RPP products there are no NTGRs either in DEER or that could be transferred from evaluations of similar MT programs. Therefore, a different approach was identified for estimating NTGRs for all RPP measures that is more appropriate for a MT program. This method is briefly described in Section 1.4.5.

Effective Useful Life / Remaining Useful Life

Table 3 shows the EUL/RUL values for products that are included in DEER.

Table 3. DEER EUL Values/Methodology

READi EUL ID	Market	End Use	Measure	EUL (Years)	RUL (Years)
Appl-ESFrzr	Residential	KitchenApp	High Efficiency Freezer	11	3.7
HV-RAC-ES	Residential	HVAC	Room AC – Energy Star	9	3
Appl-EffCW	Residential	Laundry	High Efficiency Clothes Washer	11	3.7
Appl-ESRefg	Residential	KitchenApp	High Efficiency Refrigerator	14	4.7

DEER 2017 does not provide EUL/RUL values for the remaining products in RPP.

In-Service Rate / First Year Installation Rate:

Table 4. Installation Rate

N/A

It is assumed that the installation rate for all RPP products is 100%. Consumers don't typically stockpile home appliances or consumer electronics products.

READi Technology Fields

Table 5. READi Tech IDs

READi Field Name	Product	Values included in this workpaper
Measure Case UseCategory	Freezers	AppPlug
	Electric Clothes Dryers	
	Gas Clothes Dryers	
	Clothes Washers	
	Refrigerators	
	Room Air Cleaners	HVAC
	Room Air Conditioners	
	Soundbars	AppPlug
Measure Case UseSubCats	Freezers	KitchenApp
	Refrigerators	
	Electric Clothes Dryers	Laundry
	Gas Clothes Dryers	
	Clothes Washers	
	Room Air Cleaners	VentAirDist
	Room Air Conditioners	SpaceCool
	Soundbars	Electronics
Measure Case TechGroups	Freezers	Ref_Storage
	Refrigerators	
	Electric Clothes Dryers	Clean_equip

READi Field Name	Product	Values included in this workpaper
	Gas Clothes Dryers	
	Clothes Washers	
	Room Air Cleaners	Electronics
	Room Air Conditioners	dxAC_equip
	Soundbars	Electronics
Measure Case TechTypes	Freezers	Freezer
	Refrigerators	
	Electric Clothes Dryers	ClothesWash
	Gas Clothes Dryers	
	Clothes Washers	
	Room Air Cleaners	AllEquip
	Room Air Conditioners	RoomAC
	Soundbars	AllEquip
Base Case TechGroups	Freezers	Ref_Storage
	Refrigerators	
	Electric Clothes Dryers	Clean_equip
	Gas Clothes Dryers	
	Clothes Washers	
	Room Air Cleaners	Electronics
	Room Air Conditioners	dxAC_equip
	Soundbars	Electronics
Base Case TechTypes	Freezers	Freezer
	Refrigerators	
	Electric Clothes Dryers	ClothesWash
	Gas Clothes Dryers	
	Clothes Washers	
	Room Air Cleaners	AllEquip
	Room Air Conditioners	RoomAC
	Soundbars	AllEquip

1.4.2 Codes and Standards Requirements Base Case and Measure Information

Title 20: Freezers, clothes dryers, clothes washers, and refrigerators fall under Title 20 and have the same requirements under Federal DOE Energy Regulations. The combined EER of room air conditioners manufactured on or after June 1, 2014 shall be not less than the applicable values shown in Table 6 below.

Table 6. Title 20 Requirements for Room Air Conditioners

Product Class	Louvered Sides?	Cooling Capacity (Btu/h)	Minimum Combined EER
Room Air Conditioner	Yes	< 6,000	11.0
		6,000 – 7,999	11.0
		8,000 – 13,999	10.9
		14,000 – 19,999	10.7
		20,000 – 27,999	9.4
		≥ 28,000	9.0
	No	<6,000	10.0
		6,000 – 7,999	10.0
		8,000 – 10,999	9.6
		11,000 – 13,999	9.5
		14,000 – 19,999	9.3
		≥ 20,000	9.4
Room Air Conditioning Heat Pump[5]	Yes	< 20,000	9.8
		≥ 20,000	9.3
	No	< 14,000	9.3
		≥ 14,000	8.7
Casement-Only Room Air Conditioner	Either	Any	9.5
Casement-Slider Room Air Conditioner	Either	Any	10.4

Title 24: These measures do not fall under Title 24.

Federal Standards: The following measures fall under Federal DOE Energy Regulations.

Table 7. Effective September 14, 2014, the following is required for refrigerators (not shown) and freezers (Residential Refrigerators and Freezers):

Product Class	**Equations for Maximum Energy Use (kWh/yr)**	
	Based on AV (cu. ft.)	Based on av (L)
8. Upright freezers with manual defrost.	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker.	8.62AV + 228.3	0.305av + 228.3
9I. Upright freezers with automatic defrost with an automatic icemaker.	8.62AV + 312.3	0.305av + 312.3
9-BI. Built-In Upright freezers with automatic defrost without an automatic icemaker.	9.86AV + 260.9	0.348av + 260.9
9I-BI. Built-in upright freezers with automatic defrost with an automatic icemaker.	9.86AV + 344.9	0.348av + 344.9
10. Chest freezers and all other freezers except compact freezers.	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost.	10.24AV + 148.1	0.362av + 148.1

Effective January 1, 2015, the following is required for clothes dryers (Residential Clothes Dryers). As of January 1, 2015, manufacturers are required to show compliance using the test

[5] Room air conditioning heat pumps are also frequently referred to as reverse cycle room air conditioners.

procedure in Appendix D1 in the Code of Federal Regulations (Title 10: Energy, Part 430 - Energy Conservation Program for Consumer Products, 2015). Manufacturers may also use Appendix D2 to show early compliance with the January 1, 2015 energy conservation standards.

Table 8. Federal Minimum Requirements for Clothes Dryers

Product Class	Combined Energy Factor (pounds/kWh)
1. Vented Electric, Standard (4.4 ft^3 or greater capacity)	3.73
2. Vented Electric, Compact (120V) (less than 4.4 ft^3 capacity)	3.61
3. Vented Electric, Compact (240V) (less than 4.4 ft^3 capacity)	3.27
4. Vented Gas	3.30
5. Ventless Electric, Compact (240V) (less than 4.4 ft^3 capacity)	2.55
6. Ventless Electric Combination Washer/Dryer	2.08

Effective March 7, 2015, the following is required for clothes washers:

Table 9. Federal Minimum Requirements for Clothes Washers

Product Class	Integrated Modified Energy Factor (ft^3/kWh/cycle) (minimum values)	Integrated Water Factor (gal/cycle/ft^3) (maximum values)
1. Top-loading, Compact (less than 1.6 ft^3 capacity)	0.86	14.4
2. Top-loading, Standard (1.6 ft^3 or greater capacity)	1.29	8.4
3. Front-loading, Compact (less than 1.6 ft^3 capacity)	1.13	8.3
4. Front-loading, Standard (1.6 ft^3 or greater capacity)	1.84	4.7

1.4.3 Relevant EM&V Studies

A large number of potentially relevant evaluations of programs that reported some form of participant and/or nonparticipant spillover were examined (Ridge & Chen, 2012). Programs that were relatively recent and similar to the RPP Program were identified and reviewed to inform the workpaper as well as the design of the RPP Program and its evaluation. Three evaluations were identified. Each is presented below followed by a discussion of the lessons learned.

1.4.3.1. The New York Products Program (Dimetrosky, Lieb, Rowberry, Peters, & Scholl, 2014)

The New York Products Program (NYPP; previously called the New York Energy $mart[SM] Products Initiative), established in 1999, seeks to increase sales of residential energy-efficient appliances, lighting and home electronics products. NYPP works on the supply side with retailers and manufacturers and on the demand side by marketing to consumers. NYPP's overall goal is to increase awareness of and demand for energy-efficient products, including ENERGY STAR certified appliances, lighting, and home electronics. Program activities include incentives for cooperative advertising and special promotions, as well as marketing campaigns on both the supply and demand sides of the appliance and lighting markets. Other activities include the development and distribution of special point-of-purchase (POP) materials; development of educational materials, inclusion on the www.nyserda.ny.gov website, coordination with retailers to obtain donations of ENERGY STAR certified appliances and lighting in support of the Program's outreach at trade shows, home shows, and county and state fairs, as well as training sessions for retail sales staff and managers.

Though not a direct change in program design, the most significant event that affected the NYPP was the introduction of American Recovery and Reinvestment Act (ARRA) funds. The significance of the availability of millions of dollars in ARRA funding during the 2010-2012 timeframe (though most of the appliance rebate funds were concentrated in the program year 2010) cannot be overstated. ARRA funding provided the availability of the following appliance programs:

- In 2010 NYSERDA implemented "New York's Great Appliance Swap Out," an energy-efficient appliance rebate program that offered rebates for the purchase of ENERGY STAR certified refrigerators, freezers, and clothes washers, and larger rebates were included when bundled with recycling of older inefficient refrigerators and clothes washers, dishwashers. This program began on February 12, 2010 and ended in early March 2011.
- In September 2011 and March 2012, NYSERDA initiated the statewide "Buy Green, Save Green" appliance rebate initiative. This initiative offered rebates for high efficiency refrigerators and clothes washers, defined as models that qualified for the Consortium for Energy Efficiency's Tiers 2 and 3 efficiency levels. Retail partners promoted it heavily, and funding was exhausted in less than a week during both efforts.
- In September 2011, NYSERDA initiated a "New York Storm Relief" rebate initiative to help New Yorkers whose homes had been damaged by Hurricane Irene and Tropical Storm Lee recover with rebates on efficient appliances and space and hot water heating systems.

Evaluation Methods

This evaluation relied on multiple methods and analytical techniques to characterize and assess the market and to estimate net savings. Both primary and available secondary data were used in the analysis. To determine how well the program raised awareness, the evaluation team used information gathered in a residential end-use customer telephone survey (the MCAP Survey), the 2012 National Household CEE Survey (U.S. Environmental Protection Agency, 2013), corporate retailer interviews, and a participating retailer storefront survey. The evaluation team relied primarily on three data sources to estimate market share for ENERGY STAR certified products in the NYSERDA region:

- National Partner Sales Data collected by D&R International[6]
- NYSERDA Partner Sales Data collected by Lockheed Martin[7]

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[6] D&R collects sales data from national ENERGY STAR partners, combining all partner data (removing retailer names). This data is extremely valuable in detail, providing ENERGY STAR market share for four appliance types (refrigerators, clothes washers, dishwashers, and room ACs) by state, region, and year. The primary caveat to using these data, however, is that the compliance rate for retailers providing sales data fluctuates, as the delivery of sales data is requested but not required to remain in the national program. For use in this study, D&R International provided total market share data (rather than individual store data) for 2010 and 2011 in two categories: 1) national ENERGY STAR partners that are also NYSERDA partners and 2) national ENERGY STAR partners excluding NYSERDA partners.

[7] Lockheed Martin collects monthly sales data from NYPP retail partners. The reporting of sales data, including the number of ENERGY STAR and non-ENERGY STAR certified units sold, by month, is a requirement for partners in

- The MCAP Residential End-Use Customer Telephone Survey[8]

Finally, to assess attribution, interviews with retailers and manufacturers were conducted. Responses from areas outside of New York (Washington, D.C. and Houston, TX to represent downstate NY and Virginia to represent upstate NY) were used as points of comparison.

Market Characterization Findings
Market characterization provides background information useful in defining programs, delivery concepts, target markets, and the program potential. "Big box" retailers continue to dominate the market based on the results of the distribution channel analysis: Over 60 percent of the combined consumer survey respondent purchases for every product category came from the top five "big box" retailers, with the highest concentration for refrigerators (70 percent) and lowest for room air conditioning units (49 percent). Market share was estimated for all products using the residential end-use customer survey, sales data from the National ENERGY STAR Partners, and NYSERDA ENERGY STAR Partners. ENERGY STAR market shares were high for all products studied, with the highest market share for dishwashers (74%), followed by clothes washers (61%), refrigerators (55%), and room air-conditioners (48%).

Market Assessment Findings
Market assessment tracks changes in markets over time with a specific focus on market indicators that might be influenced by the NYPP. Consumer awareness and understanding of the ENERGY STAR label has effectively plateaued: aided awareness was 89 percent in 2010 and was slightly lower at 86 percent in the current telephone survey of residential end-use customers. The ENERGY STAR stocking trend among NYSERDA retailers continues to increase steadily over time, with 2012 ENERGY STAR certified appliance-stocking levels higher than in the previous 2010 survey. In addition, all NYSERDA partner retailers now recognize the profitability of promoting ENERGY STAR, as 100 percent of store managers said they would continue to stock (56 percent would continue to advertise) ENERGY STAR certified products even without NYSERDA's assistance. The majority agreed, however, that without NYSERDA's Program, ENERGY STAR sales would likely decrease.

However, market share analysis indicates that the ENERGY STAR market share of most appliances has increased only slightly since 2009. A portion of this increase can be traced to the ARRA rebates (both within New York and nationally), which were available through most of the evaluation timeframe of 2010-2012 (though most of the ARRA rebates occurred in 2010). Market shares of ENERGY STAR products in NYSERDA territory are no longer any higher than shares in non-program areas. The incremental cost analysis showed that ENERGY STAR features are typically bundled with high-end features. This was the reason that simple prices are higher than modeled analyses (this is particularly true for refrigerators). The incremental cost has actually gone down or

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the Program, and compliance is typically above 90% for active retailers. Data are collected for all relevant program-supported products. In order to allow for the analysis of NYSERDA-only partners and NYSERDA partners that are also national partners (also called NYSERDA and national partners, or dual partners), the evaluation team split the retailers by partnership status.

[8] As part of a residential end-use customer random-digit dial survey, the evaluation team targeted 200 respondents per product who had purchased a new refrigerator, clothes washer, dishwasher, or room AC over the 2010-2012-time span. Respondents were asked to provide detailed information about where purchases were made, as well as about the energy efficiency of the product. In order to validate the self-reported purchases of ENERGY STAR certified products, the evaluation team asked respondents to provide the make and model number of the appliance.

stayed flat when modeled and controlled for covariates (such as the inclusion of high-end features) and inflation.

Estimated Net Savings
The evaluation team examined data from a multitude of resources related to ENERGY STAR products in order to estimate net savings from NYPP activities. The 2010-2012 Program resulted in the installation of over 154,966 ENERGY STAR appliances, resulting in estimated savings of 14,816 MWh of energy and 3.4 MW of peak demand. From the program inception through year-end 2012, the program saved 784,832 MWh and 149 MW. The final NTGR was approximately 0.10.

Recommendations
The following recommendations are based on the evaluation team's review of the extensive evaluation data and results.

Issue: The NYSERDA ENERGY STAR market share is very high, awareness has not changed since 2010, and the ENERGY STAR market is considered a mature market.

- Recommendation: Continue shift of focus towards ENERGY STAR Most Efficient to push market forward to even higher efficiency levels.

Issue: Market lift of ENERGY STAR products was somewhat evident in NYSERDA-only partners, of limited impact for retailers that team with both NYSERDA and also work with national ENERGY STAR program (big box), and not evident at all for retailers outside of the program.

- Recommendation: Continue to team with retailers that are not receiving support through the national ENERGY STAR program to help them sell more energy-efficient products. In addition, while the program has moved to promoting ENERGY STAR Most Efficient rather than all ENERGY STAR products, it is important to develop a plan to track market share and potential program impacts.

1.4.3.2. PG&E Business and Consumer Electronics (BCE) Program (Kema, Inc., 2013)
PG&E ran the BCE program from 2008 – 2013 and the program was a core sub-program to CalSPREE. According to the IOU Program Implementation Plans (PIP), Jan. 2011, the PG&E and SCE programs provided "…midstream incentives to retailers to increase the stocking level and promotion activities of high-efficiency (i.e., ENERGY STAR®) electronic products including computers, computer monitors, cable and satellite set-top boxes, televisions and additional business and consumer electronics as they become available to the market."

According to the PIPs filed with the CPUC, the BCE programs generated energy savings by paying rebates to retailers for televisions that were least 15 percent more energy efficient than the prevailing ENERGY STAR standard. Influenced by these rebates, retailers altered their inventory and increased the percentage of these qualifying units in stock. This led to unit sales that are more efficient than they would have been without the program influence.

During the course of operation, the BCE Program added two market transformation elements. First, IOUs claimed that the program influenced the efficiency levels of televisions sold throughout the rest of the U.S. due to national purchasing practices and second, it encouraged ENERGY STAR to adopt more aggressive standards through lobbying efforts aimed at ENERGY STAR and television manufacturers.

The evaluation team used five main data sources to construct a narrative for the BCE program. These were:

- **IOU program staff interviews** - Interviews to record program operations, perceptions of the market, and interactions with target market actors.
- **Regional and national retail TV buyer interviews** - Interviews to understand retailers' product purchase decision criteria, process for procurement, and perceptions of the program.
- **Panel of experts (Delphi)** - An anonymous panel using a hypothetical scenario to gather and understand their insights and opinions about the program's influence on the market.
- **The NPD Group sales data** - Retailer point-of-sale data from The NPD Group for analysis of TV model market shares, feature sets, energy use, and sales trends before and during the program period.
- **IOU program tracking data** - IOU data to which the net-to-gross values that emerged from the interviews, sales data and Delphi panel were applied.

The evaluation team analyzed IOU program staff interviews, interviews with retailers, national and California-specific sales data. In addition the team considered the development of TV technologies and standards. Finally, experts estimated the impact of the BCE program on market share through an anonymous facilitated panel. Averaging these estimates of market share without the program resulted in an estimated 11.4 percent increase in the program-qualifying market share. In other words, the BCE Program increased the market share of energy-efficient televisions in California on average by 11.4 percent.

To generate net savings estimates for the program, the evaluation team converted this 11.4 percent market share increase into kWh savings of 51,913,723 kWh. The IOUs reported gross savings of 182,641,713 kWh over the same period. When the ex-ante savings are adjusted using the study findings, this gross number is reduced to 118,641,713 kWh. Accepting the assertion that BCE paid rebates on ENERGY STAR 4.0 units longer than it should have and, therefore, slowed the uptake of ENERGY STAR 5.0 units, reduces the savings attributed to BCE further. As a result of these adjustments, the net-to-gross ratio becomes 22.3 percent for the BCE program on a statewide basis based on kWh savings and using the mean estimate (adjusted) from the Delphi panel.

Due to the uncertainty around this estimate, alternate calculations for NTG were explored. These alternate approaches yield NTG results that range from 5.8 to 39.3 percent and are lower than the unadjusted mean value from the Delphi panel (43.7 percent).

In the end, the evaluation conceded that " . . . given the issues surrounding the panel (perceived upward and downward[9] bias, panelist attrition and failure to approach consensus) the uncertainty around the NTG recommendation of 22.3 percent limits its applicability to the 2010-2012 program cycle."

The results are limited in their application to future programs. The panel focused on the program period from Q1 2010 through Q3 2011. Extrapolating the findings from this study

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[9] NRDC asserted a downward bias of panelists in their comments to the CPUC, April 2013

to future periods may not be appropriate due to the rapid evolution of TV technology, the expectations for new ENERGY STAR specifications, or both.

1.4.3.3. NEEA Consumer Electronics Television Initiative Market Progress Evaluation Report #3 *(Research Into Action, Inc. & DeHoratius, 2014)*

The Northwest Energy Efficiency Alliance (NEEA) is a non-profit organization that works to accelerate the innovation and adoption of energy-efficient products, services, and practices in the Pacific Northwest. In 2009, NEEA launched the Consumer Electronics Television Initiative (the Initiative) to increase the availability of energy-efficient televisions. The Initiative provides retailers with financial incentives to encourage them to include a higher number of the most efficient televisions in their assortments than they would have otherwise. In addition, Initiative field staff place promotional point-of-purchase (POP) television tags in participating retail stores to help consumers identify efficient televisions.

There were five key research questions for this report:

1. Did sales associate behavior change during customer interactions, since the 2012 "mystery shopping" data collection activity, reported in the Market Progress Evaluation Report (MPER) #2?
2. Did customers ask about Energy Forward[10] when interacting with sales associates?
3. Did the impact of the Initiative's in-store video differ by retail chain?
4. When and why did the in-store video impact sales?
5. Did the 2012 marketing campaign impact sales?

The evaluation involved multiple data sources and methods including: in-depth interviews, Initiative data review, retail store manager surveys, store manager surveys, mystery shopping, ride-alongs with field staff, and a literature review.

Key Findings

MPER #3 yielded seven key findings about the Initiative's progress relative to the research questions:

- **Key Finding #1**: Sales associates were less likely to promote energy efficiency to customers in 2013 than in 2012.
- **Key Finding #2**: Sales associates' ability to locate efficient televisions increased in 2013, and evidence suggests a link between this increase and outreach efforts by energy efficiency organizations, including NEEA's Television Initiative.
- **Key Finding #3**: Television buyers rarely asked about Energy Forward when shopping at participating retailers.
- **Key Finding #4**: In 2012 as in 2011, sales data suggest that the Initiative's in-store video and other marketing activities increased the proportion of Energy Forward televisions sold. The 2012 data show the impact varied by retail chain.

[10] NEEA developed a unique brand for the Initiative, "Energy Forward," and produced several types of marketing materials, including: in-store materials ("point-of- purchase" or POP) like shelf tags and/or product stickers, and a 15-second video played in retail stores and available on the Initiative website. The Initiative also coordinated a cross platform marketing campaign that took place in October 2012 and included social media, earned media, and limited in-store promotion at selected retail stores.

- **Key Finding #5**: Academic and trade research suggest that in-store videos and POP materials can be a powerful way to influence purchase decisions because they "prime" interested consumers to prioritize some decision-making factors over others.
- **Key Finding #6**: The Initiative's in-store video met some best practices for in-store video, but there are opportunities for improvement.
- **Key Finding #7**: The Initiative's "Most Efficient" television tags are valued by retailers and are the critical causal link between the Initiative's marketing activities and any potential impact on qualified television sales.

Conclusions and Recommendations

MPER #3 yielded the following conclusions and recommendations:

- **Conclusion #1**: NEEA has established strong working relationships with its retail partners.
    - **Recommendations:** If NEEA wants to continue a consumer products initiative, its strong retailer relationships could serve as a platform for a midstream market initiative.
- **Conclusion #2**: NEEA may be able to increase the Initiative's influence by addressing three issues: the large number of qualified models, the lack of retailer-led in-store promotion of the Energy Forward brand, and confusion about the brand and the specification-setting process.
    - **Recommendations**: Consider using a stringent third-party specification to determine qualified products. Consider developing online training for sales associates, modeled on trainings developed by retailers and product manufacturers, and focused on helping sales associates use qualification as a sales tool.
- **Conclusion #3**: The Initiative's in-store marketing activities are critical to increasing sales of qualified products and creating evaluable impact.
    - **Recommendations**: Continue placing television tags on qualified models in participating stores. Seek ways to make the television tags and in-store video more effective by altering the message to focus on other attributes of qualified products or educating consumers about the cumulative impact of energy use in their homes.

1.4.3.4 Lessons Learned

From these three evaluations the following essential lessons have been learned:

- Multiple methods within the overarching framework of a theory-driven evaluation are needed for assessing program attribution for complex market transformation programs.
- Participating retailers must faithfully execute their marketing plan to promote program-qualified models.
- Multiple program and market performance metrics should be identified before program launch in order to gain a comprehensive understanding of the efficacy of the program in the short-, mid- and long-term.
- If Delphi panels are used as one approach to estimating attribution, they should be conducted according to best practices.
- All relevant quantitative and qualitative data must be reviewed by the evaluators in order to avoid premature termination of the program.

- Data availability for participating retailers is critical and can be challenging to obtain.
- Reliable data for non-participating retailers is also critical but even more challenging to obtain.
- It is critical that, when calculating Unit Energy Savings (UES), dynamic baselines are identified in a timely and cost-effective manner.
- Because the market for basic tier (ENERGY STAR) models appears to have been transformed for many products, promoting the more efficient models on the ENERGY STAR list will increase the chances of obtaining savings that would not have occurred without the Program.
- It is critical to have a product-specific exit or transition strategy when market share reaches a predetermined threshold indicating market transformation. For information on the product transition strategy for RPP, refer to the Retail Products Platform (RPP) Product Introduction and Transition Guidance document found in Appendix 1 – Supplemental Files.
- Strong retailer relationships can serve as a platform for a successful midstream market intervention.

1.4.4 Relevant Work Paper Dispositions

- CPUC issued a disposition for this Retail Products Platform workpaper on December 15, 2016. This resulted in revised UES and NTG values in this workpaper.
- The recommendation made in the September 3, 2008 ED memo that the existing home CFL impact load shapes, included with the 2008 DEER database, should be examined as a potential load shape has been incorporated in the RPP Program for soundbars.
- The recommendation made in the September 3, 2008 ED memo to include incentive levels in the workpaper has been adopted.
- The recommendation made in the September 3, 2008 ED memo to develop base case costs based on current availability through common retail sales channels has been adopted.
- The coincident demand factor for televisions (0.031) from the Energy Division's March 2013 Workpaper Disposition on Energy Efficient Televisions (California Public Utilities Commission, Energy Division, 2013) is used as a proxy for soundbars.

1.4.5 Other Sources for Non-DEER Methods

For a discussion of the data sources reviewed and ultimately selected for each of the products included in the RPP Program, see Appendix 6 – Product-Specific Savings Values and Calculation Methodologies (discussion is product-specific and can be found under each product heading).

Hours of Operation:
Sources for hours of operation for RPP products include the EPA's Appliance Calculator *(U.S. Environmental Protection Agency, 2016)*, DOE Test Procedures, and other secondary data sources including metering and monitoring studies and surveys. Specific sources for each product are can be seen in Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

Efficiency:
Sources for the efficiencies of both program-qualified and base-case RPP products include federal minimum standards, ENERGY STAR criteria, and the EPA's Appliance Calculator. Specific sources

for each product are can be seen in Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

Modal Power Draw:

Sources for modal power draw for RPP products include the EPA's Appliance Calculator, the EPA's Consumer Electronics Savings Calculator (U.S. Environmental Protection Agency, 2013), metering studies, internal EPA analysis for ENERGY STAR, and other credible secondary data sources. Specific sources for each product can be seen in Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

The data needs and general sources for calculating the UEC and UES for each of the products currently included in the RPP Program are summarized in Table 10 below.

Table 10: UEC/UES Data Needs and Data Sources, by RPP Products

	Freezers	Electric Clothes Dryers	Gas Clothes Dryers	Room Air Cleaners	Soundbars	Room Air Conditioners
Data Needs	Capacity, configuration, defrost type, through-the-door ice	Load size, number of cycles per year, combined energy factor, 120V versus 240V, compact versus standard, coincidence factor	Load size, number of cycles per year, combined energy factor	Capacity, efficiency, hours-of-operation by mode, idle power draw, coincidence factor	Power usage by mode, hours-of-operation by mode, coincidence factor	Capacity, configuration, efficiency (CEER), hours-of-operation (FLHc), coincidence factor or kW/kWh factor
Data Source(s)	DEER	DOE Notice of Proposed Rulemaking, DOE Technical Support Document, ENERGY STAR criteria, federal minimum standards, secondary research/literature	DOE Notice of Proposed Rulemaking, DOE Technical Support Document, ENERGY STAR criteria, federal minimum standards	EPA's Appliance Savings Calculator, AHAM's 2004 Analysis of Energy Efficiency of Room Air Cleaners, NEEA retailer sales data, secondary research/literature	Secondary research/literature	Federal minimum standards, ENERGY STAR criteria, DEER, retailer websites

Effective Useful Life:

Sources for effective useful life for RPP products include Appliance Magazine, EPA's Appliance Calculator, other secondary literature/research, the EPA. Specific EUL sources and values can be seen in Appendix 7 – Product-Specific EUL Values.

NTGR:

The long-term forecasts of program-qualified product adoption *with* and *without* the RPP Program were created using a version of the standard Bass Diffusion Model. Three key inputs are required when forecasting the RPP program-qualified product market share for a particular product:

- Market potential
- Coefficient of innovation
- Coefficient of imitation

In the Bass Diffusion Models, potential buyers are divided into two major classes: innovators and imitators. Innovators (*p*) are viewed as the first buyers to enter a market during a given period of time.[11] Their purchases are assumed to be motivated by commercial or external sources of communication over the planning period. Imitators (*q*) are assumed to purchase on the basis of interpersonal influence processes within a market. Equation 1 presents the formulation of the diffusion model.

Equation 1

$$n_t = p[m - N_t] + q\left(\frac{N_t}{m}\right)[m - N_t]$$

Where

- n_t= The number of adopters at time t
- m= The potential number of adopters
- N_t= The cumulative number of adopters at time t
- p= Coefficient of innovation
- q= Coefficient of imitation

Typically, the p and q 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 given there are insufficient historical data. Consequently, an analogical diffusion model was explored. Analogical diffusion models follow the structure of Equation 1 but rely on estimated values of p and q from previous studies of similar products. The literature was reviewed to identify estimates of the two parameters (p and q) that were estimated from the historical data of existing product analogies. The literature and parameters selected are presented in

[11] The Bass diffusion model is also used in the evaluation of the California Codes and Standards Program.

Appendix 8 – Estimation of Net-to-Gross Ratios for the PG&E RPP Program.

The most important extension of the Bass Model is referred to as the Generalized Bass Model (Bass, Trichy, & Dipak, 1994). From Equation 2 below, one can see that the Generalized Bass Model examines the impact of marketing mix variables such as pricing, increased advertising and promotion on demand levels.

Equation 2

$$(St) = m\frac{(p+q)^2}{p}(1+\beta_1)\frac{Pr'(t)}{Pr(t)} + \beta_2\frac{A^t(t)}{A(t)}\frac{e^{-(p+q)(t+\beta_1 Ln(Pr)+\beta_{2Ln(A)})}}{1+\frac{q}{p}e^{-(p+q)(t+\beta_1 Ln(Pr)+\beta_{2Ln(A)})}}$$

Where

S(t)= Sales at time *t*
Pr´(t)= Rate of change in price at time *t*
Pr(t)= Price at time *t*
A´(t)= Rate of change in advertising at time *t*
A(t)= Advertising at time *t*
β_1= Price coefficient
β_2= Advertising coefficient

However, while changing these marketing mix elements shifts the demand curve in time, e.g., the shape of the demand curve is changed, the total demand is unchanged. To address this constraint, Boehner and Gold (Boehner & Gold, 2012) build on the Generalized Bass Model to include the impact of changes in the marketing mix on market size. The extended model Generalized Bass Model is presented below in Equation 3. We have added assortment and its elasticity to this model to better reflect the strategies that retailers in the RPP Program will likely employ.

Equation 3

$$N_t = pMP^{-e}A^fB^g + (1+q-p)N_{t-1} - \left(\frac{q}{MP^{-e}A^fB^g}\right)N_{t-1}$$

where

N_t= Percentage of energy-efficient products sold at time t

p= Coefficient of innovation

q= Coefficient of imitation

M= Total potential ratio of sales of energy-efficient products to total sales

N_0= Percentage of energy-efficient products sold at time 0.

P_0= Ratio of price for energy-efficient product to price for standard product at time 0

e= Coefficient of sensitivity (elasticity) for price term

A_0= Ratio of advertising expenditure with the program to without the program at time 0

f= Coefficient of sensitivity (elasticity) for advertising

B_0= Ratio of energy-efficient assortment with the program to without the program at time 0

g= Coefficient of sensitivity (elasticity) for assortment

N_{t-1}= Percentage of energy-efficient products sold in the previous period

In this model for a given product we forecasted purchases of program-qualified products by forecasting market share of program-qualified models and then applying it to the expected annual purchases (see attached spreadsheets in Appendix 1 – Supplemental Files). Once the market potential was estimated, Monte Carlo simulations were conducted to produce a distribution of NTGRs for each product. The NTGR that is the best measure of central tendency was selected as the ex ante NTGR.

More details of this method and product-specific NTGRs are provided in Appendix 8 – Estimate of Net-to-Gross Ratios for the PG&E RPP Program.

Section 2. Calculation Methods

2.1 Program Implementation Analysis

Table 11. Baseline by Measure Application Type

Measure Application Type	Baseline	Baseline Technology	Duration
ROB	First	Code/Standard	Full EUL
	Second	N/A	N/A
NC	First	Code/Standard	Full EUL
	Second	N/A	N/A

2.2 Electric Energy Savings Estimation Methodologies

Figure 1 depicts the proposed decision rules for determining the appropriate approach for computing UECs and UESs for RPP Program products. These are the proposed decision rules:

- First, the energy consumption/savings estimation method proposed for the RPP Program varies based on whether a product is listed in DEER. For those products with values listed in DEER, the *DEER Products Approach* will be used.
- Second, for products not listed in DEER, the method used for estimating UEC and UES values vary depending on whether credible secondary data sources are available that differentiate energy consumption for program-qualified models and base-case models within appropriate product subcategories. For those products where such secondary data *is* available, the *Non-DEER Measure Level Approach* is used; for those products where such secondary data *is not* available, the *Non-DEER Model Level Approach* is used.

There are several reasons for proposing this approach. First and notably, it is worth emphasizing that the preferred method for deriving UEC and UES estimates for the non-DEER products that are part of the RPP Program (i.e., the measure-level approach) generally parallels the DEER approach, which is essentially a measure-level approach, as well.

Second, utilizing a measure-level approach will reduce the potential month-to-month variability in UEC and UES estimates. The model-level approach would require relatively frequent recalculation to account for shifting product assortments and variable sales of program-qualified and non-program-qualified models. In contrast, measure-level UEC/UES estimates will need to be recalibrated only when the underlying data sources–such as DEER or other secondary sources—are updated, because computationally, the measure-level approach does not rely on the specific UECs of models sold.

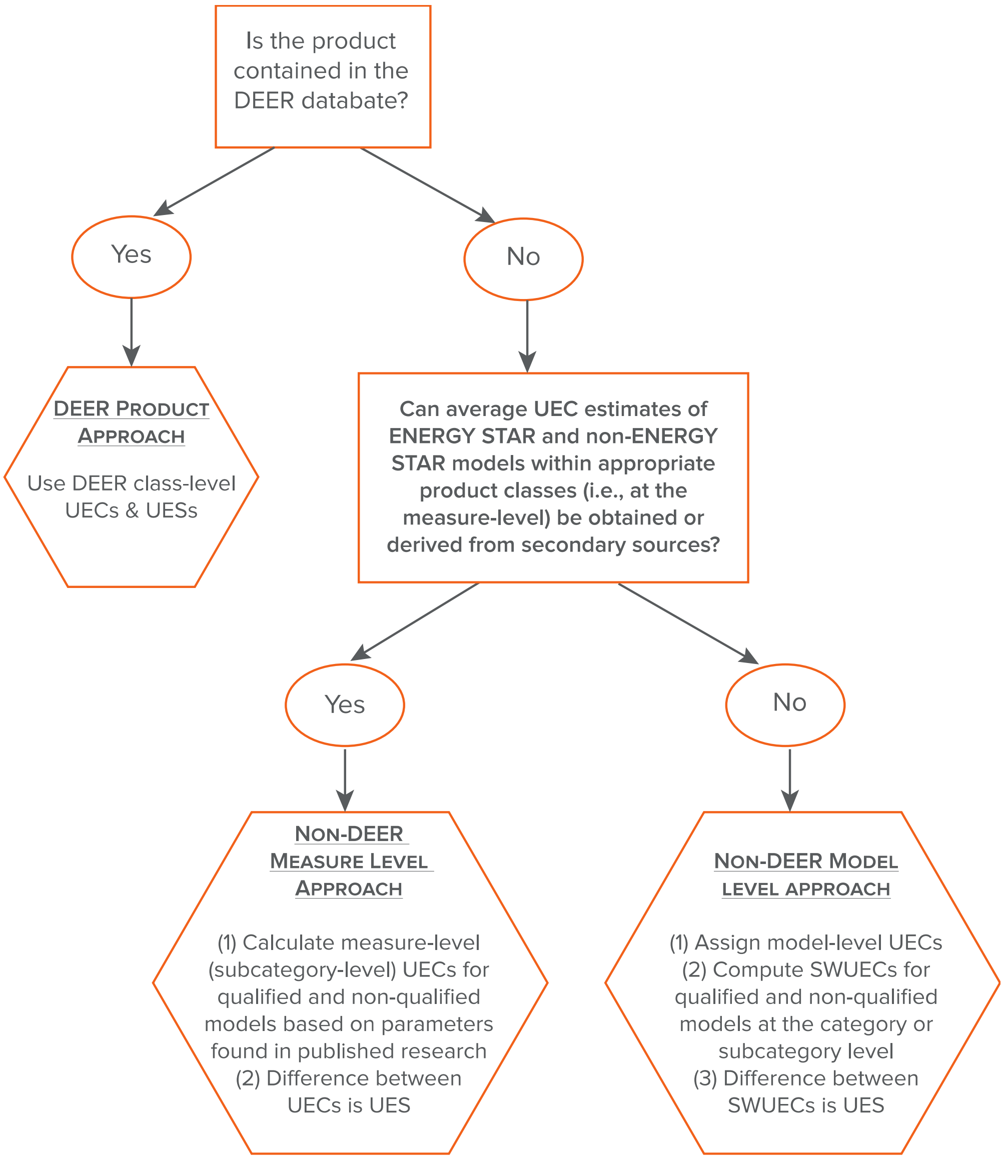
Third, a fundamental component of the RPP Program design relies on the notion that a program confronting products with small per-unit savings can be cost-effectively implemented when the scale (i.e., number of retailers, total sales volumes) is large enough. This requires the minimization of operational costs associated with the program, a significant part of which is data processing. The model-level approach is quite resource intensive and financially costly. For most of the RPP products, there may well be *hundreds* of models that appear in the data when multiple large retailers participate in the program. Under the model-level approach, UEC values for every model appearing in the sales data need to be determined on a case-by-case basis and monitored throughout the study. While this is not a significant issue for program-qualified models (since they appear in the ENERGY STAR Qualified Products Lists, which typically include credible UEC values that can be used), it is a significant issue for non-program-qualified models, as estimating reliable UEC estimates can be challenging when there are no validated sources for this information. In these cases, we are forced to rely on coarse estimates or so-called "proxy" values.

Overall, the model-level approach is a tedious, time-consuming, costly, and potentially coarse approach (depending on the level of proxying required). However, to further explore this issue, PG&E proposes to conduct an analysis of a few products to assess any potential differences between the measure-level and model-level approaches. We propose conducting this analysis after at least one year of comprehensive program sales data are available to support a robust analysis.

Definitions and Calculations

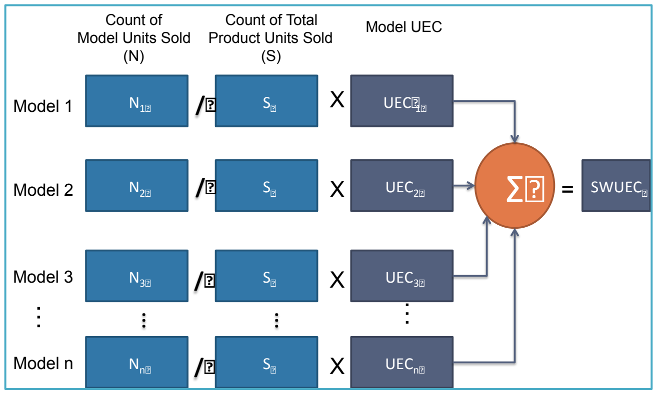
Unit energy consumption (UEC) is the average estimated annual electricity usage, in kilowatt-hours (kWh), for a specific product or device. UECs are calculated for RPP products using standard, industry accepted engineering equations. For product-specific equations, please refer to Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

Figure 1. RPP Decision Tree for Determining UEC/UES Estimation Approach



Sales-weighted unit energy consumption (SWUEC) estimates are calculated as the average UEC value, in kilowatt-hours (kWh), of all models sold by a retailer, for a specific product (or product subcategory), weighted by their respective sales volume. SWUEC values are estimated over a specified time period. The SWUEC calculation for a specific product (or product subcategory) is shown in Figure 2. For a specific product (or product subcategory), SWUEC values are estimated separately for program-qualified and non-program-qualified models.

Figure 2. SWUEC Calculation Process for a Product



Though some details vary with regards to the final computation of UEC estimates depending on the availability of data and the approach taken, the basic premise is that the *unit energy savings (UES),* in kilowatt-hours (kWh), for an energy efficient model within a particular subcategory (*p*) for a particular period of time (*t*) is the difference between the average UEC for the base-case models and the average UEC for program-qualified models. This calculation is shown in Equation 4.

Equation 4

$$UES_{p,t} = UEC_{Base-Case_{p,t}} - UEC_{Program-Qualified_{p,t}}$$

Note that the time period (t) is incorporated to account for the fact that the UECs will change over time as either the retailers' product assortments change or the other sources of data (e.g., DEER) are updated. As a result, UES estimates will need to be recomputed periodically.

Ex ante gross program energy savings are derived by multiplying the UES, in kilowatt-hours (kWh), for a product subcategory (p) and time period (t) by the total number of units sold (Q) for that product subcategory and time period and then summing across all subcategories across all products, as shown in Equation 5.

Equation 5

$$Ex\ Ante\ Gross\ Program\ Energy\ Savings = \sum(UES_{p,t} \times Q_{p,t})$$

Methods for Estimating UEC and UES Values

DEER Products Approach

For products included in the DEER database, DEER UEC and UES values will be assigned to each model contained in the retailer sales data. Products will be subcategorized to align with DEER type and size classes. The values in the most recent publicly available update of DEER will be used.

Non-DEER Products Measure-Level Approach

Existing secondary data sources and published research can be used to estimate UEC values (and in turn, UES values) for most products at the measure or product subcategory level. The steps involved in deriving these estimates include:

(1) **Calculate measure-level UEC values.** Different measure-level UECs are calculated for program-qualified and base-case products based on secondary research (e.g., ED-led ex post evaluations, other published literature). All program-qualified models within a

subcategory will have the same UEC value. Likewise, all non-program-qualified models within a subcategory will have the same value (the base-case value). Within a product subcategory, the non-program-qualified UEC values (base-case values) are larger than the program-qualified model UEC values.

(2) **Compute UES estimates.** The UES estimates are computed as the difference between the base-case and program-qualified UEC values within each subcategory.[12]

More formally, under the measure-level approach the gross UES estimate for a particular product or product subcategory (p) for a specific period of time (t) is shown in Equation 6.

Equation 6

$$UES_{p,t} = UEC_{Base-Case_{p,t}} - UEC_{Program-Qualified_{p,t}}$$

Non-DEER Products Model-Level Approach

At the model level, each individual *model* contained in the retailer sales data is assigned its own specific UEC value based on the best available information. Under this approach, computation of UES estimates for these non-DEER products is a three-step process:

(1) **Assign model-specific UEC estimates.** This is done based on credible secondary data sources such as ENERGY STAR Qualified Product Lists (QPLs), ED-led ex post evaluations, the Department of Energy's Certification Compliance Management System (CCMS), manufacturer/retailer/industry websites or data sources, or other reliable sources (e.g., product review websites). This process involves matching specific model numbers with existing data sources, extracting the associated UEC value, and cross-checking estimates between sources when possible. Different models of a product or product subcategory can have different UEC values. In some cases, estimating specific model-level UECs is not possible because model numbers are not available or cannot be matched to reliable data sources. In these cases, default assumptions of model specifications can be used to estimate UEC values.

(2) **Compute SWUEC estimates**. SWUECs are calculated as the average UEC estimate of all models sold within each product subcategory weighted by their respective sales volume over a specified time period (see Figure 2). Within each subcategory, SWUEC estimates are computed separately for program-qualified and non-program-qualified models.

(3) **Compute UES estimates.** The UES estimates are the difference between the non-program-qualified and program-qualified SWUEC estimates for each product or product subcategory.

As noted above in Step 2, the model-level approach involves computing SWUEC estimates for non-program-qualified and program-qualified models over a specified time period. As such, more formally, under the model-level approach the gross UES estimate for a product or product subcategory (*p*) is calculated by taking the difference between the non-program-qualified SWUEC and the program-qualified SWUEC values for a specified time frame (*t*), as shown below in Equation 7.

[12] It is important to note that under the measure-level approach, there is no need to sales-weight the program-qualified and base-case model UEC values within a subcategory in order to compute the UES values since all program-qualified models within a subcategory have the same UEC and all base-case models within a subcategory have the same UEC.

Equation 7

$$UES_{p,t} = SWUEC_{Non-Program-Qualified_{p,t}} - SWUEC_{Program-Qualified_{p,t}}$$

More detailed UES calculations as well as UES values for each product can be seen in Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

Interactive Effects

Because the interactive effects factors specific to many products in the RPP Program are not available, the DEER 2017 HVAC interactive effects for CFLs were applied to all non-DEER measures except HVAC measures. The interactive effects factors for all products except HVAC were selected for each utility's "IOU Territory", "Existing" building vintage, and "Res" building type and can be seen in Table 12 below.

Table 12. Interactive Effects Factors Used for All Non-DEER Products

IOU Territory	Building Type	kWh/kWh	kW/kW	therm/kWh
PG&E	Res	1.02	1.35	-0.02
SCE		1.07	1.38	-0.02
SCG		1.07	1.38	-0.02
SDG&E		1.03	1.28	-0.02

2.3 Demand Reduction Estimation Methodologies

In addition to energy savings, the RPP Program will also result in demand reductions that will be claimed by the IOUs. In order to estimate *unit demand reduction (UDR),* peak coincident factors (*CF*) need to be derived for each product subcategory (*p*) as well as the average kilowatt (kW) demand for non-program-qualified models and the average kilowatt (kW) demand for program-qualified models for the product subcategory for a specific time period (*t*). This calculation is shown in Equation 8.

Equation 8

$$UDR_{p,t} = (CF_p \ x \ kW_{Base-Case_{p,t}}) - (CF_p \ x \ kW_{Program-Qualified_{p,t}})$$

Ex ante gross program demand savings will be derived by multiplying the UDR, in kilowatts (kW), for a product subcategory (*p*) and time period (*t*) by the total number of units sold (*Q*) for that product subcategory and time period and then summing across all subcategories, as shown in Equation 9.

Equation 9

$$Ex\ Ante\ Gross\ Program\ Demand\ Reduction = \sum(UDR_{p,t} \times Q_{p,t})$$

Product-specific demand reduction estimates and calculation methods can be seen in Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

2.4 Gas Energy Savings Estimation Methodologies

The general methodology for determining gas energy savings is the same as the methodology described above for estimating electric energy savings. For product-specific gas energy savings, refer to Appendix 6 – Product-Specific Savings Values and Calculation Methodologies.

Section 3. Load Shapes

For each measure, an appropriate residential load shape was chosen from the E3 calculator. If the exact load shape was not available, then the closest match was chosen based on the usage patterns of the measure.

Table 13. Load Shapes for Measures in RPP

Measure	Load Shape
Freezers	PGE:RES:DEER:RefgFrzr_HighEff
Clothes Dryers	PGE:Res_New_Construction:32 = Res. Clothes Dry
Room Air Cleaners	PGE:RES:DEER:RefgFrzr_HighEff
Soundbars	PGE:RES:DEER:Indoor_CFL_Ltg
Room Air Conditioners	PGE:RES:DEER:HVAC_Eff_AC
Clothes Washer	PGE:RES:DEER:Res_ClothesDishWasher
Refrigerator	PGE:RES:DEER:RefgFrzr_HighEff

Section 4. Base Case, Measure, and Installation Costs

Incremental Measure Cost Coverage of RPP Products by Existing Sources

RPP's portfolio approach utilizes a dynamic assortment of products over time, in which products may be added or removed for each program year based on program objectives. An accepted approach to developing IMCs is to use the values found in the 2010-2012 Measure Cost Study (Itron, Inc., 2014), which is typically updated every 3-4 years. However, the 2010-2012 Measure Cost Study does not cover many of the products proposed for the 2015 Program.[13] Since most products within the RPP program have small individual savings potential, it is unlikely that they will be addressed in future Measure Cost Studies. While the 2010-2012 Measure Cost Study utilizes point-of-sale data to determine IMC, its data is limited to a specific time period. Retail product pricing is dynamic in nature, and the pricing of highly efficient or new products may come down more quickly than the pricing of less efficient products (Young, et al., 2014) (Desroches, Garbesi, Kantner, Van Buskirk, Yang, & Ganeshalingam, 2013). Due to the lack of product coverage and RPP's need to determine how product prices change over time, the applicability of the 2010-2012 Measure Cost Study data is limited to providing a general analytical framework for establishing IMCs for the RPP program.

[13] Freezers and clothes dryers were considered for inclusion in the 2010-12 MCS but ultimately not included due to a relatively low ranking in Itron's prioritization order.

Utilizing Web Harvesting to Collect Product Price Data
We propose calculating IMCs through the ongoing collection of data using a web harvester when IMCs for RPP products are not available in the Measure Cost Study. This approach is discussed briefly in the following sections. For more detail refer to Kisch et al., found in Appendix 1 – Supplemental Files (Kisch, Rubin, Richter, & Peter, 2015). Once the data are collected, hedonic price models are estimated as was done in the most recent Measure Cost Study. This approach also collects data on an ongoing basis to understand how IMC may change over time. This analysis is part of a broader program effort to understand the dynamics between product attributes and price.[14]

For the purposes of developing IMCs, the web harvester collects data from retailer websites using one of two methods: 1) Through a retailer Application Program Interface (API), which provides all the information presented on the retailer website in table format, or 2) using screen scraping methods, in which an automated script is run to collect product attribute data page-by-page.[15] Through these methods, the web harvester collects product data including retailer, brand, model number, price, and relevant product specification data (both related and unrelated to product energy consumption). The web harvester can collect hundreds or thousands of data points for a specific product at a single point in time to develop a large sample size. Minimal additional effort is needed to replicate the process so that data are collected on an ongoing basis, which can help identify changes in product price over time. In addition to collecting online price data, a limited in-store product shelf survey will be conducted to determine the relationship between online and brick-and-mortar store prices. Our understanding of this relationship will enable us to adjust for any price differences between web and brick-and-mortar stores.

The web-harvesting tool is able to collect data for different locations to identify potential differences in price by region. For example, some online retailers, such as Home Depot, display online prices based on the assumed zip code of the user browsing the website. Web harvesters can be programmed to search from any zip code, so it is possible to collect and compare prices from all over the country.

Estimating IMC through Hedonic Price Modeling
With the data collected through web harvesting methods, IMCs are developed using hedonic price modeling. Hedonic price modeling is often used to estimate the individual contribution of model characteristics (including energy efficiency) to the product's price. It is most commonly estimated using regression analysis. This is the method utilized in the 2010-2012 Measure Cost Study to identify key drivers of price and determine the fraction of price explained by specific variables (such as energy efficiency). As outlined in Young et al. (2014) (see Appendix 1 – Supplemental Files), the key drivers of cost may be unrelated to energy efficiency, such as brand (see Figure 3). In this modeling approach, IMC is defined as the fraction of cost difference between program qualified and non-program qualified that can be attributed to energy efficiency. For example, if the measure is an ENERGY STAR product and the base case is a non-ENERGY STAR product, IMC is defined as the fraction of incremental cost that can be attributed to being an ENERGY STAR product. As Figure 3 indicates, in the case of small diameter directional LED lamps, IMC may vary due to a product attribute that has larger explanatory power, such as brand. In this case, IMC may be different for various models, and therefore a weighted average is calculated across multiple model-specific IMC values to establish an overall IMC by product.

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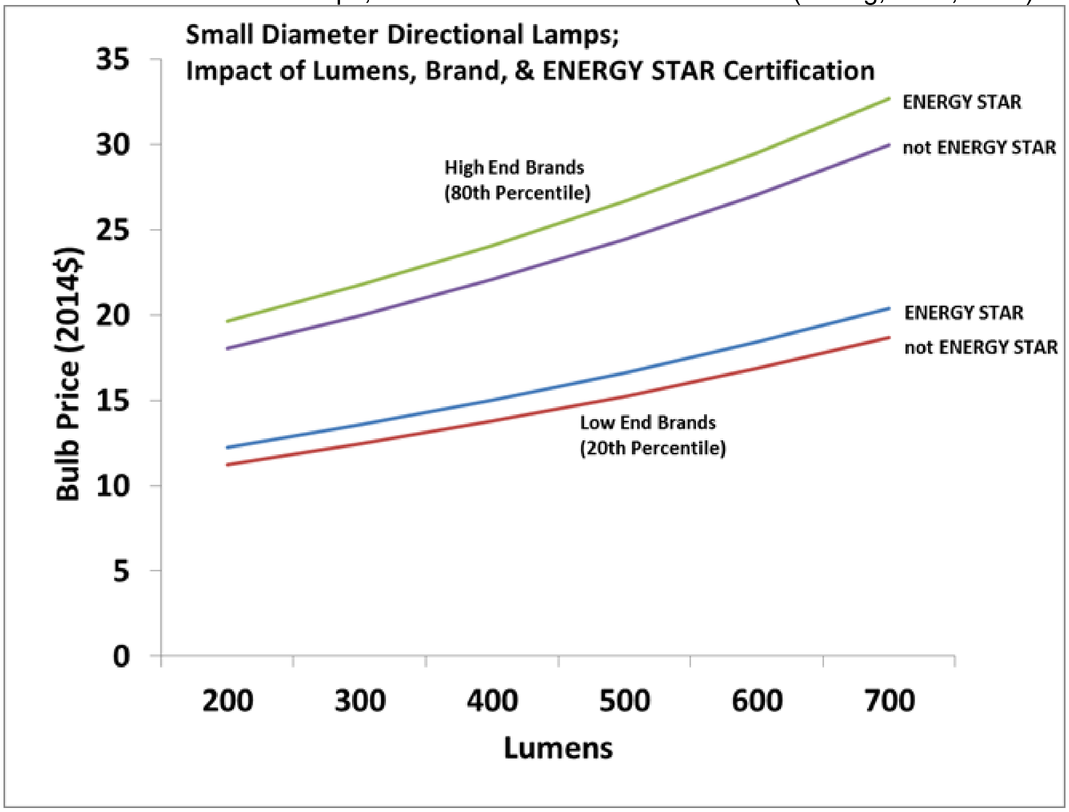
[14] This web harvesting approach was initially utilized by the Statewide IOU Codes and Standards team to identify key drivers of product costs for LED lamps from 2012-2014, and was presented at the ACEEE Summer Study Conference in 2014.

[15] For additional information on web-harvesting techniques, see the Section titled "Big Data" in Young et al. 2014.

Figure 3. Graphical Representation of the Statistical Model Developed to Estimate Pricing for Small Diameter Directional Lamps; Based on 2014 Web-Crawler Data (Young, et al., 2014)



Because IMCs may change over time for each product, data will be collected on an ongoing basis and reviewed annually to adjust IMC values as necessary. Table 14 provides an overview of measure cost by application type. It is assumed that ROB and NC measures are most applicable for this program. The approach and values for each product are discussed more in depth in the following sections.

Table 14. Measure Cost Summary by Application Type

Product	Measure Application Type	Base Case Equipment Cost ($/unit)	Measure Equipment Cost ($/unit)	Installation Cost ($/unit)	Incremental Measure Cost ($/unit)	Full Measure Cost (1st Baseline period)[16] ($/unit)	Full Base Cost (2nd baseline period)[17] ($/unit)
Upright Freezers	ROB/NC	**$849**	**$849**	N/A	**$0**	N/A	N/A
Chest Freezers		**$412**	**$412**		**$0**		
Basic Tier Electric Clothes Dryers		**$856**	**$940**		**$84**		
Advanced Tier Electric Clothes Dryers		**$856**	**$1,391**		**$535**		
Basic Tier Gas Clothes Dryers		**$856**	**$940**		**$84**		
Advanced Tier Gas Clothes Dryers		**$856**	**$1,391**		**$535**		
Room Air Cleaners		**$194**	**$274**		**$80**		
Soundbars		**$615**	**$615**		**$0**		
Room Air Conditioner		**$478**	**$500**		**$22**		
ESME Clothes Washers (Front-Loaders)		**$854**	**$933**		**$79**		

[16] Full measure cost = measure equipment cost + installation cost, for first baseline period

[17] Full base cost = 2nd baseline equipment cost + installation cost, for the second baseline period

ESME Clothes Washers (Top-Loaders)		**$450**	**$585**		**$135**		
CEE Tier 3 Clothes Washers (Front-Loaders)		**$854**	**$999**		**$145**		
CEE Tier 3 Clothes Washers (Top-Loaders)		**$450**	**$602**		**$152**		
ESME Refrigerators		**$621**	**$696**		**$75**		

4.1 Base Case(s) Costs

Because many of the initial RPP products are not included in DEER or the Measure Cost Studies, a regression equation (as demonstrated in Figure 3 above) was developed to estimate base case product price for each product (or product subcategories) not covered by the Measure Cost Studies. The base case cost as determined by the regression can be seen in Figure 4 – Figure 8 below (second teal bar, center). These figures show the following:

- **Average and Median Price (set of gray bars, far left):** These values are for all products, regardless of whether they are ENERGY STAR qualified or not.
- **Absolute Difference between ENERGY STAR and non-ENERGY STAR (set of teal bars, center):** These values represent the average cost of ENERGY STAR and non-ENERGY STAR models. The difference between them is the average IMC. This IMC value does not account for any collinear variables, which may also contribute to the difference in price. To be conservative, we did not include models that did not explicitly indicate whether or not they were ENERGY STAR qualified, as this could introduce unintended bias into our model.
- **ENERGY STAR IMC (set of light green bars, far right):** This represents the portion of average incremental cost that can be directly attributable to increased product efficiency (in this case, ENERGY STAR). The first value represents the estimated IMC and identifies whether or not it's statistically significant. The second value represents our recommended IMC value, based on its statistical significance (if it is not significant, we recommend a $0 IMC).

Note that there is no figure below for room air conditioners, because there are currently no room air conditioners available on the market that meet the ENERGY STAR version 4.0 specification. An alternate approach was used to estimate the base case, measure case, and incremental costs for room air conditioners, which is explained below.

Figure 4. IMC Analysis for Upright Freezers

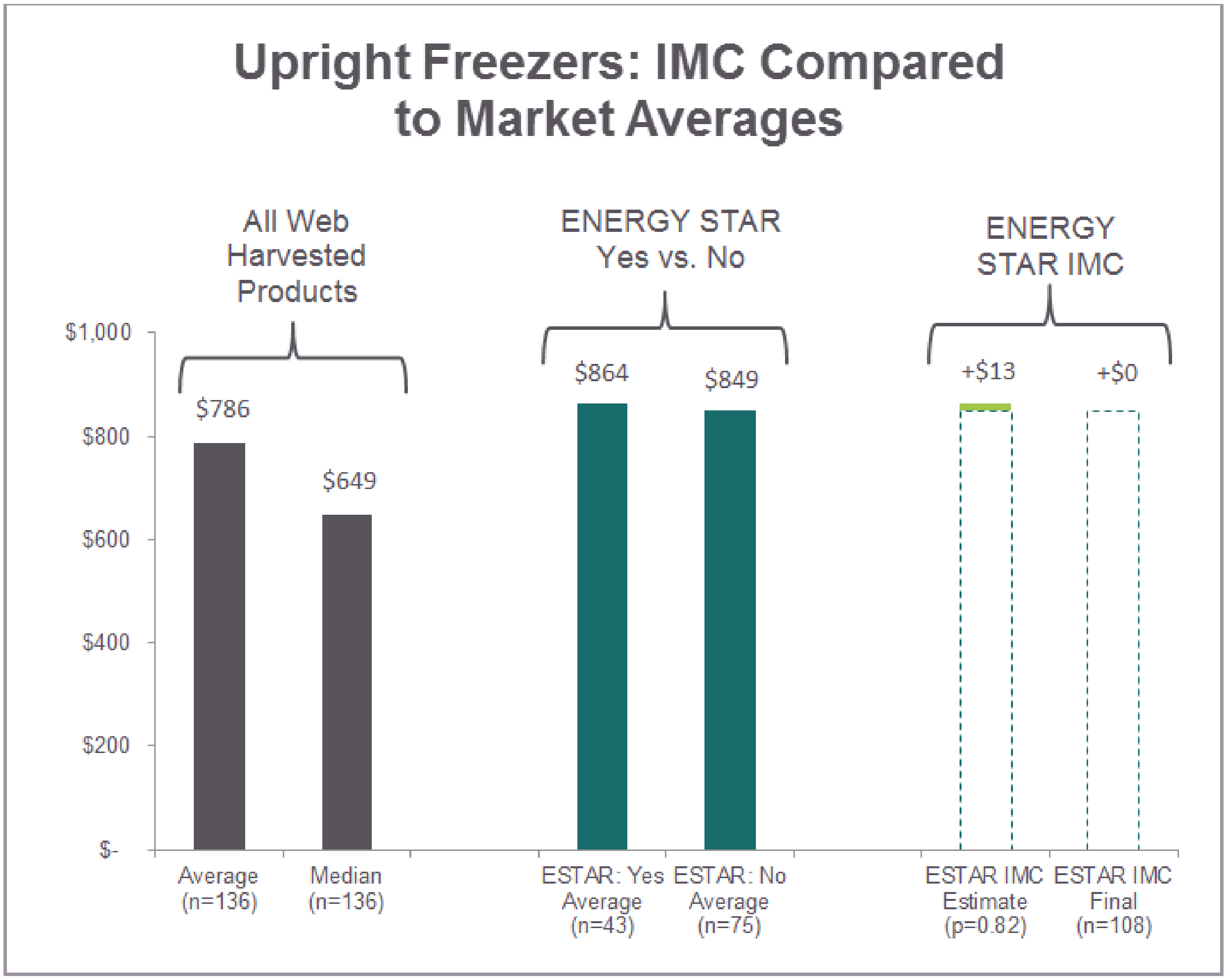


Figure 5. IMC Analysis for Chest Freezers

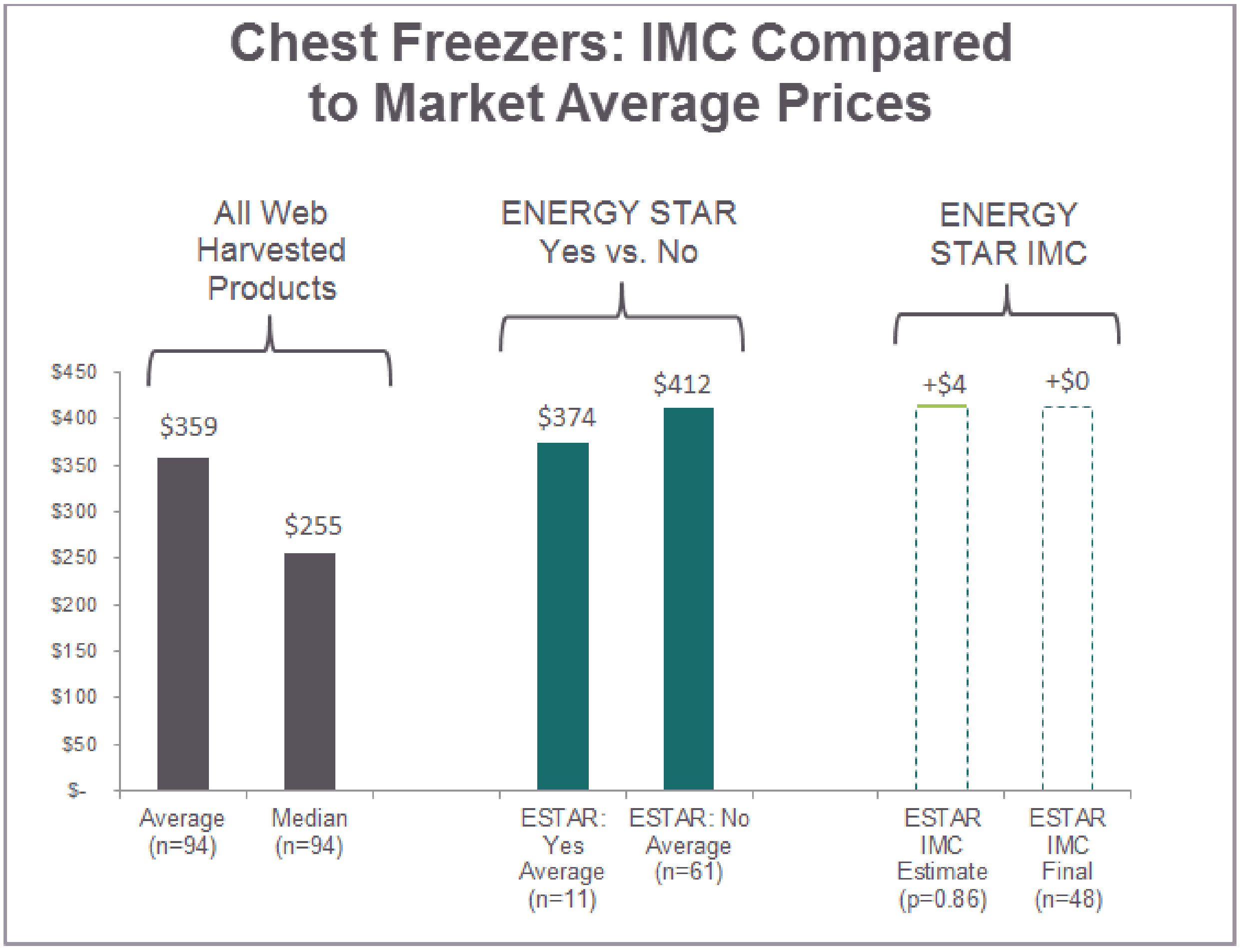
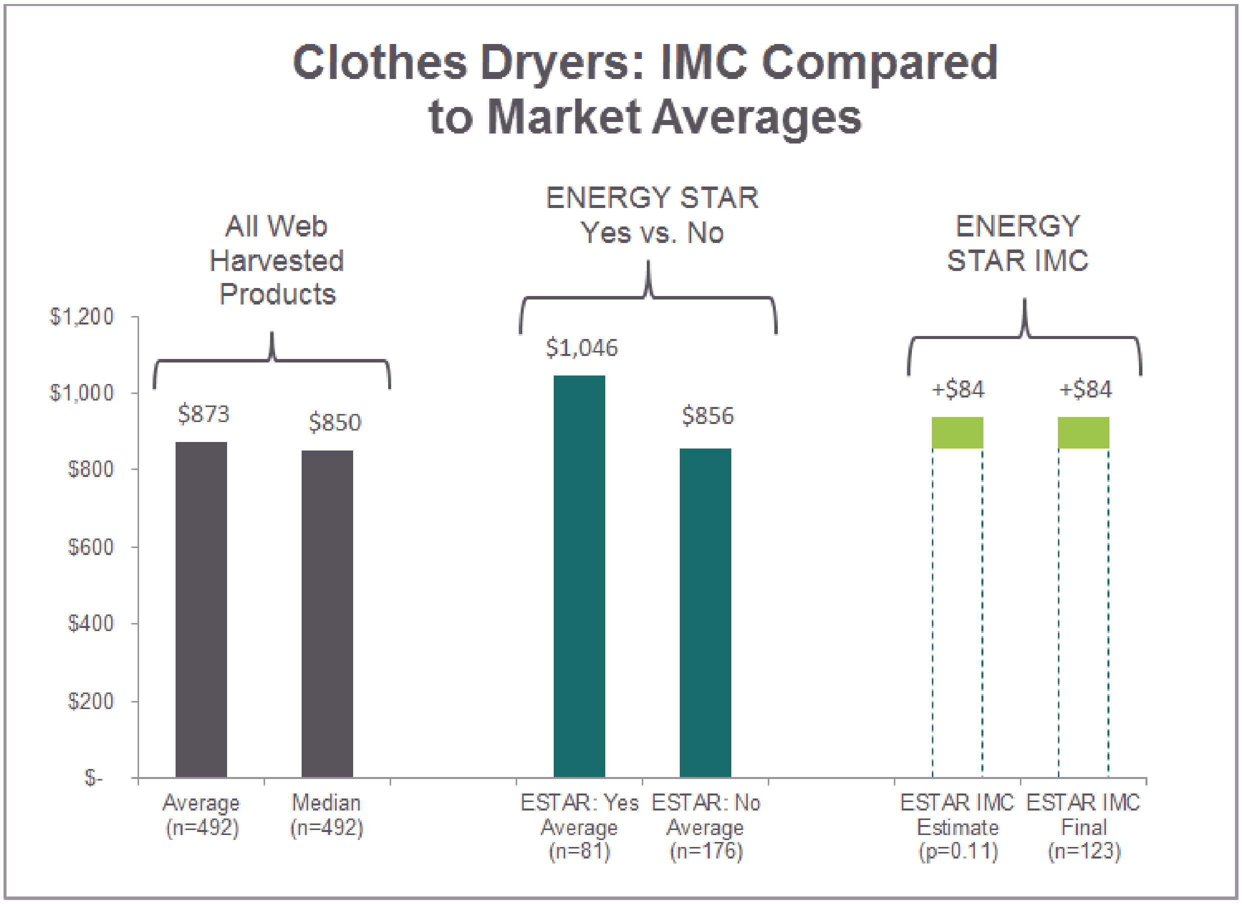


Figure 6. IMC Analysis for Dryers[18]



[18] Note that we will use the electric clothes dryers analysis for gas clothes dryers until better data become available.

Figure 7. IMC Analysis for Room Air Cleaners

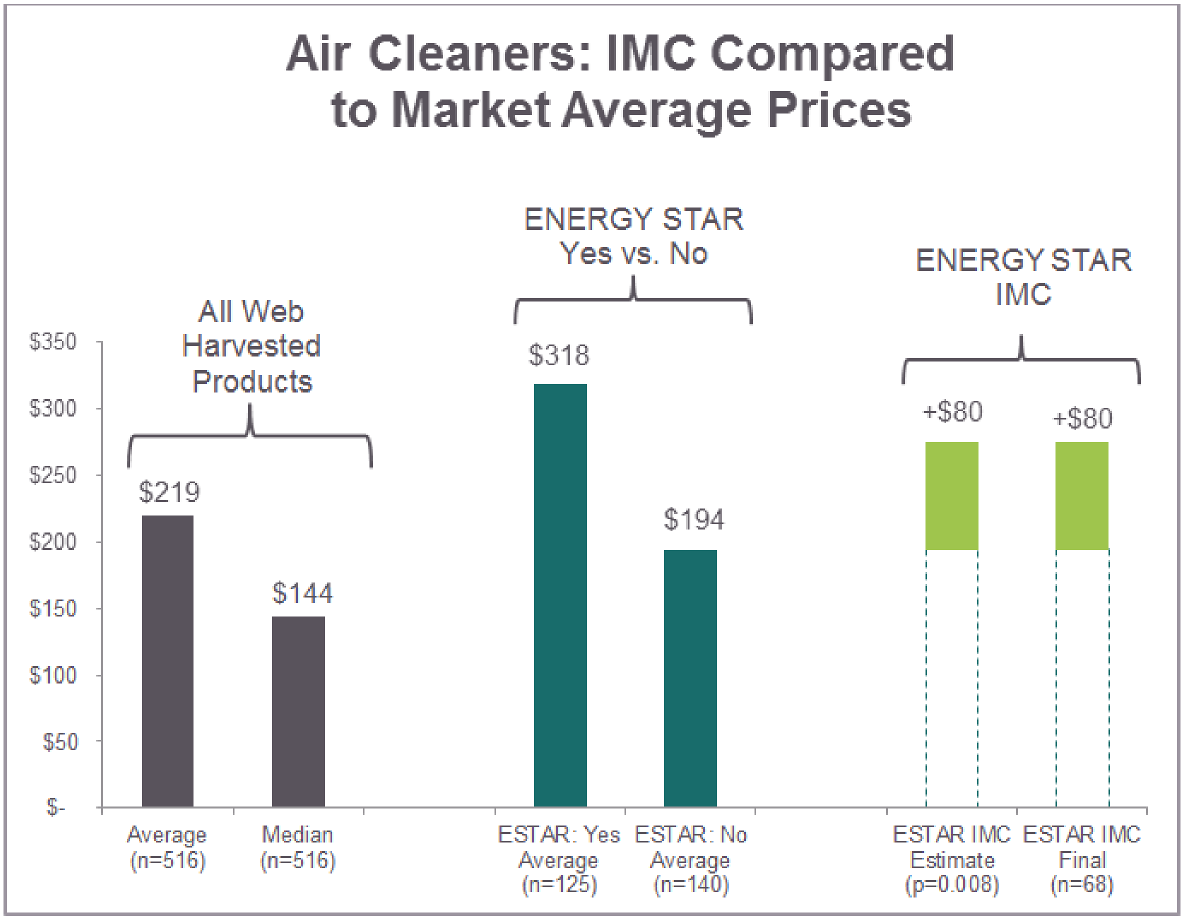
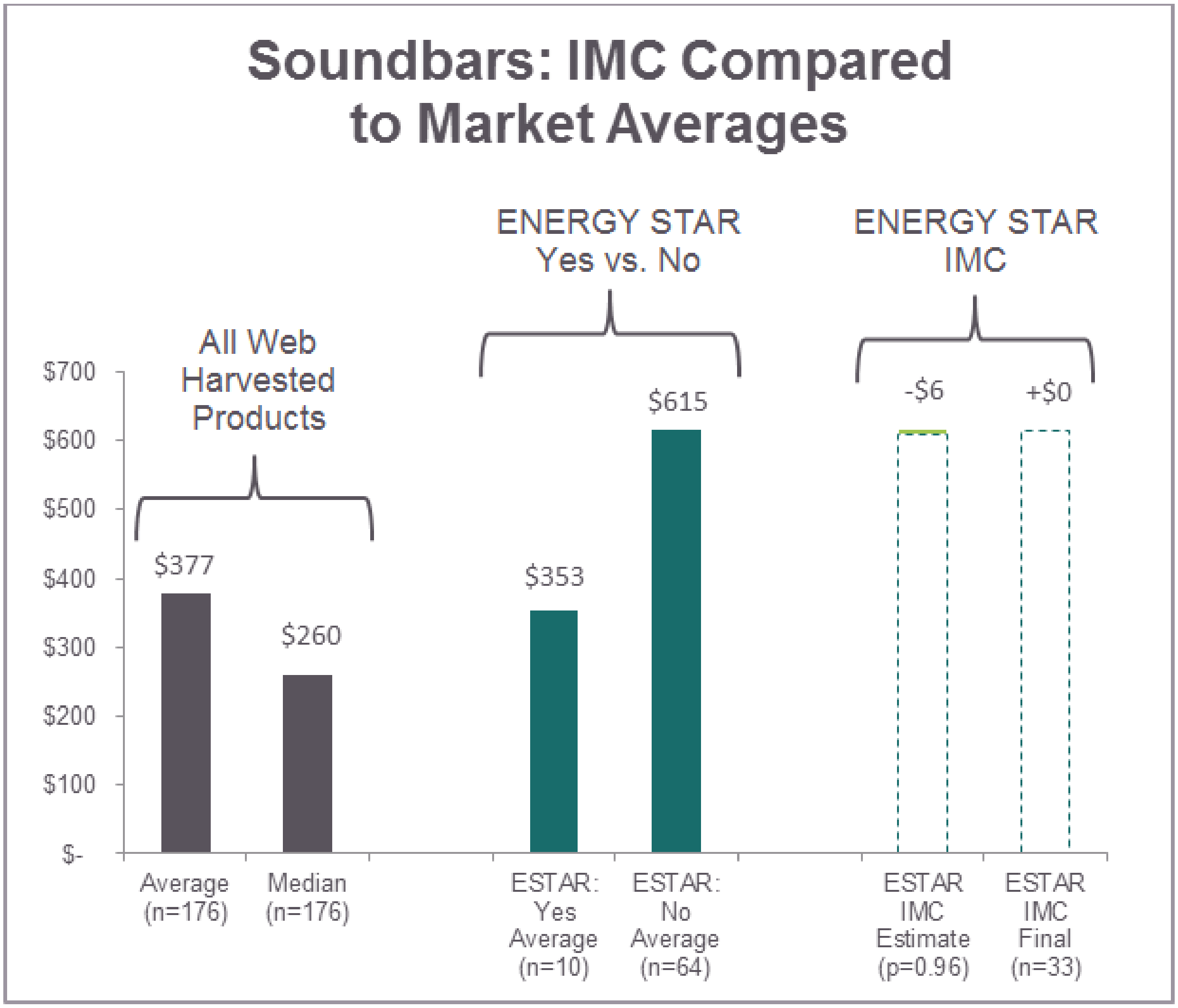


Figure 8. IMC Analysis for Soundbars



A full analysis like the ones presented above was not feasible for room air conditioners because there are currently no room air conditioners available on the market that meet the ENERGY STAR version 4.0 specification. However, we were able to collect data via web harvesting on the price of non-ENERGY STAR and ENERGY STAR V3.1 models offered by retailers. The average price of non-ENERGY STAR models was $478. This is our recommended value for the base case cost of room air conditioners.

4.2 Measure Case Costs

Because many RPP products are not included in DEER or in the Measure Cost Studies, a regression equation (as demonstrated in Figure 3 above) was developed to estimate measure case product price for each product (or product subcategory) not covered by the Measure Cost Studies. The measure case costs for each product not included in the Measure Cost Study can be seen in Figure 4 – Figure 8 above and in the second column of Table 15 below. Note that a regression analysis was not feasible for room air conditioners because there are currently no room air conditioners available on the market that meet the ENERGY STAR version 4.0 specification The measure case cost for room air conditioners was calculated as $500 by adding the incremental measure cost ($22) to the base case cost ($478) that was determined from our web harvesting data collection efforts. The incremental measure cost for room air conditioners was estimated using the Measure Cost Study's algorithm for room air conditioners. See the section on Incremental and Full Measure Costs for a more detailed explanation of how the room air conditioner IMC was estimated.

Table 15[19]**.** Average Prices of Non-ESTAR and ESTAR Products Not Included in Measure Cost Study; Absolute IMC, IMC Attributable to ESTAR and Significance of ESTAR IMC

Product	Average Price of Products Analyzed			ENERGY STAR IMC Estimate		
	Base Case ($)	ENERGY STAR ($)	Difference ($)	($)	(%)	*p*-value
Air cleaners	$194	$318	$124	$80	41%	0.008
Clothes dryers	$856	$1,046	$190	$84	9%	0.11
Upright freezers	$849	$864	$15	$13	2%	0.82
Chest freezers	$412	$374	($38)	$4	1%	0.86
Soundbars	$615	$353	($262)	-$6	-1%	0.96

4.3 Installation/Labor Costs

There are no applicable installation or labor costs associated with these measures. RPP impacts products sold through the retail channel, and therefore installation and labor costs, if any, are assumed to be borne by the end user.

4.4 Incremental and Full Measure Costs

The most appropriate measure application type for RPP products is ROB/NC, since customers are purchasing these products through retail channels and are either replacing old products or purchasing new ones. The IMC calculation methodology for products not included in the Measure Cost Study is explained in Section 4 above. The recommended values for base case cost, measure case cost, and incremental cost for products not included in the Measure Cost Study can be seen in Table 17 below. Note that while there may have been an incremental cost shown in the figures and table above, the incremental costs seen in Table 17 represent our recommendations based on whether the IMC for products not included in the Measure Cost Study was attributable to the ENERGY STAR qualified product's increased energy efficiency and also the statistical significance of the IMC. Where needed, notes about each product follow.

[19] Note that we will use the electric clothes dryers analysis for gas clothes dryers until better data becomes available.

Table 16. Incremental and Full Measure Cost Calculations

Measure Application Type	Incremental Measure Cost ($/unit)	Full Measure Cost (1st Baseline period) ($/unit)	Full Base Cost (2nd baseline period) ($/unit)
ROB/NC	**Incremental Measure Cost** = (Measure Equipment Cost + Measure Labor Cost) – (Base Case Equipment Cost + Base Case Labor Cost)	N/A	N/A
ER	N/A	**Full Measure Cost** = Measure Equipment Cost + Labor Cost	**Full Base Cost** = (-1)*(Second Base Case Equipment Cost + Labor Cost)[20]
REA	N/A	**Full Measure Cost =** Measure Equipment Cost + Labor Cost	N/A

Table 17. Recommended Values for Base Case, Measure Case, and IMC[21]

Product	Base Case Avg. Price ($)	Measure Avg. Price ($)	ENERGY STAR IMC (%)	ENERGY STAR IMC ($)
Air cleaners	$194	$274	41%	$80
Clothes dryers	$856	$940	9%	$84
Upright freezers	$849	$849	0%	$0
Chest freezers	$412	$412	0%	$0
Soundbars	$615	$615	0%	$0

Room Air Cleaners:
We specify an $80 IMC (Table 17). Room air cleaners have a statistically significant IMC value ($p<0.00001$). Notice that the median price is significantly lower than the average price, which suggests that there are a number of high-end air cleaners that dramatically increase average price.

Electric Clothes Dryers:
We specify an $84 IMC (Table 17) for basic tier electric dryers. Although this IMC is statistically significant at the 0.11 level, but not at the pre-established 0.05 level, we believe this point estimate is the most credible initial IMC value at this time. We believe that once we are able to increase our sample size,

[20] The E3 calculator determines the net present value of the second baseline cost and subtracts it from the first baseline cost to determine the measure cost for the early retirement measure. According to the Energy Efficiency Policy Manual v.5 at page 32, the measure cost for an early-retirement case is "the full cost incurred to install the new high-efficiency measure or project, reduced by the net present value of the full cost that would have been incurred to install the standard efficiency second baseline equipment at the end of the [RUL] period".

[21] Note that we will use the electric clothes dryers analysis for gas clothes dryers until better data becomes available.

the statistical power[22] of the regression models will increase and, as a result, our revised estimate will be close to this IMC estimate at the 0.05 level of significance.

ENERGY STAR Emerging Technology Award qualifying dryers (advanced tier dryers) command a high price premium (due to incorporation of heat pump technology for electric dryers). However, a full regression analysis was not feasible for advanced tier electric dryers given the limited number of models that meet this requirement. By comparing the price of ENERGY STAR heat pump dryers available on the American retail market with non-heat pump dryers with similar features, we estimate an incremental measure cost of $535. Note that we assume the same IMC for basic and advanced tiers for all other product categories.

Gas Clothes Dryers:
Data for gas clothes dryers were not available at the time of this workpaper submittal. Therefore, we will use the electric clothes dryers analysis for gas clothes dryers until better data becomes available. As with electric clothes dryers, we specify an $84 IMC. Although this IMC for electric clothes dryers is statistically significant at the 0.11 level, but not at the pre-established 0.05 level, we believe this point estimate is the most credible initial IMC value at this time. We believe that once we are able to increase our sample size, the statistical power of the regression models will increase and, as a result, our revised estimate will be close to this IMC estimate at the 0.05 level of significance.

While there are no gas clothes dryers currently on the market that meet the advanced tier requirement (ENERGY STAR Emerging Technology Award criteria), we assume that advanced tier gas clothes dryers will command a high price premium. Because there are currently no models available on the market, a regression analysis was not feasible for advanced tier gas dryers. Until better data become available, we assume that the IMC for advanced tier gas dryers is the same as the IMC for advanced tier electric dryers ($535).

Freezers and Soundbars:
Next, we address the estimates of zero IMCs for freezers and soundbars. Program administrators typically use incremental measure cost, the additional cost associated with adopting a high-efficiency technology compared to a standard- or average-efficiency technology, as a key input for determining incentive levels. The logic is that end-user cost is the key barrier for purchase of the more efficient models. When there is a finding of zero or negative incremental measure costs for efficient models of products, it begs these questions:

- Besides cost, what other market barriers are preventing the purchase of energy efficiency models?
- How will the RPP program address these barriers through the use of midstream incentives?

We identify the following potential market barriers that retailer incentives may help to overcome:

- Low levels of awareness and knowledge regarding product specifications or differentiation regarding efficiency levels among retail merchandizers.
- Lack of availability of energy efficient models from the upstream actors from which retail merchandizers purchase their goods.

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[22] Statistical power is the probability that you will detect an "effect" that is there in the true population that you are studying. Put another way, the power of a statistical test of a null hypothesis is the probability that it will lead to a rejection of the null hypothesis when it is false, i.e., the probability that it will result in the conclusion that the phenomenon exists. The "effect" could be a difference between two means, a correlation between two variables (r), a regression coefficient (b), a chi-squared, etc. Power analysis is a statistical technique that can be used (among other things) to determine sample size requirements to ensure that statistical significance can be found (The TecMarket Works Team. (2006). *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*, p. 249. Directed by the CPUC's Energy Division, and with guidance from Joint Staff.

- Limited experience among retail merchandizers with purchasing energy efficient equipment
- Retailer perception of risk with stocking or installing efficient appliances when customer demand or product quality has yet to be proven (uncertainty about product performance and profit potential)
- Institutional policies and practices that prevent some retailers from shifting their assortment to the more energy efficient models simply because they never have. Research underscores that energy use is not always an attribute that retail merchandizers consider when buying products from manufacturers.
- Lack of differentiated product marketing by retailers to motivate customers to make more efficient purchasing choices.
- Market lacks experience in determining the best way to create a profitable long-term business model for efficient products.

For example, incentives can motivate the retailers to change their assortment to include more efficient program-qualified models, reduce the risks associated with this assortment change, and develop a profitable long-term business model with greater availability of energy-efficient products. Motivating retailers to increase their assortment, advertising and promotion of higher efficiency models may help to overcome barriers faced by customers such as:

- Customers being unaware and lacking knowledge and understanding of energy-efficient products and services
- Information costs associated with understanding the energy-related features and associated benefits of energy-efficient technologies and services.
- Lack of perceived value of energy-efficient products and services. Because energy efficiency is rarely valued by the customer more than the requested functionality, efficient models do not always receive consumer attention.

There may be cases in which hedonic price models might need to be supplemented by a teardown analysis of incremental costs, particularly for consumer electronics (Donnelly & Dayem, 2014). A teardown analysis enables a direct link of efficiency improvements to bill of materials (BOM) incremental cost. Interviews with key manufacturers could also be a possible source of IMC estimates.

Room Air Conditioners:

Because there are currently no room air conditioners available on the market that meet the ENERGY STAR version 4.0 specification, the web-crawler approach used for the other RPP products is not yet a viable option. Instead, the room AC IMC algorithm from the Measure Cost Study was used with updated input data from our web-harvesting efforts.

The Measure Cost Study specifies an IMC of $17.29 for an ENERGY STAR room AC with an EER rating that is 1.0 BTU/hr/W higher (i.e. ∆EER = 1.0) than a comparable, non-ENERGY STAR room AC, and an IMC of $14.54 for an ENERGY STAR room AC with an EER rating that is 0.9 BTU/hr/W higher (i.e. ∆EER = 0.9) than a comparable, non-ENERGY STAR room AC. Hedonic price modeling based on point-of-sale data purchased from NPD Group was used to develop these IMCs. The algorithm for the room AC IMC can be distilled to the formula seen in Equation 10.

Equation 10

$$IMC = \beta_{ES} + \beta_{EER}\ (EER_{measure} - EER_{baseline})$$

Where

IMC = incremental cost of the measure in $;
$ß_{ES}$ is the IMC due to the ENERGY STAR branding of a product and is equal to -$10.25;
$ß_{EER}$ is the IMC due to the increased EER rating of a product and is equal to $27.54/EER;
$EER_{measure}$ is the efficiency of the measure in EER; and
$EER_{baseline}$ is the efficiency of the baseline in EER.

The Measure Cost Study relied on point-of-sale data collected from Q1 2010 to Q2 2012. In order to update the values provided in the Measure Cost Study, data was harvested from retailer web sites to establish the average difference in EER ratings between ENERGY STAR and non-ENERGY STAR room ACs. The average ∆EER between ENERGY STAR and non-ENERGY STAR products in our web harvested data from this past July was 1.16. Plugging this ∆EER into Equation 10 we determined that the IMC for room ACs is $22.

Clothes Washers

Due to different market characteristics between front-loading and top-loading clothes washers, a separate IMC analysis was conducted for each type.

For front-loaders, the average price of an ESME (ENERGY STAR Most Efficient)[23] certified clothes washer is found to be $802 while the average of a non-ESME qualified washer is $854. The IMC attributed to the IMEF variable alone is $79. We also note that all front-loaders found in this research to be qualified for the basic ENERGY STAR tier, so the base case cost also represents the price of an ENERGY STAR certified front-loading clothes washer. The IMC is derived using the multiple regression analysis shown using data from 5 major retailer websites:

$$\text{Log(Price)} = \beta_0 + \beta_1 IMEF + \beta_2[Attribute_2] \ldots + \beta_n[Attribute_n] + \varepsilon$$

The resulting regression coefficient for IMEF is 0.49. And the IMC is calculated as:

$$IMC = Cost_{base} * exp(\beta_{IMEF} * \Delta IMEF) - Cost_{base}$$

$$IMC = \$854 * \exp\big(0.49 * (2.79 - 2.61)\big) - \$854 = \$79$$

Where $Cost_{base}$ is the base case cost and $\Delta IMEF$ is the difference between the average IMEF of ESME only models and the average IMEF of non-ESME models.

A similar analysis is conducted to determine the IMC of a CEE Tier 3 certified front-loading clothes washer. The average IMEF of a CEE Tier 3 certified clothes washer is 2.93 with an average cost of $1,076 compared to the $854 baseline ENERGY STAR certified front-loading washers (average IMEF of 2.61).

$$IMC = Cost_{base} * exp(\beta_{IMEF} * \Delta IMEF) - Cost_{base}$$

$$IMC = \$854 * \exp\big(0.49 * (2.93 - 2.61)\big) - \$854 = \$145$$

Therefore, the incremental measure cost of a CEE Tier 3 front-loading clothes washer is $145.

For top-loaders, the average price of an ESME certified clothes washer is found to be $1,419 while the average price of a non-ENERGY STAR certified clothes washer is $450. The price difference is $969, but the IMC attributed to the IMEF variable alone is $135. The analysis is similar to above with a regression coefficient of 0.18, and average ESME IMEF of 2.76 and average non-ENERGY STAR IMEF of 1.3.

$$IMC = \$450 * \exp\big(0.18 * (2.76 - 1.3)\big) - \$450 = \$135$$

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[23] Includes clothes washers that qualify for ENERGY STAR Most Efficient 2017 (IMEF >= 2.76) but does not include CEE Tier 3 certified clothes washers (IMEF >= 2.92)

There are currently no top-loading clothes washers that meet the CEE Tier 3 specification (IMEF >=2.92). We nevertheless include this tier as an aspirational level to induce retailers and manufacturers to promote faster adoption. We estimate the incremental measure cost using the same regression equation as above:

$$IMC = \$450 * \exp\left(0.18 * (2.92 - 1.3)\right) - \$450 = \$152$$

The resulting estimated IMC for top-loading CEE Tier 3 certified clothes washers is $152.

Refrigerators

The IMC for refrigerators is calculated from a weighted average of refrigerators with top-freezers and refrigerators with bottom-freezers since 74% of ESME sales are top-freezers and the other 26% of ESME sales are bottom freezers. The average price of non-ENERGY STAR top-freezer refrigerators is $621 while the average price of ESME top-freezer refrigerators is $764. The price difference is $143, but the IMC is $79. This was based on a regression analysis comparing ESME and non-ENERGY STAR refrigerators. The analysis found a 13% price premium for ESME refrigerators.

Our analysis did not yield a statistically significant IMC for bottom-freezers. Thus, we determined the IMC for bottom-freezer refrigerators by applying the regression coefficient from Work Order 17 to the UEC difference between and ESME bottom-freezer refrigerator and an ENERGY STAR bottom-freezer refrigerator (the ENERGY STAR baseline is used since the majority of units sold through RPP are at the ENERGY STAR level).

$$IMC = -0.47 * (526\ kWh - 662\ kWh) = \$64$$

The overall IMC for refrigerators is calculated as:

$$IMC = 74\% * \$79 + 26\% * \$64 = \$75$$

Appendix 1 – Supplemental Files

Appendix 2 – Commission Staff Comments / Review

Appendix 3 – Measure Application Type Definitions

The DEER Measure Cost Data Users Guide found on www.deeresources.com under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata_format-V0.97.xls*, defines the measure application type terms as follows:

Measure Application Type

Code	Description	Comment
ER	Early retirement	Measure applied while existing equipment still viable, or retrofit of existing equipment
EAR	Retrofit Add-on	Retrofit to existing equipment without replacement
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

Baseline Technologies for UES and Cost Calculations[24]

Measure Application Type	Baseline	Baseline Technology	Measure Cost Calculation	Duration
ER	First	Existing technology	Measure equipment cost + labor cost	RUL = 1/3*EUL[25]
	Second	Code or standard	(-1)*(Code/standard equipment cost + labor cost)	EUL - RUL
REA	First	Existing technology	Measure equipment cost + labor cost	EUL
	Second	N/A	N/A	N/A
ROB	First	Code or standard	(Measure equipment cost + labor cost) – (Code/standard cost + labor cost)	Full EUL
	Second	N/A	N/A	N/A
NC	First	Code or standard	(Measure equipment cost + labor cost) – (Code/standard cost + labor cost)	Full EUL
	Second	N/A	N/A	N/A

[24] According to the Energy Efficiency Policy Manual (v.5 at page 32), the measure cost for an early-retirement case is "the full cost incurred to install the new high-efficiency measure or project, reduced by the net present value of the full cost that would have been incurred to install the standard efficiency second baseline equipment at the end of the [RUL] period". Page 33 elaborates that "the period between the RUL and EUL defines the second baseline calculation period…the measure cost for this period is the full cost of equipment, including installation, for the second baseline equipment measure".

[25] The Energy Efficiency Policy Manual (v.5 at page 33) states "the remaining useful life (RUL)…[is established by DEER] as one-third of the expected useful life (EUL) for the equipment type".

Measure cost overview developed by SCE:

measure cost
overview.docx

Appendix 4 – CPUC Quality Metrics

CPUC workpaper development actions to ensure quality are listed below, adapted from ex ante implementation scoring metrics described in Attachment 7 of Decision (D).13-09-023. The corresponding scoring metrics are shown below.

Metric	Workpaper Development Action to Ensure Quality
2	Address all aspects of the Uniform Workpaper Template[26]
3a[27]	Include appropriate program implementation background
3b	Include analysis of how implementation approach influences development of ex ante values
3c	Include all applicable supporting materials
3d	Include an adequate[28] description of assumptions or calculation methods
4	Pursue up-front collaboration on high impact measures with Commission staff prior to formal submission for review
7	Include analysis of recent and relevant existing data and projects that are applicable to workpaper technologies for parameter development that reflects professional care, expertise, and experience
9	Appropriately incorporate DEER assumptions, methods, and values for new or modified existing measures using professional care and expertise
10	Incorporate cumulative experience into workpaper through inclusion of an analysis of previous activities, reviews, and direction. (ED expects IOUs to immediately incorporate disposition guidance into workpapers to be submitted for formal review)

[26] The Uniform Workpaper Template is not posted on the DEER website as of 4/21/14, and is currently in Microsoft Access Database format.

[27] Metric 3 is not split among a – d in Attachment 7, however metric 3 was separated into four subcategories in this document for the purposes of identifying individual workpaper development actions to address quality.

[28] “Adequate” is defined in Attachment 7 such that derivations of underlying assumptions of workpaper are easy to understand by the CPUC reviewer.

Appendix 5 – DEER Resources Flow Chart

draft DEER flow chart.docx

Appendix 6 – Product-Specific Savings Values and Calculation Methodologies

1. Freezers

The DEER Products Approach, as described in Section 2.2 above, is used to estimate the energy savings from basic tier (ENERGY STAR) freezers. The advanced tier is set at ENERGY STAR +5%, and is not included in DEER. However, UES values for the advanced tier can be scaled from the DEER UES values.

Data Source Selection

For freezers, all UES values are either directly taken from DEER 2017 or scaled from DEER 2017. In addition to DEER, we also considered values from DOE's Compliance Certification Management System (CCMS) database (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2015), which provides model-level UEC values for all models sold in the U.S.[29] While the CCMS is the most comprehensive database of models available, we defer to existing DEER values where they are available.

UEC/UES Calculation and Values – Basic Tier

The DEER database classifies basic tier freezers into 12 classes based on configuration (upright or chest), and size (small: <13 cu. ft., medium: 13-16 cu. ft., or large: >16 cu. ft.).

UEC/UES Calculation and Values – Advanced Tier

For freezers, the advanced tier is set at ENERGY STAR +5%. This is defined as 5% lower energy consumption than the ENERGY STAR maximum allowance. Note that the ENERGY STAR specification requirement is 10% lower energy consumption than the federal maximum annual energy consumption allowance (i.e., 90% of the federal maximum). This means that we are defining ENERGY STAR +5% as 95% of the ENERGY STAR maximum, or 95% of 90% of the federal maximum (which is equal to 85.5% of the federal standard maximum, or 14.5% lower than the federal standard maximum)[30].

Advanced tier (ENERGY STAR +5%) freezers are not included in DEER. However, UES values for the advanced tier can be easily scaled from the UES values in DEER. The UES values in DEER are for ENERGY STAR freezers, or freezers that consume 10% less energy than the federal standard. Since we are defining the advanced tier as ENERGY STAR + 5%, or 14.5% less than the federal standard, we can simply multiply the DEER UES values for a factor of $\frac{10\%}{14.5\%}$ or 1.45.

Demand Reduction Calculation and Values – Basic Tier

The demand reduction estimate for basic tier freezers is taken from DEER 2017.

Demand Reduction Calculation and Values – Advanced Tier

The demand reduction estimates for advanced tier freezers are scaled values from DEER 2017. The scaling factor is the same factor used to scale the kWh savings values (1.45).

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[29] Refrigerators and freezer specifications for both ENERGY STAR and Federal Standards do not report modal power and usage, but instead report values as UEC (in kWh per year).

[30] This is in contrast to simply adding the 5% to the 10% lower than the federal maximum (15% lower than the federal maximum).

2. Electric Clothes Dryers

The Non-DEER Measure Level Approach, as described in Section 2.2 above, is used to calculate the energy savings from electric clothes dryers.

Data Source Selection
Data sources considered include those listed in **Table 18**.

Table 18. Data Sources Considered for Clothes Dryers

Source	Data
2011-04 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Residential Clothes Dryers and Room Air Conditioners (Navigant Consulting and LBNL, 2011)	Electric Standard: 283 cycles/year, 8.45 lbs./cycle Electric Compact and Ventless: 251 cycles/year, 3 lbs./cycle
NEEA Clothes Dryers Field Study (Ecotope Inc., 2014)	311 cycles/year, 7.87 lbs./cycle

In *Chapter 7: Energy Use Analysis* of the technical support document (TSD) for clothes dryers conducted on behalf of the Department of Energy, average clothes dryer utilization was derived from data collected from a sample of households in the 2005 Residential Energy Consumption Survey (RECS). The results were 283 cycles per year for standard sized electric clothes washers, and 251 cycles per year for electric compact and ventless dryers. Using data from the July 2010 California Energy Commission (CEC) directory, the DOE also derived an average load weight of 8.45 lbs. for standard-sized dryers and 3 lbs. for compact dryers, which is consistent with the value prescribed by the DOE's clothes dryer test procedure. In 2012, the Northwest Energy Efficiency Alliance (NEEA) commissioned a field study with a sample size of 46 homes in order to quantify the factors that affect clothes dryer energy use in homes. The study found the average values of 311 cycles per year and 7.87 lbs. per load. The DOE TSD and the NEEA field study show comparable values for the total weight of laundry dried per year for standard electric clothes dryers (2391 lbs. per year according to DOE and 2,448 lbs. per year according to NEEA). Thus, 283 cycles per year and 8.45 lbs. per cycle for standard dryers and 3 lbs. per cycle for compact dryers were used in the calculations in order to be consistent with the DOE's Appendix D2 test procedure and ENERGY STAR's calculation methodology.

UEC/UES Calculation and Values
Factors affecting the energy consumption of dryers include the efficiency of the dryer (combined energy factor, or CEF), the number of cycles per year that the dryer is run and the amount (weight) of clothing dried per cycle. The typical number of drying cycles per year for electric clothes dryers is 283 and the amount of laundry dried per cycle is 8.45 lbs. for standard dryers and 3 lbs. for compact dryers according to the DOE TSD. Per the CPUC disposition on this workpaper, pending additional evaluation of the efficiency washers paired with dryers incented through the program, savings calculations assume that the remaining moisture content prior to drying the load is that of a load washed in an ENERGY STAR clothes washer that meets the lowest current ENERGY STAR criteria. According to the 2012 DOE Technical Support Document for residential clothes washers, the use of current ENERGY STAR rated clothes washers results in a remaining moisture content of the clothes of approximately 35% for standard size washers and 38% for compact washers. Clothes dryer unit energy consumption can be calculated using Equation 11 and Equation 12.

Equation 11

$$UEC = \frac{cycles * C}{CEF} * RMC_{red}$$

Equation 12

$$RMC_{red} = \frac{RMC_{w,D2} - RMC_{d,D2}}{RMC_{w,ENERGY\ STAR} - RMC_{d,D2}}$$

Where

UEC = unit energy consumption in kWh
$cycles_{standard}$ = 283 cycles per year according the DOE TSD
$cycles_{compact}$ = 251 cycles per year according the DOE TSD
$C_{standard}$ = 8.45 lbs./cycle according to the DOE TSD
$C_{compact}$ = 3 lbs./cycle according to the DOE TSD
CEF = combined energy factor
RMC_{red} = a factor accounting for the lower remaining moisture content (RMC) of clothes washed in ENERGY STAR washers
$RMC_{w,D2}$= 57.5%, RMC of clothes prior to drying per DOE Appendix D2 test protocol
$RMC_{d,D2}$ = 1.75%, RMC of clothes after drying per DOE Appendix D2 test protocol
$RMC_{w,ENERGY\ STAR}$= RMC of clothes washed in an ENERGY STAR dryer per DOE TSD. Value is 35% for standard size washers and 38% for compact washers. Calculations for compact dryers include a weighting of 72.4% with compact washers and 27.6% paired with standard size washers (from PG&E Customer Voice Panel survey research)

The minimum CEF for basic tier (ENERGY STAR) electric clothes dryers is shown in Table 19 along with the corresponding (maximum) UEC for each dryer type. Note that ENERGY STAR requires testing under the Appendix D2 (Appendix D2 to Subpart B of Part 430 – Uniform Test Method for Measuring the Energy Consumption of Clothes Dryers, 2015) protocol of the Code of Federal Regulations for their certification process.

Table 19. Electric Clothes Dryer Combined Energy Factor Assumptions – Basic Tier Models

Product Type	Size	Voltage (V)	Minimum Combined Energy Factor[31] (lbs/kWh)	UEC (kWh/yr)	Source
Electric Ventless or Vented	Standard*	Any	3.93	363	ENERGY STAR Clothes Dryers Key Product Criteria
Electric Ventless or Vented	Compact**	120	3.80	126	
Electric Vented	Compact**	240	3.45	139	
Electric Ventless	Compact**	240	2.68	179	

* Standard is 4.4 cu-ft or greater
** Compact is less than 4.4 cu-ft

The advanced tier for dryers is set as ENERGY STAR Most Efficient 2017. These values and the corresponding UECs can be seen in Table 20 below.

[31] Using the Code of Federal Regulations' Appendix D2 testing protocol for measuring the energy consumption clothes dryers

Table 20. Electric Clothes Dryer Combined Energy Factor Assumptions – Advanced Tier Models

Product Type	Size	Voltage (V)	Minimum Combined Energy Factor[32] (lbs/kWh)	UEC (kWh/yr)	Source
Electric Ventless or Vented	Standard*	Any	4.3	332	ENERGY STAR specification criteria for 2017
Electric Ventless or Vented	Compact**	Any	4.3	111	

* Standard is 4.4 cu-ft or greater
** Compact is less than 4.4 cu-ft

The minimum CEF of base-case electric clothes dryers (as dictated by federal regulation) can be seen in Table 21.

Table 21. Electric Clothes Dryer Combined Energy Factor Assumptions – Base-Case Models

Product Type	Size	Voltage (V)	Minimum Combined Energy Factor[33] (lbs/kWh)	Source
Electric Ventless or Vented	Standard*	Any	3.73	2011-04-21 Energy Conservation Program: Energy Conservation Standards for Residential Clothes Dryers and Room Air Conditioners; Direct final rule
Electric Ventless or Vented	Compact**	120	3.61	
Electric Vented	Compact**	240	3.27	
Electric Ventless	Compact**	240	2.55	

* Standard is 4.4 cu-ft or greater
** Compact is less than 4.4 cu-ft

Note that the federal minimum efficiency requirements are based on the testing method described in the Appendix D1 protocol of the Code of Federal Regulations. Currently manufacturers are not required to test under the Appendix D2 protocol, but they can if they so choose. Furthermore, as noted above, ENERGY STAR requires testing under the Appendix D2 protocol for their certification process. The Appendix D1 and Appendix D2 test protocols give very different CEF values, which cannot be directly compared. However, the DOE did some tests under both protocols in their 2013 Notice of Proposed Rulemaking on Test Procedures for Residential Clothes Dryers (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2013). Oak Ridge National Laboratory (ORLN) and Pacific Northwest National Laboratory (PNNL) also carried out some testing to compare CEF values across the test protocols. Table 22 shows the results of these tests for electric clothes dryers.

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[32] Using the Code of Federal Regulations' Appendix D2 testing protocol for measuring the energy consumption clothes dryers

[33] Using the Code of Federal Regulations' Appendix D1 testing protocol for measuring the energy consumption clothes dryers

Table 22. DOE Appendix D1 and D2 Residential Clothes Dryer Test Protocol Comparison

Product Type	Size	Voltage (V)	Source	Appendix D1 CEF (lbs/kWh)	Appendix D2 CEF (lbs/kWh)
Electric Vented	Standard*	Any	DOE	3.58	3.16
			DOE	3.93	2.73
			DOE	3.83	3.49
			DOE	3.71	3.48
			DOE	3.90	3.51
			DOE	3.80	2.71
			DOE	3.84	3.06
			DOE	3.71	3.11
			PNNL	3.99	3.22
			PNNL	4.01	3.41
			ORNL	3.92	3.19
			ORNL	3.78	3.19
			Avg	**3.83**	**3.19**
Electric Vented	Compact**	240	DOE	3.53	3.32
			DOE	3.56	2.27
			PNNL	3.69	3.19
			ORNL	3.74	3.51
			ORNL	3.74	3.14
Electric Vented		120	DOE	3.75	2.18
Electric Ventless		240	DOE	2.98	2.73
			Avg	**3.57**	**2.91**

* Standard is 4.4 cu-ft or greater
** Compact is less than 4.4 cu-ft

Based on these results, a simple conversion factor can be used to convert the minimum CEF per federal regulations (as seen in Table 21) to an equivalent D2 CEF. For example, the conversion factor for electric vented standard dryers is 3.19 (D2)/3.83 (D1) = 0.83. The converted code baseline can then be directly compared to the minimum ENERGY STAR CEF. The converted Appendix D2 equivalent federal minimum CEF values can be seen in Table 23 along with the UEC for each product type.

Table 23. Converted Electric Clothes Dryer Combined Energy Factor Assumptions – Base-Case Models

Product Type	Size	Voltage (V)	Appendix D1 Minimum Combined Energy Factor (lbs/kWh)	Appendix D2 Equivalent Minimum Combined Energy Factor (lbs/kWh)	UEC (kWh/yr)
Electric Ventless or Vented	Standard*	Any	3.73	3.10	**460**
Electric Ventless or Vented	Compact**	120	3.61	2.94	**163**
Electric Vented	Compact**	240	3.27	2.66	**180**
Electric Ventless	Compact**	240	2.55	2.08	**231**

* Standard is 4.4 cu-ft or greater

** Compact is less than 4.4 cu-ft

Unit energy savings can be calculated from program-qualified and base-case UECs using Equation 13.

Equation 13

$$UES = UEC_{Base-Case} - UEC_{Program-Qualified}$$

Finally these UES values must be adjusted for interactive effects using the factors shown in Table 12. Based on PG&E's Customer Voice Panel survey research, 66% of dryers are located in a conditioned space and the other 34% in unconditioned spaces. Furthermore, we assume that interactive effects apply in full to ventless dryers[34] and to 20% of the energy consumption of vented dryers. This factor of 20% is taken from the DEER values for the internal gain fractions for residential appliances.

<u>Demand Reduction Calculation and Values</u>

Per the CPUC's disposition on this workpaper dated 12/15/2015, the following equation is used to estimate peak demand savings for residential clothes washers in individual residences.

Equation 14

$$UDR = \frac{UES}{365} * CDF$$

Where

UDR = unit demand reduction in kW
UES = unit energy savings in kWh/year
CDF = 0.058, dryer coincident demand factor per the Building America analysis spreadsheet.

Finally these values must be adjusted for interactive effects using the factors shown in Table 12. Based on PG&E's Customer Voice Panel survey research, 66% of dryers are located in a conditioned space and the other 34% in unconditioned spaces. Furthermore, we assume that interactive effects apply in full to ventless dryers[35] and to 20% of the energy consumption of vented electric dryers. This factor of 20% is taken from the DEER values for the internal gain fractions for residential appliances.

[34] According to the DOE test procedure "ventless clothes dryer" means a clothes dryer that uses a closed-loop system with an internal condenser to remove the evaporated moisture from the heated air. The moist air is not discharged from the cabinet.

[35] According to the DOE test procedure "ventless clothes dryer" means a clothes dryer that uses a closed-loop system with an internal condenser to remove the evaporated moisture from the heated air. The moist air is not discharged from the cabinet.

3. Gas Clothes Dryers

The Non-DEER Measure Level Approach, as described in Section 2.2 above, is used to calculate the energy savings from gas clothes dryers.

Data Source Selection
Data sources considered include those listed in Table 24.

Table 24. Data Sources Considered for Gas Clothes Dryers

Source	Data
2011-04 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Residential Clothes Dryers and Room Air Conditioners (Navigant Consulting and LBNL, 2011)	Standard* Gas: 274 cycles/year, 8.45 lbs./cycle
NEEA Clothes Dryers Field Study (Ecotope Inc., 2014)	311 cycles/year, 7.87 lbs./cycle

* Standard is 4.4 cu-ft or greater

In *Chapter 7: Energy Use Analysis* of the technical support document (TSD) for clothes dryers conducted on behalf of the Department of Energy, average clothes dryer utilization was derived from data collected from a sample of households in the 2005 Residential Energy Consumption Survey (RECS). The results were 274 cycles per year for gas dryers. Using data from the July 2010 California Energy Commission (CEC) directory, the DOE also derived an average load weight of 8.45 lbs. for standard-sized dryers, which is consistent with the value prescribed by the DOE's clothes dryer test procedure.

In 2012, the Northwest Energy Efficiency Alliance (NEEA) commissioned a field study with a sample size of 46 homes in order to quantify the factors that affect clothes dryer energy use in homes. The study found the average values of 311 cycles per year and 7.87 lbs. per load. The DOE TSD and the NEEA field study show comparable values for the total weight of laundry dried per year for standard electric clothes dryers (2,315 lbs. per year according to DOE and 2,448 lbs. per year according to NEEA). Thus, 274 cycles per year and 8.45 lbs. per cycle for standard dryers were used in the calculations in order to be consistent with the DOE's Appendix D2 test procedure and ENERGY STAR's calculation methodology.

UEC/UES Calculation and Values
Factors affecting the energy consumption of dryers include the efficiency of the dryer (combined energy factor, or CEF), the number of cycles per year that the dryer is run and the amount (weight) of clothing dried per cycle. The typical number of drying cycles per year for gas clothes dryers is 274 and the amount of laundry dried per cycle is 8.45 lbs. for standard dryers according to the DOE TSD. Clothes dryer unit energy consumption can be calculated using Equation 15 and Equation 16.

Equation 15

$$UEC = \frac{cycles * C}{CEF} * RMC_{red}$$

Equation 16

$$RMC_{red} = \frac{RMC_{w,D2} - RMC_{d,D2}}{RMC_{w,ENERGY\ STAR} - RMC_{d,D2}}$$

Where

UEC = unit energy consumption in kWh
cycles = 274 cycles per year according the DOE TSD
$C_{standard}$ = pounds of laundry dried per cycle, 8.45 lbs. for standard dryers
CEF = combined energy factor
RMC_{red} = a factor accounting for the lower remaining moisture content (RMC) of clothes washed in ENERGY STAR washers
$RMC_{w,D2}$= 57.5%, RMC of clothes prior to drying per DOE Appendix D2 test protocol
$RMC_{d,D2}$ = 1.75%, RMC of clothes after drying per DOE Appendix D2 test protocol
$RMC_{w,ENERGY\ STAR}$= 35%, RMC of clothes washed in an ENERGY STAR dryer per DOE TSD

The minimum CEF for basic tier (ENERGY STAR) clothes dryers is 3.48 lbs/kWh for gas dryers. Note that ENERGY STAR requires testing under the Appendix D2 protocol of the Code of Federal Regulations for their certification process.

The minimum CEF for advanced tier (ENERGY STAR Most Efficient 2017) clothes dryers is 3.8 lbs/kWh for gas dryers. Note that ENERGY STAR requires testing under the Appendix D2 protocol of the Code of Federal Regulations for their certification process.

The minimum CEF of base-case gas clothes dryers (as dictated by federal regulation) is 3.3 lbs/kWh (Residential Clothes Dryers). Note that the federal minimum efficiency requirements are based on the testing method described in the Appendix D1 protocol of the Code of Federal Regulations. Currently manufacturers are not required to test under the Appendix D2 protocol, but they can if they so choose. Furthermore, as noted above, ENERGY STAR requires testing under the Appendix D2 protocol for their certification process. The Appendix D1 and Appendix D2 test protocols give very different CEF values, which cannot be directly compared. However, the DOE did some tests under both protocols in their 2013 Notice of Proposed Rulemaking on Test Procedures for Residential Clothes Dryers (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2013). Oak Ridge National Laboratory (ORLN) and Pacific Northwest National Laboratory (PNNL) also carried out some testing to compare CEF values across the test protocols. Table 25 shows the results of these tests for gas clothes dryers.

Table 25. DOE Appendix D1 and D2 Residential Clothes Dryer Test Protocol Comparison

Product Type	Size	Voltage (V)	Source	Appendix D1 CEF (lbs/kWh)	Appendix D2 CEF (lbs/kWh)
Vented Gas	Standard*	Any	DOE	3.43	2.70
			DOE	3.31	2.87
			DOE	3.49	3.07
			DOE	3.39	2.69
			DOE	3.37	3.25
			DOE	3.37	2.94
			PNNL	3.35	2.54
			ORNL	3.74	2.93
			Avg	**3.43**	**2.87**

* Standard is 4.4 cu-ft or greater

Based on these results, a simple conversion factor can be used to convert the minimum CEF per federal regulations (as seen in Section 1.4.2) to an equivalent D2 CEF. The conversion factor for vented gas standard dryers is of 2.87 (D2)/3.43 (D1) = 0.84. The converted code baseline can then be directly compared to the minimum ENERGY STAR CEF. The converted Appendix D2 equivalent federal minimum CEF is 2.76 lbs/kWh. Using this value for the CEF of base-case gas dryers results in a base-case UEC of 530 kWh/year. Unit energy savings can be calculated from program-qualified and base-case UECs using Equation **17**.

Equation 17

$$UES = UEC_{Base-Case} - UEC_{Program-Qualified}$$

The resulting UES for basic tier gas dryers is 3.51 therms/year. The resulting UES for advanced tier gas dryers is 4.65 therms/year. There is no need to adjust for interactive effects because all gas dryers are assumed to be vented.

Demand Reduction Calculation and Values

There is no demand reduction from gas clothes dryers.

4. Room Air Cleaners

The Non-DEER Measure Level Approach, as described in Section 2.2 above, is used to calculate the energy savings from room air cleaners.

Data Source Selection

Device Usage: The data sources for room air cleaner hours of use that were reviewed can be seen in Table 26.

Table 26. Data Sources Reviewed for Room Air Cleaner Hours of Use Assumption

Source	Sponsoring Organization	Year of Publication	Data Point(s)	Notes
Draft Analysis of Standards Options for Portable Room Air Cleaners (Davis Energy Group and Energy Solutions, 2004)	PG&E	2004	38% of air cleaner owners run their units 24 hours per day, and 44% of the owners run their units 8 hours or fewer per day On average, households run their air cleaners 13.6 hours per day during the season in which they use their air cleaner Three-quarters of households surveyed use their air cleaner all year round One-quarter use it only during allergy season	Source of data is actually research conducted by NFO Worldwide Research for AHAM in 2003
Analysis of Energy Efficiency of Room Air Cleaners (Morris, 2004)	Association of Home Appliance Manufacturers (AHAM)	2004	Average usage of 2,921 hours per year (approximately 8 hours per day, 365 days per year)	
Internal research with manufacturers for EPA savings calculator	EPA	2011	Average usage of 16 hours per day, 365 days per year	Source of data not well documented
Electricity Savings Opportunities for Home Electronics and Other Plug-In Devices in Minnesota Homes (Bensch, Pigg, Koski, & Belshe, 2010)	Energy Center of Wisconsin	2010	24 hour per day operation	Metering study with very small sample size (4) Did not clarify the CADR of each unit metered
2016 PG&E Retail Products Platform (RPP) – Air Cleaner Hours of Use Research Results	PG&E	2016	3,641 hours per year on active mode, 1332 hours per year in off (unplugged) mode.	Survey study of PG&E customers.
2016 PG&E Retail Products Platform (RPP) – Air Cleaner Laboratory Research Results	PG&E	2016	Efficiency of non-ENERGY STAR certified air cleaners tested have an average efficiency of 2.2 CADR/W and standby power draw of 0.7 W.	Laboratory testing of 13 non-ENERGY STAR certified air cleaners.

Device Modal Power Draw: Air cleaner active mode power draw (in watts) is based on the air cleaner size (in terms of CADR) divided by its efficiency (CADR per Watt). Average air cleaner size within each size bin was determined based on internal retailer sales data collected by the Northwest Energy Efficiency Alliance for five major retailers during the September – December 2014 period. For each size bin the sales-weighted average size was calculated. These sales-weighted average sizes can be seen in Table 27 below. Note that for room air cleaners, ENERGY STAR +30% is defined as 30% higher efficiency (CADR/W) than the ENERGY STAR requirement.

Other than data from the EPA's Appliance Savings Calculator (U.S. Environmental Protection Agency, 2016), there is very little publicly available metering data on air cleaner idle power draw. Therefore, in 2016, PG&E funded a project to conduct laboratory testing on a sample of 13 non-ENERGY STAR certified air cleaners. The average tested efficiency of 2.2 CADR/watt and 0.7 watt standby power draw are used for baseline assumptions. All active and idle power draw assumptions can be seen in Table 28 below.

Table 27. Room Air Cleaner Sales-Weighted Average Sizes

Size Bin (CADR)	Sales-weighted average size (CADR)
< 100	70.3
100 - 150	132.2
> 150	240.5

<u>UEC/UES Calculation and Values</u>

The main factors that drive room air cleaner energy consumption include the capacity or CADR, the efficiency of the unit (given in CADR per watt), the power draw in idle mode and the number of hours in each mode (active and idle). The unit energy consumption of room air cleaners can be calculated using Equation 18 and Equation 19.

Equation 18

$$UEC = \frac{P_A * T_A + P_I * T_I}{1000\ {}^{Wh}/_{kWh}} * PLF$$

Equation 19

$$P_A = \frac{Cap}{Eff}$$

Where

UEC = unit energy consumption in kWh
P_A = power draw in active mode in watts
T_A = number of hours per year spent in active mode
P_I = power draw in idle mode in watts
T_I = number of hours per year spent in idle mode
Cap = capacity of air cleaner in CADR
Eff = efficiency of air cleaner in CADR/W
PLF = part-load factor, a weighted average of how often partial-load fan settings are use and percentage of power draw vs. power draw at full speed.
1000 = conversion factor to change from watt-hours to kilowatt-hours.

The efficiency of base-case models is 2.2 CADR/Watt (PG&E, 2016), the efficiency of basic tier (ENERGY STAR) program-qualified models is 2.0 CADR/Watt (U.S. Environmental Protection Agency), and the efficiency of advanced tier (ENERGY STAR +30%) program-qualified models is 2.6 CADR/Watt. Idle mode power draw is 0.7 watts for base-case models, 0.6 watts for basic tier (ENERGY STAR) program-qualified models (U.S. Environmental Protection Agency, 2016), and advanced tier (ENERGY STAR + 30%) program-qualified models.

Table 28. Air Cleaner Power Consumption and Efficiency Assumptions

Product Type	Size Bin (CADR)	Sales-Weighted Average Size (CADR)	Efficiency (CADR/W)	Idle Power Draw (W)	Source
Basic Tier (ENERGY STAR) Air Cleaner	< 100	70.3	2.0	0.6	ENERGY STAR QPL: CADR, EPA Appliance Savings Calculator: Idle Power Draw and Efficiency
	100 – 150	132.2			
	> 150	240.5			
Advanced Tier (ENERGY STAR + 30%) Air Cleaner	< 100	70.3	2.6	0.6	Minimum Efficiency to Meet ENERGY STAR +30% Requirement: Efficiency EPA Appliance Savings Calculator: Idle Power Draw and Efficiency
	100 – 150	132.2			
	> 150	240.5			
Conventional Air Cleaner	< 100	70.3	2.2	0.7	2016 PG&E Retail Products Platform (RPP) – Air Cleaner Laboratory Research Results
	100 – 150	132.2			
	> 150	240.5			

PG&E's Air Cleaner Hours of Use Research Results show average runtime hours for room air cleaners as 3,641 hours per year. The same study also shows that air cleaners are off for 1,332 hours per year, as shown in Table 29 below.

Table 29. Air Cleaner Hours-of-Operation Assumptions

Hours of Operation					Source
Active	Idle	Sleep	Off	Total	
3,641	3787	0	1332	8,760	2016 RPP Air Cleaners Hours of Use Research Results (PG&E, 2016)

The part-load factor (PLF) is 0.692 and is derived from the data in Table 30. The source of this data is from two separate research efforts: customer survey research to study air cleaner usage habits and laboratory testing on a sample on non-ENERGY STAR certified air cleaners.

Table 30: Data Used to Derive Part-Load Factor

	Air Clean Fan Speed Setting			Source
	Low	Medium	High	
% of users using settings	0.3	0.5	0.2	2016 PG&E Retail Products Platform (RPP) – Air Cleaner Hours of Use Research Results
power draw as % of max.	0.59	0.63	1	2016 PG&E Retail Products Platform (RPP) – Air Cleaner Laboratory Research Results

The UECs for room air cleaners are calculated using Equation 18 and can be seen in Table 31.

Table 31. Air Cleaner UECs

Product Type	Size Bin (CADR)	UEC (kWh/yr)
Conventional Air Cleaners	< 100	82.3
	100 – 150	153.2
	> 150	277.3
Basic Tier (ENERGY STAR) Air Cleaners	< 100	90.1
	100 – 150	168.1
	> 150	304.6
Advanced Tier (ENERGY STAR +30%) Air Cleaners	< 100	69.7
	100 – 150	129.7
	> 150	234.6

The UES is then calculated as the difference between the UECs for base-case and program-qualified models according to Equation 13. The UES values are shown in Table 32 below.

Table 32. Air Cleaner UESs

Product Type	Size Bin (CADR)	UES (kWh/yr)
Basic Tier (ENERGY STAR) Air Cleaners	< 100	0
	100 – 150	0
	> 150	0
Advanced Tier (ENERGY STAR +30%) Air Cleaners	< 100	12.6
	100 – 150	23.6
	> 150	42.6

Finally these UES values must be adjusted for interactive effects using the factors.

Demand Reduction Calculation and Values

The coincident demand factor of 0.319 is estimated from PG&E’s Air Cleaner Hours of Use Research Results. The active mode power draw was used to calculate the demand reduction for room air cleaners. The active mode power draw values can be seen in Table 28. The demand reduction is calculated as the difference between the active mode power draw for base case and program-qualified room air cleaners, multiplied by the CF (0.319). Finally, these values must be adjusted for interactive effects using the factors.

5. Soundbars

The Non-DEER Measure Level Approach, as described in Section 2.2 above, is used to calculate the energy savings from soundbars.

<u>Data Source Selection</u>
Device Usage: As is assumed elsewhere in literature, we assume that the usage patterns of soundbars are similar to the usage patterns of home theater/home theater in a box systems. For this product, there are no metering studies that provide usage data with a significant sample size (i.e., >10) or monitoring duration, so the best estimates are based on a 2,000-person survey (Roth & McKenney, 2007). Bensch et al. (2010) has usage data for home theater systems, but the sample size is 1 and is therefore too small to utilize.

Device Model Power Draw: Fraunhofer's 2014 report for the Consumer Electronics Association (Urban, Shmakova, Lim, & Roth, 2014) used a combination of field measurements from Bensch et al and field measurements taken by the Fraunhofer team to estimate average power draw for mini shelf stereo systems. We assume, as does the Fraunhofer report, that the power draw of soundbars is the same as the power draw of mini shelf stereo systems because the basic functionality and total system output power of the two products is similar. In 2016, PG&E conducted laboratory testing of 23 non-ENERGY STAR qualified sound bars in the market to inform more accurate values for active, idle, and standby mode power draw. We revised our calculations to use the values from this research as estimates for non-program-qualified power draw by mode. Because no other reliable sources were found, power consumption for basic tier and advanced tier program-qualified soundbars is based on an internal analysis done by the EPA of ENERGY STAR Version 3.0 and Version 2.1 certified models.

<u>UEC/UES Calculation and Values</u>
The main drivers of energy consumption of soundbars are modal power draw and the number of hours the device is in each mode. Equation 20 can be used to calculate the UEC for soundbars.

Equation 20

$$UEC = \frac{P_A * T_A + P_I * T_I + P_S * T_S}{1000\ {}^{Wh}/_{kWh}}$$

Where

UEC = unit energy consumption in kWh
P_A = power draw in active mode in watts
T_A = number of hours per year spent in active mode
P_I = power draw in idle mode in watts
T_I = number of hours per year spent in idle mode
P_S = power draw in sleep mode in watts
T_S = number of hours per year spent in sleep mode
1000 = conversion factor to change from watt-hours to kilowatt-hours.

Roth and McKenney 2007 estimate the hours of operation for home theater in a box systems, which we use to approximate the hours of operation of soundbars, as seen Table 33 below.

Table 33. Soundbar Hours of Use Assumptions

Hours of Operation				Source
Active	Idle	Sleep	Total	
1,580	730	6,450	8,760	Roth & McKenny 2007

Laboratory testing funded by PG&E in 2016 provides average power consumption for non-ENERGY STAR qualified sound bars from a sample of 23 models tests. Table 34 presents the power consumption by mode and resulting UEC values for conventional soundbars. Although active mode power draw (or input power) does not directly represent the efficiency of a device, we believe that the 14.2 watts average of input power from our tested models is a reasonable value to use for our assumptions.

Table 34. Soundbar Power Consumption Assumptions – Base-Case Models

Power Consumption (W)			UEC (kWh/yr.)	Source
Active	Idle	Sleep		
14.2	8.5	1.7	39.6	PG&E, 2016

Because no other reliable sources were found, power draw for basic tier (ENERGY STAR +15%) and advanced tier (ENERGY STAR + 50%) soundbars is based on an internal analysis done by the EPA of ENERGY STAR Version 3 and Version 2.1 certified models. In this analysis, ENERGY STAR +xx% is designated as models with xx% less power draw than the ENERGY STAR maximum allowance for each power draw allowance listed in the ENERGY STAR specification and amplifier efficiency that is xx% higher than the ENERGY STAR criteria. The EPA then took the average modal power draw of every model meeting each set of criteria (ENERGY STAR +15% and ENERGY STAR +50%) See Table 35 for these values. The ENERGY STAR specification requires soundbars with input power between 20 watts to 100 watts to have an amplifier efficiency of at least 0.44. The average amplifier efficiency of non-qualified models tested is 0.27. This means that a non-qualified model would consume 66% more energy than a similar qualified model, which agrees with the active mode power draw assumptions in our calculation.

Table 35. Soundbar Power Consumption Assumptions – Program-Qualified Models

Product Tier	Power Consumption (W)			UEC (kWh/yr.)	Source
	Active	Idle	Sleep		
Basic Tier (ENERGY STAR +15%) Soundbars	8.0	9.2	1.5	29.0	EPA Internal Analysis of ENERGY STAR v3.0 & v2.1 certified models
Advanced Tier (ENERGY STAR + 50%) Soundbars	9.0	5.5	1.0	24.7	

Unit energy savings are calculated using Equation 13 and can be seen in Table 36 below.

Table 36: UES Estimates for Soundbar

Product Tier	Base-Case UEC (kWh/yr.)	Program-Qualified UEC (kWh/yr.)	UES (kWh/yr.)
Basic Tier (ENERGY STAR +15%)	39.6	29.0	**10.6**
Advanced Tier (ENERGY STAR + 50%)	39.6	24.7	**14.9**

Finally these UES values must be adjusted for interactive effects using the factors

Demand Reduction Calculation and Values
The coincident demand factor for televisions (0.031) from the Energy Division's March 2013 Workpaper Disposition on Energy Efficient Televisions (California Public Utilities Commission, Energy Division, 2013) is used as a proxy for soundbars. The active mode power draw was used to calculate the demand reduction for soundbars. These power draw values can be seen in Table 37 for base case, basic tier (ENERGY STAR +15%) and advanced tier (ENERGY STAR +50%) program-qualified models.

Table 37. Power Draw for Soundbars

Product Type	Base Case kW	Basic Tier (ENERGY STAR + 15%) kW	Advanced Tier (ENERGY STAR + 50%) kW
Soundbars	14.2	8.0	9.0

The demand reduction was calculated as the difference between the program-qualified and the base-case equipment power draw, multiplied by 0.031. The resulting demand reduction values are 0.00019 kW for basic tier (ENERGY STAR +15%) and 0.00016 for advanced tier (ENERGY STAR + 50%) models. Finally these values must be adjusted for interactive effects using the factors.

6. Room Air Conditioners

The Non-DEER Products Measure-Level Approach, as described in Section 2.2 above, is used to estimate the energy savings from room air conditioners.

Data Source Selection

Device Usage: Energy and demand savings estimates for basic tier room air conditioners were obtained directly from SCE's ENERGY STAR Room Air Conditioners workpaper (Southern California Edison, 2014). The UES values in this workpaper were based on the Residential Retrofit High Impact Measure Evaluation Report (The Cadmus Group, Inc.; Itron, Inc.; Jai J. Mitchell Analytics; KEMA; PA Consulting Group; Summit Blue Consulting, LLC, 2010), which provides room air conditioner modeled annual energy savings and peak demand reduction in climate zones 6, 8, 9 and 10 based on a 10,000 Btu/h unit and the Title 20 code effective as of October 1, 2000. The SCE workpaper team updated the results of the study to reflect the new federal code, effective June 1, 2014 and the ENERGY STAR Version 4.0 criteria. The Cadmus study did not estimate annual energy savings and peak demand reduction in climate zones 13, 14, 15 and 16, so the SCE workpaper team used the California Statewide Residential Appliance Saturation Study (KEMA, 2010) results by climate zone to develop estimated annual energy and peak demand savings for these climate zones.

Table 38. Room AC Energy Savings Values from SCE Workpaper

Climate Zone	Sources	Estimated Annual Energy Savings (kWh/unit)	Estimated Peak Demand Reduction (kW/unit)
1	RASS EUC scaling factor	0.0	0.0000
2	RASS EUC scaling factor	12.5	0.0094
3	RASS EUC scaling factor	4.5	0.0034
4	RASS EUC scaling factor	19.8	0.0149
5	RASS EUC scaling factor	1.8	0.0013
6	Residential Retrofit HIM evaluation Report	18.3	0.0137
7	Residential Retrofit HIM evaluation Report	21.8	0.0147
8	Residential Retrofit HIM evaluation Report	30.2	0.0334
9	Residential Retrofit HIM evaluation Report	44.1	0.0402
10	Residential Retrofit HIM evaluation Report	53.8	0.0618
11	RASS EUC scaling factor	82.6	0.0950
12	RASS EUC scaling factor	37.4	0.0412
13	RASS EUC scaling factor	86.2	0.0990
14	RASS EUC scaling factor	94.3	0.1084
15	RASS EUC scaling factor	72.5	0.0833
16	RASS EUC scaling factor	23.7	0.0261

DEER climate zone weightings were used to map climate zone specific savings and demand impacts to IOU weighted impacts.

UEC/UES Calculation and Values

The efficiency of base-case models is based on the Title 20 minimum efficiency requirements shown in Table 6. The efficiency of program-qualified models is based on the Energy Star 4.0 minimum efficiency requirements (U.S. Environmental Protection Agency) for the basic tier (ENERGY STAR) and is set to 10% above the ENERGY STAR minimum efficiency requirements for the advanced tier. These efficiency values can be seen in Table 39 below.

Table 39. Program-Qualified Efficiency Requirements for Room Air Conditioners

Product Class	Louvered Sides?	Cooling Capacity (Btu/h)	Minimum CEER for Basic Tier (ENERGY STAR)	Minimum CEER for Advanced Tier (ENERGY STAR +10%)
Room Air Conditioner	Yes	< 6,000	12.1	13.3
		6,000 – 7,999	12.1	13.3
		8,000 – 13,999	12.0	13.2
		14,000 – 19,999	11.8	13.0
		20,000 – 27,999	10.3	11.3
		≥ 28,000	9.9	10.9
	No	<6,000	11.0	12.1
		6,000 – 7,999	11.0	12.1
		8,000 – 10,999	10.6	11.7
		11,000 – 13,999	10.5	11.6
		14,000 – 19,999	10.2	11.2
		≥ 20,000	10.3	11.3
Room Air Conditioning Heat Pump	Yes	< 20,000	10.8	11.9
		≥ 20,000	10.2	11.2
	No	< 14,000	10.2	11.2
		≥ 14,000	9.6	10.6
Casement-Only Room Air Conditioner	Either	Any	10.5	11.6
Casement-Slider Room Air Conditioner	Either	Any	11.4	12.5

Unit energy savings values for advanced tier room air conditioners are scaled from basic tier UES values using Equation 21.

Equation 21

$$UES_{ES+10\%} = UES_{ES} * \frac{\frac{1}{CEER_{base-case}} - \frac{1}{CEER_{ES+10\%}}}{\frac{1}{CEER_{base-case}} - \frac{1}{CEER_{ES}}}$$

where

UES_{ES} = unit energy savings for ENERGY STAR room ACs in kWh
$UES_{ES+10\%}$ = unit energy savings for ENERGY STAR + 10% room ACs in kWh
$CEER_{base-case}$ = efficiency of base case room ACs

$CEER_{ES}$ = efficiency of ENERGY STAR room ACs
$CEER_{ES+10\%}$ = efficiency of ENERGY STAR +10% room ACs

Unit energy savings for basic and advanced tiers can be seen in Table 40 below.

Table 40. Room Air Conditioner UESs

Utility	Basic Tier (ENERGY STAR) UES (kWh/year)	Advanced Tier (ENERGY STAR + 10%) UES (kWh/year)
PGE	32.8	62.4
SCE	44.6	84.8
SCG	40.6	77.1
SDGE	31.2	59.3

The spreadsheet that was used to calculate all these values can be seen in Appendix 1 – Supplemental Files.

Demand Reduction Calculation and Values

Demand savings estimates for basic tier room air conditioners were obtained directly from the SCE workpaper. Demand savings for advanced tier room air conditioners were derived using Equation 22 below.

Equation 22

$$UDR_{ES+10\%} = UDR_{ES} * \frac{\frac{1}{CEER_{base-case}} - \frac{1}{CEER_{ES+10\%}}}{\frac{1}{CEER_{base-case}} - \frac{1}{CEER_{ES}}}$$

where

UDR_{ES} = unit demand reduction for ENERGY STAR room ACs in kW
$UDR_{ES+10\%}$ = unit demand reduction for ENERGY STAR + 10% room ACs in kW
$CEER_{base-case}$ = efficiency of base case room ACs
$CEER_{ES}$ = efficiency of ENERGY STAR room ACs
$CEER_{ES+10\%}$ = efficiency of ENERGY STAR +10% room ACs

Unit demand reduction basic and advanced tiers can be seen in Table 41 below.

Table 41. Demand Reduction for Room Air Conditioners

Utility	Basic Tier (ENERGY STAR) UES (kWh/year)	Advanced Tier (ENERGY STAR + 10%) UES (kWh/year)
PGE	0.0353	0.0671
SCE	0.0474	0.0901
SCG	0.0420	0.0798
SDGE	0.0289	0.0550

7. *Clothes Washers*

For front-loading clothes washers, the basic tier is ENERGY STAR Most Efficient, which is equivalent to the following measure in DEER:

Measure ID: RB-Appl-EffCW-med-Tier2-Front
Measure Description: Clothes washer, Front loading, Weighted Fuel Type, Tier2, IMEF =2.74-2.92, IWF <=3.2

The advanced tier for front-loading clothes washers is CEE Tier 3, which is equivalent to the following measure in DEER:

Measure ID: RB-Appl-EffCW-med-Tier3-Front
Measure Description: Clothes washer, Front loading, Weighted Fuel Type, Tier3, IMEF >2.92, IWF <=3.2

For top-loading clothes washers, DEER does not include a measure that meets the ENERGY STAR Most Efficient or CEE Tier 3 criteria. We calculated impacts based on the methodology used to calculate energy impacts for clothes washers for DEER 2016. Calculations are included in the file titled “DEER2016-ClothesWasherUpdate-15May2015-PGE_supplement.xlsx”

8. *Refrigerators*

For refrigerators, the measure efficiency is set to ENERGY STAR Most Efficient, which 15% more efficient than the code baseline. DEER 2017 includes energy impacts for a refrigerator that is 10% more efficient than code:

Measure ID: RE-Frzr-Wtd-Tier1
Measure Description: Weighted Freezer Type, Size Range: Weighted Size, Energy Star (10% less than Code Maximum)

We scale this DEER measure to ENERGY STAR Most efficient by multiplying the above DEER impacts by 1.5.

Appendix 7 – Product-Specific EUL Values

Freezers
According to DEER the effective useful life of freezers is 11 years.

Electric Clothes Dryers
According to Appliance Magazine (The U.S. Appliance Industry: Market Value, Life Expectancy & Replacement Picture 2013, 2013),[36] the product lifetime for clothes dryers is 12 years.

Gas Clothes Dryers
According to Appliance Magazine,[37] the product lifetime for clothes dryers is 12 years.

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[36] See page 9.

Room Air Cleaners
According to the U.S. EPA's Appliance Calculator the product lifetime for room air cleaners is 9 years. The source for this assumption is Appliance Magazine, Portrait of the U.S. Appliance Industry, 1998.

Soundbars
A 2008 Ecos report for Natural Resources Canada states the EUL of compact audio products as 4.4 years (Ecos, 2008). The DOE's Energy Conservation Standards Rulemaking – Battery Chargers and External Power Supplies Market Assessment and Product Price Determination Workbook (U.S. Department of Energy, 2012) lists the EULs of clock radios as 4 – 6 years. We were unable to find any other sources documenting the EUL of soundbars. Given the available data, we propose using an EUL of 4 years for soundbars.

Room Air Conditioners
According to DEER the effective useful life of room air conditioners is 9 years.

Clothes Washers
According to DEER, the effective useful life of a high efficiency clothes washer is 11 years.

Refrigerators
According to DEER, the effective useful life of a high efficiency refrigerator is 14 years.

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[37] See page 9.

Appendix 8 – Estimation of Net-to-Gross Ratios for the PG&E RPP Program

1. 2015 RPP Program

Because plug loads represent a significant proportion of residential electricity consumption, reducing plug load energy consumption is a critical step on the path towards achieving California's residential Zero Net Energy (ZNE) goals. The 2012 ZNE Technical Feasibility Report states that "…minimizing plug loads will be critical to meeting ZNE goals", (Arup, Davis Energy Group, Sun Light & Power, New Buildings Institute, Engineering 350, and Sustainable Design + Behavior, 2012)[38] and recommended that utilities "continue equipment efficiency incentive programs" and "aggressively promote equipment efficiency regulations at the state and federal level".[39]

In response, PG&E has developed and launched the Retail Products Platform (RPP) Program. The RPP Program uses a mid-stream design to influence retailers to stock and sell more energy efficient models of home appliances and consumer electronics in targeted product categories. Retailers are paid per-unit incentives for every program-qualified model that they sell during the program period. Program-qualified models are typically models that meet or exceed the minimum ENERGY STAR specification for each product. By increasing the sales of energy efficient models over less efficient models, the RPP Program will generate gross energy and demand savings in the short- and mid-term through participating retailers while transforming the overall market towards higher efficiency in the long-term. The broader RPP Program strategy is discussed in detail in the PG&E document *Retail Plug-Load Portfolio Trial Plan* (Navitas Partners, 2013). Note that the name of the program has since changed to Retail Products Platform.

The RPP Program was tested with a single participating retailer in a limited number of stores in the PG&E service territory in a trial that took place from November 2013 to December 2014. The 2013-2014 Trial incented six products, including: (1) air cleaners, (2) DVD/Blu-Ray players, (3) home theaters-in-a-box (HTIBs), (4) freezers, (5) refrigerators, and (6) room air conditioners.

The 2015 RPP Program Trial is being expanded to include more retailers (see Table 42), with plans to launch in 2016. The 2016 RPP Program Trial will include incentives for six targeted products (see Table 43), including: (1) air cleaners, (2) soundbars, (3) freezers, (4) electric clothes dryers, (5) gas clothes dryers, and (6) room air conditioners. The 2016 RPP Program will possibly add other measures such as refrigerators in 2016. Because it targets primarily retailers, it is considered to be a market transformation (MT) program.

Table 42. Participating Retailer Stores in the PG&E 2015 RPP Program

Retailer	Number of Stores
Home Depot	98
Best Buy	42
Sears Holdings (Kmart and Sears)	74
Total	214

[38] See page 8.

[39] Ibid see page 51.

Table 43. 2015 RPP Program Efficiency Specifications and Incentives, By Product

Product	Efficiency Specification		Per-Unit Incentive	
	Basic Tier	Advanced Tier	Basic Tier	Advanced Tier
Air Cleaners	ENERGY STAR V1.2	ENERGY STAR V1.2 +30%	$20	$30
Soundbars	ENERGY STAR V3.0 + 15%	ENERGY STAR V3.0 + 50%	$10	$20
Freezers	ENERGY STAR V5.0	ENERGY STAR V5.0 + 5%	$20	$50
Electric Clothes Dryers	ENERGY STAR V1.0	ENERGY STAR 2014 Emerging Technology Award	$50	$250
Gas Clothes Dryers	ENERGY STAR V1.0	ENERGY STAR 2014 Emerging Technology Award	$50	TBD
Room Air Conditioners	ENERGY STAR V4.0	ENERGY STAR V4.0 + 10%	$20	TBD
Refrigerators	ENERGY STAR Most Efficient 2017	N/A	TBD	N/A
Clothes Washers	ENERGY STAR Most Efficient 2017	N/A	TBD	N/A

2. Estimating Net-to-Gross Ratios (NTGRs) for MT Programs

The net-to-gross ratio (NTGR) is defined as:

> …a factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts. The factor itself may be made up of a variety of factors that create differences between gross and net savings, commonly including free riders and spillover. Other adjustments may include a correction factor to account for errors within the project tracking data, breakage, and other factors that may be estimated which relate the gross savings to the net effect of the program. The NTGR can be applied separately to either energy or demand savings (Horowitz, 2011).

Estimating the NTGR for a MT program requires a different method than commonly used for resource acquisition programs. The NTGRs in DEER are all based on evaluations of resource acquisition programs, which are evaluated over a relatively short period of time, typically once every evaluation cycle. These are the types of programs that California IOUs have designed and implemented for over 30 years. As a result, forecasting a NTGR and a Total Resource Cost Test (TRC) for a residential audit program, for example, which is scheduled to run for a three-year cycle is relatively easy. During that cycle, the fact that the number of other interventions in the same market(s) and the number of social and economic factors are relatively few and change little contribute to the relative ease with which program attribution can be estimated.

MT programs, on the other hand, extend over a much longer period of time during which key parameters such as incremental cost can change dramatically and the number of interventions and social/economic factors are not only far more numerous but can also change dramatically (i.e., great recession). Prahl and Keating (2014) observed:

> 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. (pp. 45-46)

Furthermore, there is very little experience among the California IOUs in designing, implementing, and evaluating MT programs. Outside of California, while market transformation has been implemented more frequently, rigorous evaluations of these programs are rare. The few exceptions such as the evaluation of NYSERDA's 2010-2012 Energy Star Product Program have provided some valuable insights. However, since the RPP Program is being designed to avoid some of the program designs problems identified in the NYSERDA evaluation (e.g., incenting everything that meets or exceeds the basic Energy Star qualifications), the estimated NTGR NYSERDA's program is not particularly relevant. The lack of relevant historical experience with MT programs combined with their greater complexity and duration creates enormous challenges in forecasting the NTGR. For all these reasons, we relied on a different approach that is discussed in the following sections.

Recommendations for estimating NTGRs for MT programs that have, as Prahl and Keating observed above, very unique characteristics have been offered by Sebold et al.(2001), as well as Prahl and Keating (2014) that involve long-term forecasting:

> 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. (Prahl and Keating, p. 46)

For each product, the NTGRs calculated in Appendix 8 are based on a long-term forecast that represents the net influence of the RPP Program over the 10-year program life. These NTGRs will be used in combination with other key parameters (e.g., IMCs, program administrative costs, UESs, etc.) in the E3 Calculator to compute the overall cost and benefits over the life of the RPP Program.

2.1. NTGR Calculation

NTGRs were calculated for each RPP product and the RPP Program as a whole. The NTGR is based on forecasts of the RPP share *with* and *without* the RPP Program. Market share is defined as the percent of program qualified models in a given year that meet or exceed the RPP Program specification as it was defined in 2016 when the program launched.[40]

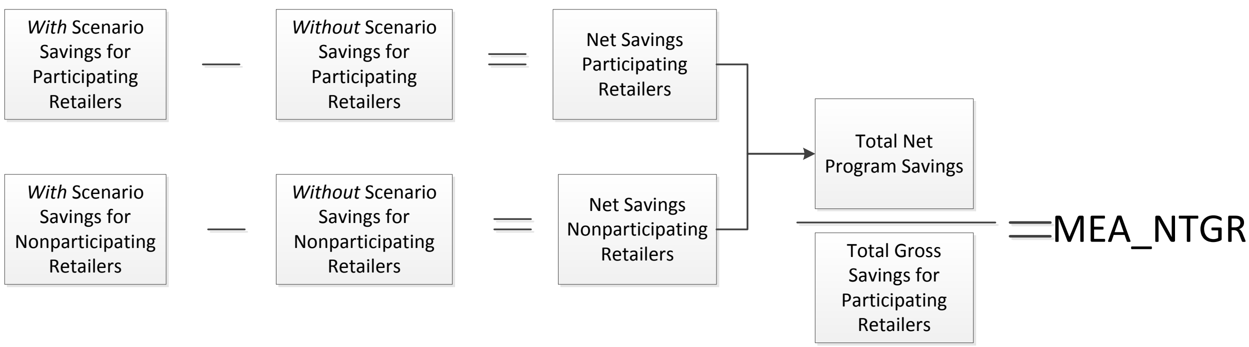
The total market is divided in that portion of the market covered by the participating retailers and that portion covered by nonparticipating retailers. The share of the market accounted for by participating and nonparticipating retailers is based on National sales data, which is shared out to California based on population. The reasons for splitting the market into two pieces are that this is consistent with the program theory and logic model and the estimation and calibration is more tractable. For participating retailers, we will have much better information on how to set the initial parameters for price, advertising, and assortment and how to update them as once the program is launched. For nonparticipating retailers, it will be difficult to obtain information of similar quality since they are not obligated to share any information

[40] If there is a change in the specification, the models that do not meet the new specification will not be eligible for incentives but since they meet the original specification, they will be counted toward the market share. Retailers will continue to sell these original models until they are no longer available. We, like NEEA, will also count their savings until those models are no longer commercially available.

regarding any of these parameters. Instead, we must rely on national, regional or state-level sales and shipment data from such sources as The NPD Group and ENERGY STAR and on information provided by merchandisers and store managers who are willing to be interviewed. After modeling these two components of the market separately, we will combine the two models to develop a picture of the entire market.

Figure 9 presents the basic participant-nonparticipant framework for estimating the NTGR, which we refer to as the market-effects-adjusted NTGR (MEA_NTGR). The non-market-effects adjusted NTGR is simply referred to as the NTGR. Although specification changes will occur over the duration of the program, their timing is unknown.

Figure 9. Basic Framework for Estimating the MEA_NTGR



This formulation, in Equation 1, is consistent with Figure 9 and the standard definition of the MEA_NTGR:

MEA_NTGR = (1-Freeridership) + Participant Inside Spillover Rate + Participant Outside Spillover Rate + Nonparticipant Spillover Rate (1)

The term (1-Freeridership) can be considered the NTGR for participating retailers. It can be adjusted using a participant inside spillover rate and/or a participant outside spillover rate. The *with the RPP Program* forecast does not attempt to model either of these two types of participant spillover. Thus, in Equation 2, the NTGR is simply the participant net savings[41] divided by the participant gross savings.

$$NTGR = \frac{PV(Participating_{Net(1-15)})}{Participating_{Gross\ (1-10)}} \quad (2)$$

Rather than use the term *Nonparticipant Spillover Rate* in Equation 1, we use the term market-effects rate (*ME_Rate*) to acknowledge the fact that the two terms are not interchangeable and that market effects require lasting structural or behavioral changes in the market. The *ME_Rate* is calculated in the same way that the nonparticipant spillover rate has been traditionally calculated.

$$ME\_Rate = \frac{PV(Nonparticipating_{Net\ (1-15)})}{PV(Participating_{Gross\ (1-10)})} \quad (3)$$

[41] The monetized net benefits for both participating and nonparticipating retailers extend 15 years, 2015 through 2029. This is done since at the end of the tenth year of the RPP Program, the behavior of retailers and consumers are assumed to be transformed such that the benefits continue for five additional years through 2029. Note that the savings associated with the purchases in any given year extend for the length of the EUL.

Equations 2 and 3 can be combined to produce the final MEA_NTGR in Equation 4.

$$MEA\_NTGR = \frac{PV(Participating_{Net\,(1-15)} + Nonparticipating_{Net\,(1-15)})}{PV(Participating_{Gross\,(1-10)})} \quad (4)$$

This MEA_NTGR is then applied to the gross savings and incremental costs for participating retailers. There are other ways to calculate the MEA_NTGR such as illustrated in Equation 5.[42]

$$\text{MEA\_}NTGR = \frac{PV[(Program_{Net\,(1-15)}) + (Market_{Net\,(1-15)})]}{PV[Program_{Gross\,(1-15)} + (Market_{Gross\,(1-15)})]} \quad (5)$$

The resulting net savings are the same whether one uses the formulation in Equation 4 or Equation 5 to adjust gross savings. We have chosen to use Equation 4. The MEA_NTGR in Equation 4 is also used to adjust upwards the incremental costs to account for units purchased outside the program.

2.2. Standard Bass Diffusion Model

For the standard Bass diffusion model,[43] three key inputs are required when forecasting the RPP share for a particular product:

- Market potential
- Coefficient of innovation
- Coefficient of imitation

In Bass diffusion models, potential buyers are divided into two major classes: innovators and imitators. Innovators (*p*) 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 (such as advertising) over the planning period. Imitators (*q*) are assumed to purchase on the basis of interpersonal influence (such as word-of-mouth communication) processes within a market. The Equation 6 presents the formulation of the diffusion model.

$$n_t = p[m - N_t] + q\left(\frac{N_t}{m}\right)[m - N_t] \quad (6)$$

Where

n_t= The number of adopters at time *t*
m= The potential number of adopters
N_t= The cumulative number of adopters at time *t*
p= Coefficient of innovation
q= Coefficient of imitation

Note that *m*, the potential cumulative number of adopters over time is first estimated outside of the model based on forecasts of the number of households or individuals who are in the market each year for a given product. The variable *m* is then introduced as a constant into the model. Typically, the *p* and *q* parameters are estimated with a multiple regression analysis based on a product's historical sales data, which is then used to predict adoptions (or market share) over time. 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 4 but rely on the values of *p* and *q* from previous studies of similar products. The literature was reviewed to identify estimates of the two parameters (*p* and *q*) that were estimated from the historical data of existing product analogies. The

[42] This is consistent with the recommendation of Prahl and Keating (2014): "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. 25)."
[43] The Bass diffusion model is also used in the evaluation of the California Codes and Standards Program.

literature and parameters selected are presented in Section 2.5.

2.3. Generalized Bass Diffusion Model

The most important extension of the Bass Model is referred to as the Generalized Bass Model (Bass, Trichy, & Dipak, 1994). From Equation 7, one can see that the Generalized Bass Model examines the impact of marketing mix variables such as pricing and increased advertising and promotion on demand levels.

$$(St) = m\frac{(p+q)^2}{p}(1+\beta_1)\frac{Pr'(t)}{\Pr(t)} + \beta_2\frac{A^t(t)}{A(t)}\frac{e^{-(p+q)(t+\beta_1 Ln(Pr)+\beta_{2Ln(A)})}}{1+\frac{q}{p}e^{-(p+q)(t+\beta_1 Ln(Pr)+\beta_{2Ln(A)})}} \tag{7}$$

Where

S(t)=	Sales at time *t*
Pr´(t)=	Rate of change in price at time *t*
Pr(t)=	Price at time *t*
A´(t)=	Rate of change in advertising at time *t*
A(t)=	Advertising at time *t*
β_1=	Price coefficient
β_2=	Advertising coefficient

However, while changing these marketing-mix elements shifts the demand curve in time, e.g., the shape of the demand curve is changed, total demand is unchanged (the end-points for cumulative sales are identical). To address this constraint, Boehner and Gold modified the Generalized Bass Model to include the impact of changes in the marketing mix on market size (Boehner & Gold, Modeling the Impact of Marketing Mix on the Diffusion of Innovation in the Generalized Bass Model of Firm Demand, 2012). The *extended* Generalized Bass Model is presented below in Equation 8. We have added assortment and its elasticity to this model to better reflect the strategies that retailers in the RPP Program will likely employ.

$$N_t = pMP^{-e}A^fB^g + (1+q-p)N_{t-1} - \left(\frac{q}{MP^{-e}A^fB^g}\right)N_{t-1}^2 \tag{8}$$

where

N_t=	Percentage of energy-efficient products sold at time t
p=	Coefficient of innovation
q=	Coefficient of imitation
M=	Total potential ratio of sales of energy-efficient products to total sales
N_0=	Percentage of energy-efficient products sold at time 0.
P_0=	Ratio of price for energy-efficient product to price for standard product at time 0
e=	Coefficient of sensitivity (elasticity) for price term
A_0=	Ratio of advertising expenditure with the program to without the program at time 0
f=	Coefficient of sensitivity (elasticity) for advertising
B_0=	Ratio of energy-efficient assortment with the program to without the program at time 0
g=	Coefficient of sensitivity (elasticity) for assortment
N_{t-1}=	Percentage of energy-efficient products sold in the previous period

In this model for a given product, we forecast purchases of program-qualified products by forecasting market share of program-qualified models and then applying it to the expected annual purchases. Once the market potential is estimated, Monte Carlo simulations were conducted to produce a distribution of

NTGRs for each product. The NTGR that is the best measure of central tendency was selected as the ex ante NTGR.

2.4. Overarching Framework

It is essential to underscore that for the RPP products 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 CPUC for energy efficiency programs, the price of electricity, the ability of participating retailers to faithfully implement their respective marketing plans, or the health of the economy cannot be accurately predicted. While there is some information regarding the current penetration and market share, the accuracy of these parameters varies by product. Having said this, for each product, two sets of diffusion parameters, one for participating retailers and one for nonparticipating retailers, were developed that define two basic scenarios. One set of parameters represents the current situation *without* the RPP Program. The second set represents a situation *with* the RPP Program.

The main advantage of working within the framework of the extended Generalized Bass diffusion model is that it provides a structured environment, which is systematic, transparent, and repeatable, within which to conduct sensitivity analyses using Monte Carlo simulations in order to converge on a set of plausible NTGRs. Also, having such a framework allows us to improve the model over time, as more information becomes available and we accumulate historical program performance data.

2.5. Selection of Model Parameters

A number of general modeling principles have been established in estimating the *with-RPP* and *without-RPP* scenarios for participating and nonparticipating retailers. The first is that we are capturing the entire market by modeling the participating and nonparticipating retailers separately. While we have done this in order to be consistent with the program theory and logic model, it also has the advantage that, because participating retailers are the focus of the RPP Program and more accurately measured (e.g., monthly sales data and access to retailer stores and decision-makers), the participating retailer model can be more easily calibrated in the short and intermediate run. The second is that the elasticities associated with *P, A,* and *B* should remain fixed for participating and nonparticipating retailers for both the *with-RPP* and *without-RPP* scenarios.

In the following sections, the key parameters are presented and how they differ in the *with-RPP* and *without-RPP* scenarios.[44]

2.5.1. *p*s and *q*s

We began with the selection of *p*s and *q*s for each of the following six products for the *without-RPP* scenario:

1. Air cleaners
2. Soundbars
3. Freezers
4. Electric clothes dryers
5. Gas clothes dryers
6. Room air conditioners

The parameters p and q are based on published parameters for analogous products (Zhengrui, Bass, & Isaacson Bass, 2006). **Table 44** presents the *p*s and *q*s for these six products.

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[44] The source for each parameter is cited in each product-specific workbook in the *Key Parameters* and *Parameter Summary* worksheets.

Table 44. Coefficients of Innovation (*p*s) and Coefficients of Imitation (*q*s) and Analogs for RPP Products

Products	*p*	*q*	Analog
Room air cleaners	0.000000044	0.5701	Room air conditioner
Soundbars	0.001400000	0.4369	Consumer electronics
Freezers	0.000038000	0.3813	Freezers
Electric clothes dryers	0.008000000	0.4000	Electric clothes dryers
Gas clothes dryers	0.0000014000	0.4792	Gas clothes dryers
Room air conditioners	0.000000044	0.5701	Room Air Conditioners

In the *with-RPP* scenario, the values for *p* and *q* are increased to reflect the direct influence of the RPP Program. These increases are based on the expected level of effort put forth by retailers (effective marketing plan faithfully implemented) with IOU support (adequate marketing support and incentives).

2.5.2. Price, Advertising and Assortment Values

The values for parameters *P, A, B* and *M* are discussed separately for the *with-RPP* and *without-RPP* scenarios.

Without RPP Scenario

- Parameters *A* and *B* were both set to 1 and remain fixed over time to reflect that fact the in the absence of the RPP Program retailers will engage in business-as usual.
- The rates of increase for both *A* and *B* were set to 0.00 since they are, absent the Program, expected to continue with business-as-usual advertising and assortment strategies.
- Prior to program launched, the values for *P* were set based on the most current estimates. Once the program is launched, values for *P* decline but at a slower faster rate than in the *with-RPP* scenario.[45] This is the case since, absent the RPP Program, incremental cost will still decrease simply due to natural technological advances, manufacturing efficiencies and economies of scale. The values for *P* are the same for both participating and nonparticipating retailers.
- The parameter *M* is the same for participating retailers and nonparticipating due to the absence of the RPP Program.
- We have incorporated the effects of other factors such as broad economic conditions, market events, cost of energy, the perceived need for conservation, increased federal and state efficiency standards and other federal, state and municipal efficiency programs into the *without* the RPP Program case (the base case) for participating and nonparticipating retailers. That is, the market share even *without* the RPP Program is expected to be higher due to these other factors.[46]

With-RPP Scenario

- Parameters *A* and *B* were set to 1.0 prior to the RPP Program. In the first Program year, they are set relative to the *without-RPP* scenario. For example, in the *with-RPP* scenario, if the first-program-year value for the advertising parameter, *A*, were set to 1.2, this would mean that the expenditures on advertising are expected to be 20% greater than in the *without-RPP* scenario. Or, in the *with-RPP* scenario, if the first-program-year value for the assortment parameter, *B*, were set

[45] Desroches (2013) notes that omitting price trends ". . . results in a considerable underestimate of consumer benefits of using more efficient appliances. (p. 5)"

[46] This is one approach to assigning some of the increase in market share for a given product category to a variety of non-program factors. Another approach would be to report the change in market share without explicitly accounting for these factors in the model and ask a Delphi panel to assess how much of the increase in market share is due to the program.

to 1.15, this would mean that the percent of program-qualified products being displayed is expected to be 15% greater than in the *without-RPP* scenario.

- Prior to program launched, the values for *P* were set based on the most current estimates. Once the program is launched, values for P, the incremental costs, decline and at a faster rate than in the *without-RPP* scenario due to price promotions. The values for *P* are the same for both participating and nonparticipating retailers. A value of 1.0 indicates that the incremental cost is zero.
- Both *A* and *B* increase over time for participating retailers since they are presumably implementing a marketing plan that deviates from business-as-usual for these targeted products. They also increase for nonparticipating retailers but at a slower rate since the effect of the RPP Program on them is only indirect.
- For nonparticipating retailers, parameters *A* and *B* are set to one for the first 2 years in recognition of the lag of two factors: 1) the influence of the participating retailers and 2) manufacturers' response to increased demand. That is, it will take some time before we see changes in nonparticipating retailers in terms of advertising, assortment and in shift to more efficient technologies by manufactures.
- These increases in *A* and *B* for both participating and nonparticipating retailers are based on the expected level of effort put forth by participating retailers (effective marketing plan faithfully implemented) with IOU support (adequate marketing support and incentives). The values in Table 46 for *A* and *B* are the tenth-year values.
- The parameter *M* is larger for participating retailers than for nonparticipating retailers due to the direct influence of the Program and to account for the fact that the model does not include everything that retailers might do to increase sales such as training sales staff to better promote and educate customers about plug load energy use and the use of specially designed planograms.[47]

2.5.3. Price, Advertising and Assortment Elasticities

The associated elasticities for price, advertising, and assortment parameters presented in

Table **45** were selected based on a meta-analysis conducted by Eisend (2014) and Gwartney et al. (2015).[48]

Table 45. Advertising, Price and Assortment Elasticities, by Product

Products	Price Elasticity (*e*)	Advertising Elasticity (*f*)	Assortment Elasticity (*g*)
Room air cleaners	0.10	0.2827	0.21
Soundbars	0.10	0.1700	0.21
Freezers	0.10	0.0804	0.21
Electric clothes dryers	0.10	0.2827	0.21

[47] A planogram is defined as a **v**isual representation of a store's products or services. They are considered a tool for visual merchandising. According to the Oxford Dictionary, "It is a diagram or model that indicates the placement of retail products on shelves in order to maximize sales." Planograms therefore help dictate a retail store's layout. The ultimate effectiveness of the planogram can be measured by sales volume.

[48] For this report, elasticity is defined as the percentage change in the market share due to a 1% increase advertising or assortment or a 1% decrease in price. An *elastic* variable (or elasticity value greater than 1) is one which responds more than proportionally to changes in other variables. In contrast, an *inelastic* variable (or elasticity value less than 1) is one which changes less than proportionally in response to changes in other variables.

Gas clothes dryers	0.10	0.2827	0.21
Room air conditioners	0.10	0.0804	0.21

While price and assortment elasticities do not vary across products, advertising elasticity does. These elasticities are the same for participating and nonparticipating retailers in both the *with-RPP* and *without-RPP* scenarios. Note that the elasticities, *e*, *f*, and *g* in the *without-RPP* scenarios do not play a role given that *P, A,* and *B* are set initially to 1.0 and remain constant.

2.5.4. Parameter Summary

Table 46 and Table 47 summarize the model parameters for the with-RPP and without-RPP scenarios for participating and non-participating retailers. The values for parameters A and B in Table 46 and Table 47 reflect the level of advertising and assortment changes at the end of the RPP Program while the value for parameter P reflects the incremental costs at the beginning of the RPP Program. Note that a value of 1.00 means that the incremental costs are estimated to be zero. Once the Program is launched, incremental costs will be monitored by Energy Solutions so that the model can be recalibrated annually. See the six spreadsheets (Air_Cleaner_A 2016.xlsm, Freezers_A 2016.xlsm, E_Dryers_A 2016.xlsm, G_Dryers_A 2016.xlsm, Sound_Bars_A 2016.xlsm, Room_Air_Conditioners_A 2016.xlsm) in Appendix 1 – Supplemental Files for details of each parameter).

Table 46. Summary of Model Parameters for the With-RPP Scenario, by Participating and Nonparticipating Retailers

		With								
		p	q	P	e	A	f	B	g	M
Air Cleaner	Participating Retailer	0.02	0.5701	1.56	0.10	2.00	0.2827	1.80	0.21	0.70
	Nonparticipating Retailer	0.01	0.5701	1.56	0.10	1.40	0.2827	1.40	0.21	0.67
Soundbar	Participating Retailer	0.02	0.4369	1.00	0.10	2.00	0.1700	2.00	0.21	0.59
	Nonparticipating Retailer	0.01	0.4369	1.00	0.10	1.40	0.1700	1.40	0.21	0.55
Room Air Conditioner	Participating Retailer	0.02	0.5701	1.00	0.10	2.00	0.0804	1.80	0.21	0.70
	Nonparticipating Retailer	0.01	0.5701	1.00	0.10	1.40	0.0804	1.40	0.21	0.60
Freezer	Participating Retailer	0.02	0.3813	1.10	0.10	2.00	0.0804	2.00	0.21	0.60
	Nonparticipating Retailer	0.01	0.3813	1.10	0.10	1.40	0.0804	1.40	0.21	0.55
Electric Clothes Dryer	Participating Retailer	0.02	0.4000	1.00	0.10	2.00	0.2827	1.90	0.21	0.58
	Nonparticipating Retailer	0.01	0.4000	1.00	0.10	1.45	0.2827	1.40	0.21	0.55
Gas Clothes Dryer	Participating Retailer	0.02	0.4792	1.00	0.10	2.00	0.2827	1.90	0.21	0.58
	Nonparticipating Retailer	0.01	0.4792	1.00	0.10	1.45	0.2827	1.40	0.21	0.55

Table 47. Summary of Model Parameters for the Without-RPP Scenario, by Participating and Nonparticipating Retailers

		Without								
		p	q	P	e	A	f	B	g	M
Air Cleaner	Participating Retailer	0.00000004	0.5701	1.56	0.10	1.00	0.2827	1.00	0.21	0.65
	Nonparticipating Retailer	0.00000004	0.5701	1.56	0.10	1.00	0.2827	1.00	0.21	0.65
Soundbar	Participating Retailer	0.00140000	0.4369	1.00	0.10	1.00	0.1700	1.00	0.21	0.50
	Nonparticipating Retailer	0.00140000	0.4369	1.00	0.10	1.00	0.1700	1.00	0.21	0.50
Room Air Conditioners	Participating Retailer	0.0000000440	0.5701	1.00	0.10	1.00	0.0804	1.00	0.21	0.50
	Nonparticipating Retailer	0.0000000440	0.5701	1.00	0.10	1.00	0.0804	1.00	0.21	0.50
Freezer	Participating Retailer	0.00003800	0.3813	1.10	0.10	1.00	0.0804	1.00	0.21	0.50
	Nonparticipating Retailer	0.00003800	0.3813	1.10	0.10	1.00	0.0804	1.00	0.21	0.50
Electric Clothes Dryer	Participating Retailer	0.00800000	0.4000	1.00	0.10	1.00	0.2827	1.00	0.21	0.50
	Nonparticipating Retailer	0.00800000	0.4000	1.00	0.10	1.00	0.2827	1.00	0.21	0.50
Gas Clothes Dryer	Participating Retailer	0.00000140	0.4792	1.00	0.10	1.00	0.2827	1.00	0.21	0.50
	Nonparticipating Retailer	0.00000140	0.4792	1.00	0.10	1.00	0.2827	1.00	0.21	0.50

2.5.5. Other Relevant Parameters

Other relevant parameters include the estimated annual unit energy savings, the effective useful life (EUL), the market share of ENERGY STAR, and the proposed incentives. These are presented in Table 48. The unit energy savings are based on values presented in the main body of this report. Note that the UES and incentive values used in our models are those for the basic tier levels for each product. We do not expect NTGRs to vary significantly with the small changes to UES and incentives values presented by the advanced tiers. In an effort to minimize the administrative cost burden of the RPP program, we have chosen not to create separate models for the advanced tier levels for each product.

Table 48. Other Relevant Parameters, by Product

Key Metrics	Soundbars (ENERGY STAR +15%)	Freezers	Electric Clothes Dryers	Room Air Cleaners	Gas Clothes Dryers	Room Air Conditioners
Est. kwh Savings	54.00	24.67	163.90	222.40	n/a	49.9
Est. Peak kw Reduction	0.0009	0.0044	0.0800	0.0330	n/a	0.0500
Est. Therm Savings	-1.300000	-0.725583	-1.900000	-5.200000	5.88	N/A
ENERGY STAR EUL (years)	4	11	12	9	12	N/A
DEER EUL	n/a	11	n/a	n/a	12	9
Market Share of ENERGY STAR (Source: US EPA	35% in 2013	29% in 2013	13% in 2015	31% in 2013	5% in 2015	30% in 2015
Adjusted Market Share of ENERGY STAR (Source: US EPA	36%	30%	13%	32%	5%	30%
Initial Incentives Proposed ($)	$15.00	$20.00	$50.00	$20.00	$50.00	$15.00
Incremental Cost	1.00	1.00	1.09	1.41	1.09	1.16

*Estimated Savings varies differently at national EPA levels compared to retailer-specific savings for qualifying products.
**Market share is defined as the percentage of all models sold in a given year that meet or exceed the Tier I specification as it was defined in 2015 when the program launched. The 2013 EPA values were increased by one percentage point to bring them to the beginning of 2015. The concept is currently based on shipment-level data.
*** An incremental cost value of 1.00 indicates zero incremental cost. An incremental cost value greater than 1.00 indicates the percent by which the program-qualified model exceeds the baseline model. For example, a program-qualified air cleaner costs 41% more than the baseline model.

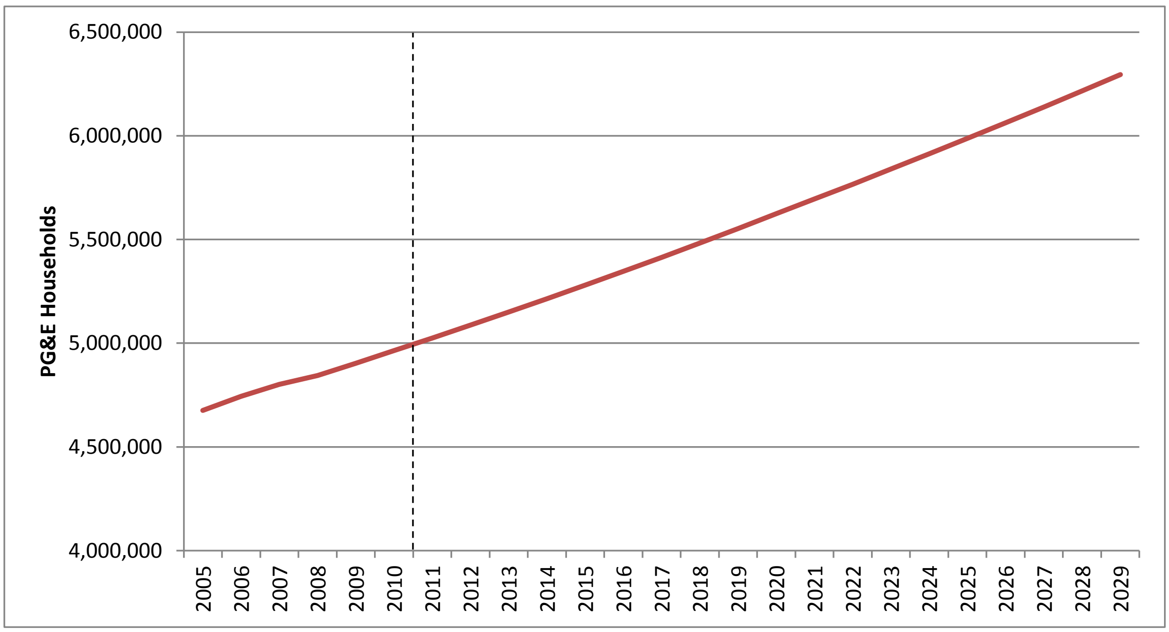
Currently, the annual energy savings do not vary by year although the baselines are expected to be dynamic. To address dynamic baselines, the UES values will be updated annually and applied going forward. These recalculated savings reflect the fact the annual energy use of both the program-qualifying and non-program-qualifying models will change over time.

For freezers, room air cleaners, and room air conditioners the proposed UES is an average of the UES values across subcategories for each product. This was done because there was insufficient information about how the diffusion model parameters would vary by the different subcategories. These UES values will be revised at the end of 2015 with sales-weighted averages. For soundbars, there is only one UES proposed since there are no subcategories. For electric clothes dryers, a single UES of 163.9 kWh is proposed since it is unlikely that very many, if any, compact dryers will be incented.

2.5.6. Estimation of Market Size

In the Bass model, the number of adopters over a given period of time is limited by the total market size, represented by *m* in the model. This section describes our method for estimating *m* as well as our estimates for each of the products. We began with a forecast of households in the PG&E service territory (California Energy Commission). Figure 10 presents the CEC's historical and forecasted household growth.

Figure 10. CEC Household Forecast



The compound annual growth rates for each decade from 1990 through 2020 are presented in Table 49. The forecast was extended through 2030 using the 1.26% growth rate for 2010-2020 decade.

Table 49. Compound Annual Growth Rates for California Households

Decade	Compound Annual Growth Rate
1990-2000	1.13%
2000-2008	1.32%
2008-2010	1.23%
2010-2020	1.26%

For each product, we then identified estimates of household saturation (*total # of devices / total # of households)*. For most of these products, we relied on the *Residential Solutions Workbook* prepared by Research Into Action (*See RSW I Dashboard Draft 6-4-14_v1.1_in progress.xls*) (Frank, 2014). For example, for air cleaners, the *2009 California Lighting and Appliance Saturation Study* estimated household saturation to be 9%. We then grew this saturation at a compound annual growth rate of 0.33% through 2020. For each year, our estimate of the number of households with air cleaners is simply the number of households multiplied by the saturation. These households were then divided into those who shop at participating retailers and those who shop at nonparticipating retailers based on an estimate of their respective market share of air cleaners. For air cleaners, Navitas Partners estimated that the participating retailers accounted for 29.5% of the market within PG&E's service territory. To estimate the numbers of households expected to purchase an air cleaner in a given year, we simply divided the number of households that have an air cleaner by the effective useful life. Equation 9 summarizes the calculation of the number of purchasers in any given year (P_t). Note that the *RS* term changes depending on whether the retailer is a participant or not.

$$P_t = \left(\frac{S_t \times HH_t \times RS}{EUL}\right) \quad (9)$$

Where

- P_t= Purchases of product at time *t*
- S_t= Household saturation of product in PG&E households at time *t*
- HH_t= Households in PG&E service territory at time *t*
- RS_t= Retailers' (either participating or nonparticipating) share of the market
- EUL= Effective useful life

Implicit in the use of Equation 9 is that these sales estimates are for all purchases, regardless of whether they occur in stores on online. However, a final adjustment to account for online sales was necessary. Available data suggest that for sound bars 75% of sales occur in stores while for the remaining product categories 95% of sales occur in stores. See the *Program Theory and Logic Model for the PG&E Retail Products Platform (RPP) Program* adjustment for a more detailed discussion.

The household saturation estimates for dryers, air cleaners and freezers in Table 50 are based on the Residential Solutions Workbook (Frank, 2014). The estimate for soundbars is based on shipment data provided by Navitas (*2015 Collaboration Portfolio Products 92514.xls* and the various *CLASS* reports).

Table 50. Household Saturation, by Product

Product	Household Saturation: 2015
Electric Clothes Dryers	28%
Room Air Cleaners	12%
Soundbars	13%
Freezers	16%
Gas Clothes Dryers	42%
Room Air Conditioners	21%

To estimate of the annual percentage point increase in saturation, we relied on the 2000, 2003, 2005, 2009 and 2012 CLASS/RASS estimates reported in the *Residential Solutions Workbook.* Data were not available for soundbars. For this product, we assumed an annual increase of 0.50%. Table 51 presents these increases for each product. Note that the estimated increase in saturation for electric clothes dryers, gas clothes dryers and freezers are estimated to be zero. The household saturation for these three products will be closely monitored.

Table 51. Annual Percentage Point Increase in Saturation, by Product

Product	Annual Percentage Point Increase
Electric Clothes Dryers	0.00%
Room Air Cleaners	0.33%
Soundbars	0.50%
Freezers	0.00%
Gas Clothes Dryers	0.00%
Room Air Conditioners	0.00%

2.5.7. Retailer Market Share of Products

For each product, Navitas Partners estimated the share of the PG&E market for each participating retailer and overall. These values are presented in Table 52.

Table 52. Estimated Retailer Share, by Product

Product	Retailer 1	Retailer 2	Retailer 3	Retailer 4	Total
Room Air Cleaners	12.00%	12.00%	0.50%	5.00%	29.50%
Soundbars	0.00%	5.00%	1.00%	30.00%	36.00%
Freezers	15.00%	35.00%	1.50%	5.00%	56.50%
Electric Clothes Dryers	20.00%	30.00%	0.30%	10.00%	60.30%
Gas Clothes Dryers	20.00%	30.00%	0.30%	10.00%	60.30%
Room Air Conditioners	1.00%	20.00%	8.00%	12.00	41.00%

Sources: **Consumer electronics**: *U.S. Consumer Electronics Sales & Forecasts 2008–2013*,Consumer Electronics Association, July 2013; **Major appliances**: *Annual Shipment Trends*, Association of Home Appliance Manufacturers

2.5.8. Sales Forecast

Table 53 presents long-term forecasts of overall sales for each of the six products. The long-term forecasts of gross and net program-qualified sales and kWh for each product based on the Generalized Bass Diffusion Model are presented in Section 4.3. For each product, the maximum market-level lifecycle GWH (or Decatherm) potential is calculated as the number of units (both program- and non-program-qualified models) times the UES times the EUL. The maximum market-level first-year annual GWH (or Decatherm) potential for each product and overall are presented in Table 54.

Table 53. Long-Term Sales Forecasts, by Product

	Air Cleaners		Sound Bars		Room Air Conditioners		Freezers		Electric Clothes Dryers		Gas Clothes Dryers	
Year	Participating Retailers	Nonparticipating Retailers	Participating Retailers	Nonparticipating Retailers	Participating Retailers	Nonparticipating Retailers	Participating Retailers	Nonparticipating Retailers	Participating Retailers	Nonparticipating Retailers	Participating Retailers	Nonparticipating Retailers
2016	15,029	48,925	50,125	104,107	50,519	74,220	33,935	35,320	66,457	53,827	99,686	80,741
2017	15,667	51,001	52,519	109,079	51,159	75,160	34,364	35,767	67,299	54,508	100,948	81,763
2018	16,320	53,126	54,969	114,168	51,810	76,116	34,802	36,222	68,155	55,202	102,232	82,803
2019	16,987	55,299	57,476	119,375	52,472	77,089	35,246	36,685	69,026	55,908	103,539	83,862
2020	17,671	57,524	60,042	124,705	53,146	78,079	35,699	37,156	69,913	56,626	104,870	84,939
2021	18,364	59,781	62,650	130,121	53,816	79,063	36,149	37,625	70,794	57,340	106,191	86,009
2022	19,072	62,087	65,313	135,653	54,494	80,059	36,605	38,099	71,686	58,062	107,529	87,093
2023	19,796	64,441	68,034	141,303	55,181	81,068	37,066	38,579	72,589	58,794	108,884	88,190
2024	20,534	66,844	70,813	147,075	55,876	82,090	37,533	39,065	73,504	59,534	110,256	89,302
2025	21,288	69,298	73,651	152,970	56,580	83,124	38,006	39,557	74,430	60,285	111,645	90,427
2026	22,057	71,803	76,549	158,989	57,293	84,171	38,485	40,056	75,368	61,044	113,052	91,566
2027	22,843	74,360	79,509	165,137	58,015	85,232	38,970	40,560	76,317	61,813	114,476	92,720
2028	23,645	76,971	82,531	171,414	58,746	86,306	39,461	41,071	77,279	62,592	115,919	93,888
2029	24,463	79,635	85,617	177,822	59,486	87,393	39,958	41,589	78,253	63,381	117,379	95,071
2030	25,298	82,354	88,767	184,366	60,236	88,494	40,461	42,113	79,239	64,179	118,858	96,269

Table 54. Maximum Gross Market-Level Lifecycle GWH and Decatherm Potential, by Product

Product	Maximum Market-Level Lifecycle Potential (GWH)	Maximum Market-Level First-Year Annual Potential (GWH)	Maximum Market-Level Lifecycle Potential (Decatherm)	Maximum Market-Level First-Year Annual Potential (Decatherm)
Electric Clothes Dryers	3,881.3	208.8		
Air Cleaners	2,547.0	171.0		
Sound Bars +50%	678.5	101.5		
Room Air Conditioners	839.9	24.8		
Freezers	308.3	18.1		
Gas Clothes Dryers			20,886,511.0	1,123,613.9
Total	8,255.0	524.3	20,886,511.0	1,123,613.9

2.5.9. Sensitivity Analysis

Once a model for a given product was created, we used Monte Carlo simulations to assess the changes in the NTGR to changes in key parameters. For each product, 200 simulations were conducted so that the variability in the NTGR could be assessed and the most defensible NTGR selected. The intention here was to set the bounds within which families of possible diffusion curves may exist.

Given the large number of parameters, the sensitivity analysis focused on a smaller set of four parameters for *participating* retailers: *p, M, v (*the assumed change in the ratio of advertising expenditure with the program to without the program) and *w* (the assumed change in the ratio of energy-efficient assortment with the program to without the program).

3. Accounting for Codes and Standards

According to the RPP Program theory and logic model, such changes are expected at least in part due to the RPP Program. There are three ways for the RPP Program affect standards:

1. First, when there is no set standard for a product but a market exists, a the RPP Program can work with regulators to negotiate a market-sourced baseline and run programs that support the adoption of more efficient products by households. The RPP Program can claim the incremental energy saving from utility-run programs compared to the market-sourced baseline.
2. Second, the RPP Program can work between final rule making and effective date of a new standard to help accelerate market adoption of high-efficiency products and secure energy savings through a market transformation effort. In this approach, the new standard becomes the baseline and the RPP Program can focus the market by incenting the purchase of higher than minimum-efficiency products. In some cases, readily available high-efficiency products will not pass cost-effectiveness tests and the utility will need to work with the product manufacturers to find a specification that passes the test.
3. A third, less common, approach is for the RPP Program to work with a state agency, such as a standard setting energy office, to develop a standard for a product that is not federally covered. A recent example of this approach is the creation of new energy- efficiency standards for color televisions in California.

The RPP Program will employ the approaches 2 and 3 and engage in such activities as:

- Holding meetings and working groups to target products ripe for new standards;
- Developing technical reports on the feasibility, costs, and benefits of candidate technologies for standards consideration;
- Developing standards-testing practices and evaluation tools;
- Increasing the market share of high-efficiency products through incentives; and
- Providing expert-witness testimony in regulatory hearings and assisting with consumer and regulator education efforts.

Unfortunately, since we could not predict the timing of the adoption of any new mandatory or voluntary efficiency codes and standards and their associated compliance rates, we were unable to incorporate them into our diffusion models. As a result, our estimates of gross and net energy and demand savings lifecycle are somewhat conservative.

4. Results

We first present the results of our sensitivity analysis followed by a discussion of the distributions. We then present our proposed MEA_NTGRs for each product and its rationale.

4.1. Sensitivity Analysis

Table 55 and Table 56 present the measures of central tendency and dispersion for the MEA_NTGRs simulated in the sensitivity analysis for each product.

Table 55. Long-Term MEA_NTGR Sensitivity Analysis, by Product

Product	Mean	Median	Mode	Standard Deviation
Room Air Cleaners	0.95	0.96	0.97	0.042
Soundbars	0.84	0.85	0.91	0.096
Freezers	0.48	0.49	0.55	0.081
Electric Clothes Dryers	0.66	0.67	0.70	0.091
Gas Clothes Dryers	0.83	0.84	0.86	0.096
Room Air Conditioners	0.81	0.81	0.82	0.028

The initial MEA_NTGRs were first estimated using the best available information in combination with expert judgment. These values are reported in Cell 132 in each of the following embedded Excel workbooks: Air_Cleaners_A 2016.xlsm, Sound_Bars_A 2016.xlsm, Freezers_A 2016.xlsm, E_Dryers_A 2016.xlsm, G_Dryers_A 2016.xlsm, and Room_Air_Conditioners_A 2016.xlsm (see Appendix 1 – Supplemental Files). Estimates of the MEA_NTGRs were also made for the short-term (1-2 years) and mid-term (3-6 years) in order to illustrate how the MEA_NTGRs start small but are expected to increase over time. These initial short-, mid-, and long-term MEA_NTGRs are presented below in Table 56.

Table 56. Initial MEA_NTGRs, Program Period, by Product

Product	Short-Term MEA_NTGR	Mid-Term MEA_NTGR	Long-Term MEA_NTGR
Room Air Cleaners	0.11	0.51	0.95
Soundbars	0.15	0.49	0.83
Freezers	0.10	0.32	0.51
Electric Clothes Dryers	0.09	0.41	0.72
Gas Clothes Dryers	0.23	0.52	0.87
Room Air Conditioners	0.24	0.42	0.81

The focus in the remainder of this appendix is on the long-term MEA_NTGRs.

Figure 11 through Figure 16 provide the distribution of each product-specific MEA_NTGR based on 200 simulations for each product.

Figure 11. Distribution of Air Cleaner MEA_NTGRs

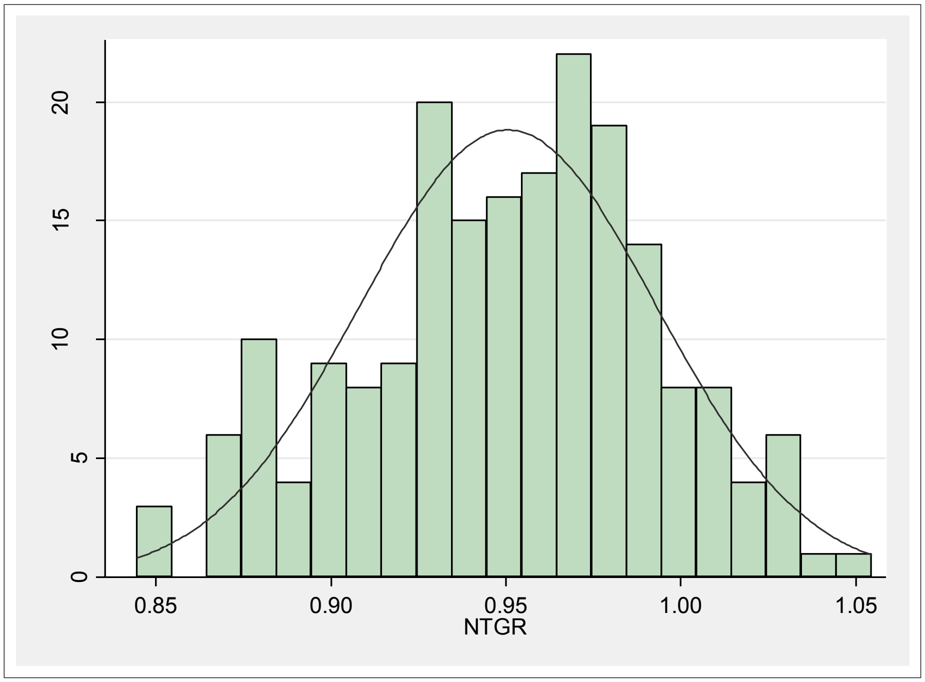


Figure 12. Distribution of Freezer MEA_NTGRs

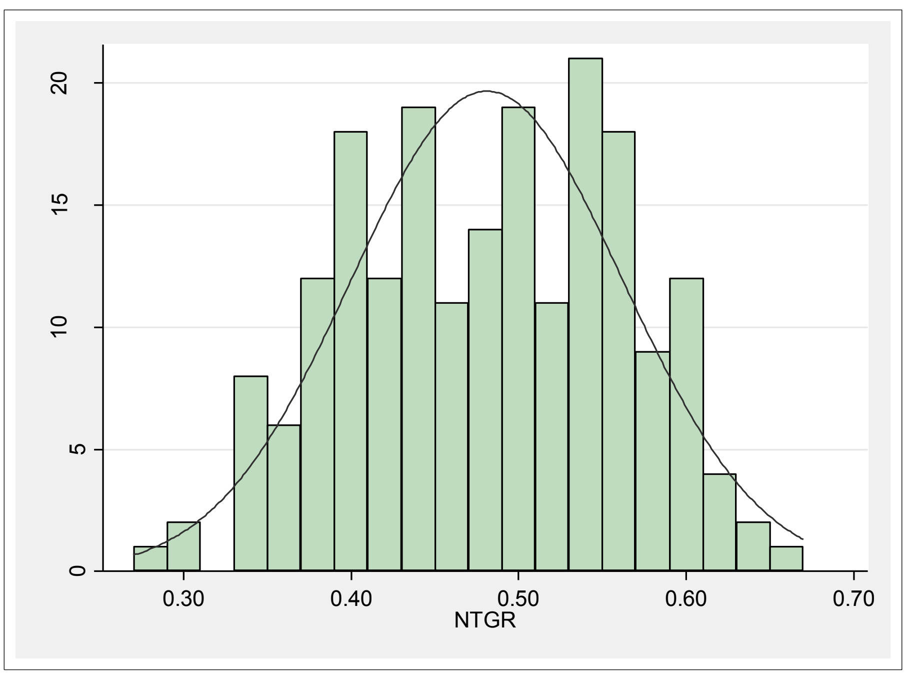


Figure 13. Distribution of Soundbar MEA_NTGRs

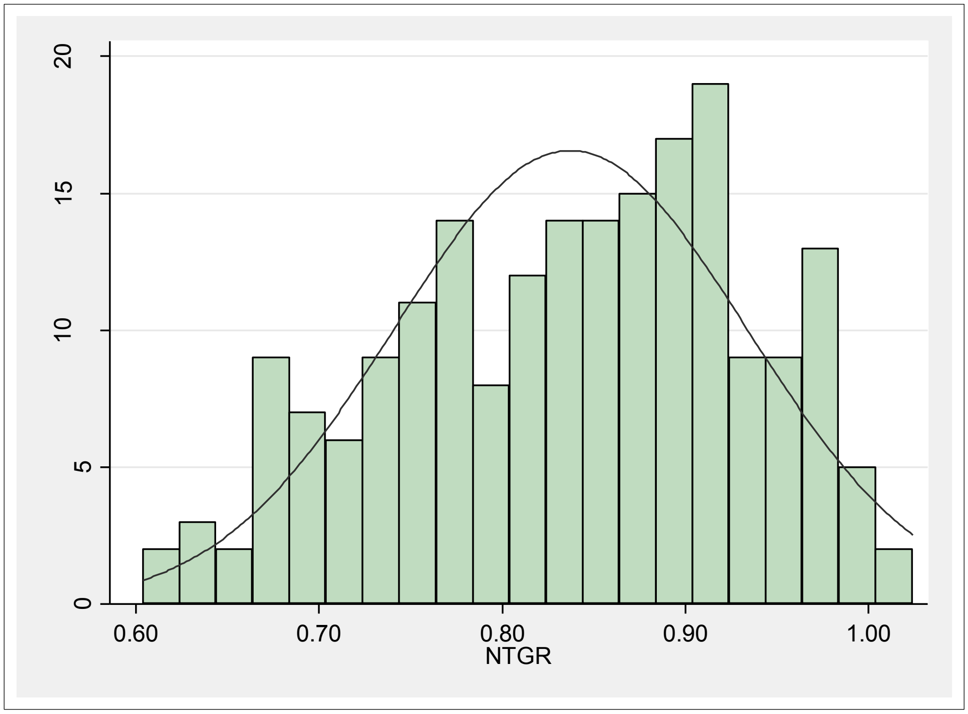


Figure 14. Distribution of Electric Clothes Dryer MEA_NTGRs

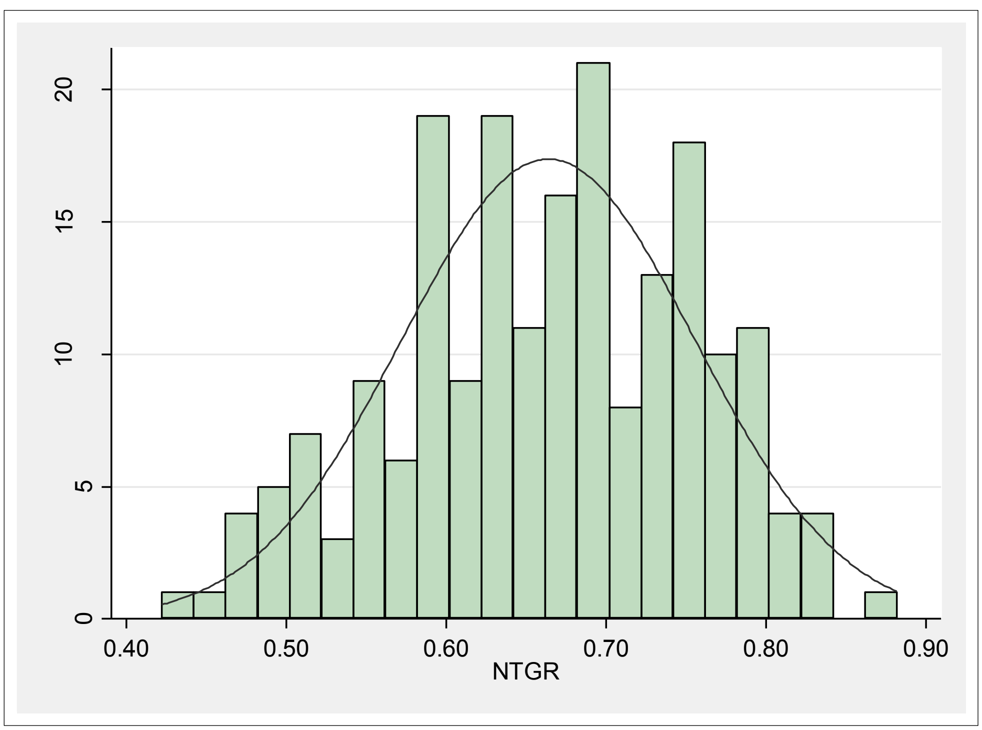


Figure 15. Distribution of Room Air Conditioner MEA_NTGRs

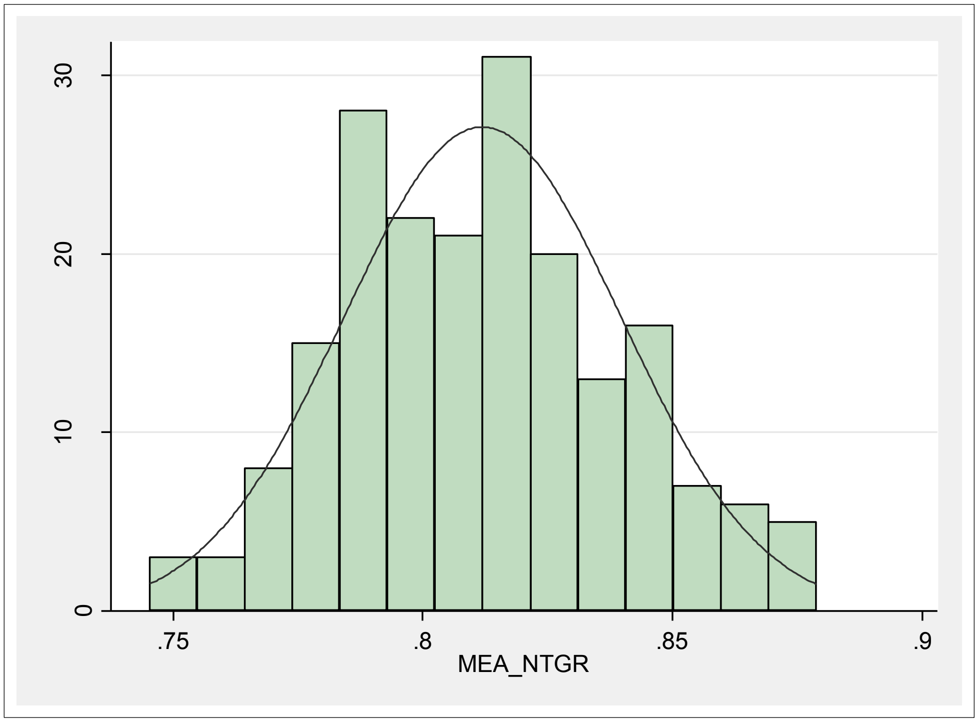
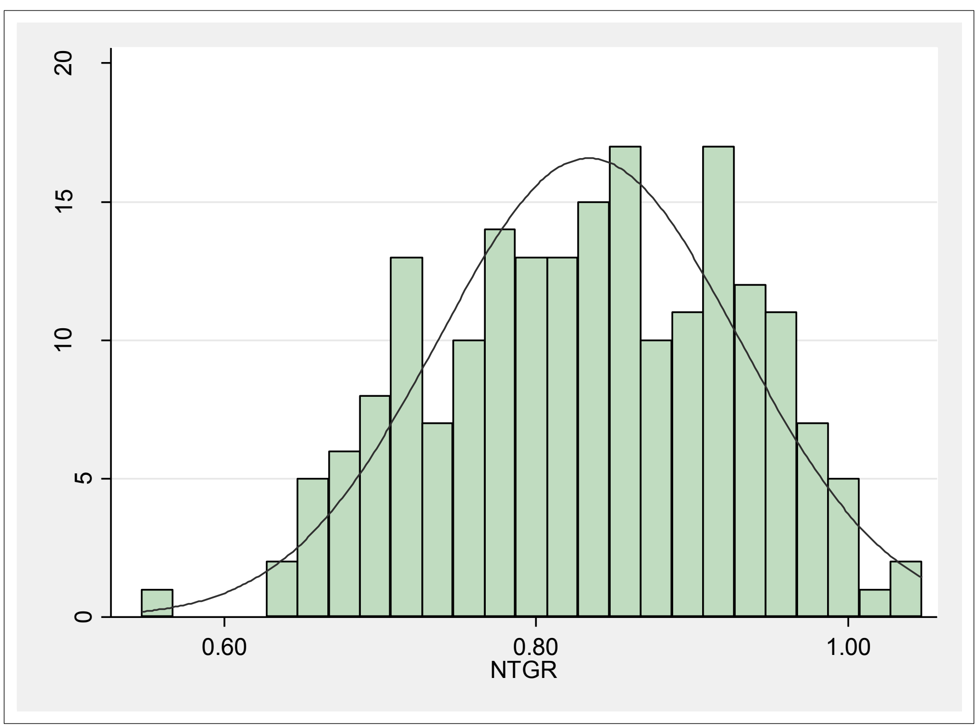


Figure 16. Distribution of Gas Clothes Dryer MEA_NTGRs



The initial MEA_NTGR estimate for each product occupies the middle of each of these distributions. For air cleaners and room air conditioners, the mean, median and mode are fairly close. For the remaining products, while the mean and the median are fairly close, the mode is somewhat larger.

4.2. Proposed Ex Ante NTGRs

Our proposed MEA_NTGRs, based on the initial analysis combined with the results of the sensitivity analysis, are presented below:

- For air cleaners, the mean of the MEA_NTGR distribution is identical to the initial MEA_NTGR of 0.95.
- For soundbars, the mean of the MEA_NTGR distribution at 0.84 is slightly larger than the initial MEA_NTGR estimate of 0.83. The more conservative value of 0.83 is proposed.
- For freezers, the mean of the MEA_NTGR distribution at 0.48 is less the initial MEA_NTGR estimate of 0.51. The more conservative value of 0.48 is proposed.
- For electric clothes dryers, the mean of the MEA_NTGR distribution at 0.66 is less than the initial MEA_NTGR estimate of 0.72. The more conservative value of 0.66 is proposed.
- For gas clothes dryers, the mean of the MEA_NTGR distribution at 0.83 is somewhat lower than the initial MEA_NTGR estimate of 0.87. The more conservative value of 0.83 is proposed.
- For room air conditioners, the mean of the MEA_NTGR distribution is identical to the initial MEA_NTGR of 0.81.

The initial and proposed MEA_NTGRs for each product are presented in Table 57.

Table 57. Proposed MEA_NTGRs, by Product

Product	Initial MEA_NTGR	MEA_NTGR Mean of Sensitivity Analysis	Final Proposed MEA_NTGR
Room Air Cleaners	0.95	0.95	0.95
Soundbars	0.83	0.84	0.83
Freezers	0.51	0.48	0.48
Electric Clothes Dryers	0.72	0.66	0.66
Gas Clothes Dryers	0.87	0.83	0.83
Room Air Conditioners	0.81	0.81	0.81

4.3. Inputs to E3 Calculator

These MEA_NTGRs were entered into the E3 Calculator to derive the RPP Program TRC and PAC. Note that the E3 Calculator requires that the *NTGR* and the *ME_Rate* be entered separately. These are summed within the model to produce the *MEA_NTGR*. Table 58 resents these values.

Table 58. NTGRs, ME_Rates, and MEA_NTGRs, by Product

Product	NTGR	ME_Rate	MEA_NTGR
Room Air Cleaners	0.39	0.56	0.95
Soundbars	0.48	0.35	0.83
Freezers	0.36	0.12	0.48
Electric Clothes Dryers	0.52	0.14	0.66
Gas Clothes Dryers	0.63	0.20	0.83
Room Air Conditioners	0.48	0.33	0.81

This insures that both the costs and the benefits are treated in a manner that is consistent with revisions to the Standard Practice Manual.

For the 2016 and 2017 program year, CPUC staff directs the use of approved NTG values in the table below:

CPUC Staff Approved NTG Values						
	Room Air Cleaners	Soundbars	Freezers	Electric Clothes Dryers	Gas Clothes Dryers	Room air Conditioners
NTG Value	0.20	0.20	0.20	0.20	0.30	0.36
NTG ID	Res-sAll-RmAirCleaner-mid	Res-sAll-Soundbar-mid	Res-sAll-Frzr-mid	Res-sAll-EffCD-Elec-mid	Res-sAll-EffCD-Gas-mid	Res-sAll-mHVAC-RmAC-mid

For refrigerators and clothes washers, we propose the following NTG values for the 2017 program year. These values will be revised when sufficient program evaluation data is available to inform a market transform based NTG value.

	NTG ID	NTG value
Refrigerators	Res-sAll-Frzr-mid	0.2
Clothes Washers	Res-sAll-mCW	0.31

5. Updating Parameters

Because there is uncertainty regarding the gross sales of program-qualified models, the MEA_NTGR and the TRC of any MT program prior to its launch, the key model parameters will be updated annually using the most recent results of the theory-driven evaluation along with recorded sales, recorded customer buy-downs and retained retailer incentives, recorded administrative costs, the most recent estimates of incremental measure cost, and the results of the on-going literature review[49]. Using these data, revised forecasts of sales with and without the program will be made resulting in revised estimates of the

[49] "Forecasts aren't like lottery tickets that you buy and file away until the big draw. They are judgments that are based on available information and that should be updated in light of changing information." Tetlock, Philip E.; Gardner, Dan (2015-09-29). *Superforecasting: The Art and Science of Prediction* (Kindle Locations 2467-2469). Crown/Archetype. Kindle Edition.

MEA_NTGR and the TRC. Only by regularly updating these key parameters can program administrators, regulators, and other stakeholders begin to effectively manage their risk.

Table 59 presents each of the key parameters in the Generalized Bass Diffusion Model and the source(s) of information that will be used to update it annually for each product.

Table 59. Source of Information for Updating Key Parameters in the Generalized Bass Diffusion Model

Parameter	**Description**	**Source of Information for Updating**
N_t=	Market share at time *t*	Recorded market share based on actual sales of program-qualified and non-program-qualified models from RPP sales database; NPD and AHAM data
p=	Coefficient of innovation (*i.e.,* external influence)	Reviews of relevant literature
q=	Coefficient of imitation (*i.e.,* internal influence)	Reviews of relevant literature
M=	Total potential ratio of sales of energy-efficient products to total sales	Most current saturation studies, estimates of retailer market share, and household forecast
P_0=	Ratio of price for energy-efficient product to price for standard product at time 0	Most current incremental data available from Web Harvester
e=	Coefficient of sensitivity (elasticity) for price term	Reviews of relevant literature
r=	Assumed annual change in P	Calculations based on most current Web Harvester data
A_0=	Ratio of advertising expenditure with the program to without the program at time 0	Results of theory-driven evaluation (e.g., interviews with merchandisers for each participating retailer)
f=	Coefficient of sensitivity (elasticity) for advertising	Reviews of relevant literature
v=	Assumed annual change in A	Results of theory-driven evaluation (e.g., interviews with merchandisers for each participating retailer and reviews of sales data)
B_0=	Ratio of energy-efficient assortment with the program to without the program at time 0	Results of theory-driven evaluation (e.g., shelf surveys and interviews with merchandisers for each participating retailer and reviews of sales data)
g=	Coefficient of sensitivity (elasticity) for assortment	Reviews of relevant literature

References

Appendix D2 to Subpart B of Part 430 – Uniform Test Method for Measuring the Energy Consumption of Clothes Dryers. (2015, Febrary 2). (U. G. Office, Producer) Retrieved February 4, 2015, from ECFR — Electronic Code of Federal Regulations: http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=ab47f0d87e4d2e34334fc7be6b62f468&n=pt10.3.430&r=PART&ty=HTML#ap10.3.430_127.d2

Arup, Davis Energy Group, Sun Light & Power, New Buildings Institute, Engineering 350, and Sustainable Design + Behavior. (2012, December 31). *The Technical Feasibility of Zero Net Energy Buildings in California.* Retrieved February 6, 2015, from Energy Data Web: http://www.energydataweb.com/cpucFiles/pdaDocs/904/California_ZNE_Technical_Feasibility_Report_Final.pdf

Bass, F. M., Trichy, K. V., & Dipak, J. C. (1994). Why the Bass Model Fits without Decision Variables. *Marketing Science , 13* (August), 203-223.

Bensch, I., Pigg, S., Koski, K., & Belshe, R. (2010). *Electricity Savings Opportunities for Home Electronics and Other Plug-In Devices in Minnesota Homes.* Retrieved from Energy Center of Wisconsin: http://www.ecw.org/resource_detail.php?resultid=430

Boehner, R., & Gold, S. (2012). *Modeling the Impact of Marketing Mix on the Diffusion of Innovation in the Generalized Bass Model of Firm Demand.* Retrieved January 30, 2015, from Developments in Business Simulation and Experiential Learning: https://absel-ojs-ttu.tdl.org/absel/index.php/absel/article/viewFile/71/69

Boehner, R., & Gold, S. (2012). Modeling the Impact of Marketing Mix on the Diffusion of Innovation in the Generalized Bass Model of Firm Demand. *Development in Business Simulation and Experiential Learning , 39*, 75.

California Energy Commission. *California Energy Demand 2010-2020 Staff Revised Forecast Form 2.2: Planning Area and Economic and Demographic Assumptions: PG&E Planning Area.*
California Public Utilities Commission. (2011, January). *California Energy Efficiency Strategic Plan, January 2011 Update.* Retrieved February 5, 2015, from http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf

California Public Utilities Commission. (2014, February). DEER2014 Lighting Measures HVAC Interactive Effects and Adjustment Factor Tables.

California Public Utilities Commission, Energy Division. (2013). *Workpaper Disposition for Energy Efficient Televisions.*

Davis Energy Group and Energy Solutions. (2004). *Draft Analysis of Standards Options For Portable Room Air Cleaners.* Retrieved May 5, 2015, from California Energy Commission: http://www.energy.ca.gov/appliances/2003rulemaking/documents/case_studies/CASE_Port_Room_Air_Cleaner.pdf

Desroches, L.-B., Garbesi, K., Kantner, C., Van Buskirk, R., Yang, H.-C., & Ganeshalingam, M. (2013, May 9). *Trends in the Cost of Efficiency for Appliances and Consumer Electronics.*

Retrieved February 6, 2015, from EScholarship University of California: http://www.escholarship.org/uc/item/6cv286q0

Dimetrosky, S., Lieb, N., Rowberry, J., Peters, J. S., & Scholl, R. (2014, April). *New York Products Program Market Characterization, Assessment, Process, and Market-Based Impact Evaluation Final Report.* Retrieved January 27, 2015, from NEEP: http://www.neep.org/sites/default/files/resources/2014%20New%20York%20Products%20Program%20Evaluation.PDF

Donnelly, C., & Dayem, K. (2014). *Innovations in Cost and Efficiency Analyses for Consumer Electronics: A Technical Analysis of Display Components and Features.* 2014 ACEEE Summer Study on Energy Efficiency in Buildings.

Ecos. (2008). *Market Analysis for Standby Power.* Natural Resources Canada.

Ecotope Inc. (2014). *NEEA Dryer Field Study.*

Eisend, M. (2014). Shelf space elasticity: A meta-analysis. *Journal of Retailing , 90* (2), 175.
EMI Consulting. (2015).

Pacific Gas and Electric Company 2015 Retail Products Platform Program: Draft Evaluation Plan. Pacific Gas and Electric Company.

Frank, M. P. (2014, July 15). *Residential Solutions Workbook Phase I: Market View*. (Southern California Edison, Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Gas Company) Retrieved February 6, 2015, from http://www.calmac.org/publications/SCE_RSW_Phase_I_Documentation_Report_07-23-2014_final.pdf

Gwartney, J. A., Stroup, R. L., Sobel, R. S., & Macpherson, D. A. (2015). *Microeconomics: Private and Public Choice.* Stamford, CT: CENGAGE Learning.

Horowitz, P. (2011). *Glossary of Terms*. Retrieved from Northeast Energy Efficiency Partnerships: http://www.neep.org/emv-forum-glossary-terms-and-acronyms

Itron, Inc. (2014, May 27). *2010-2012 WO017 Ex Ante Measure Cost Study Final Report.* Retrieved February 6, 2015, from CALMAC: http://www.calmac.org/publications/2010-2012_WO017_Ex_Ante_Measure_Cost_Study_-_Final_Report.pdf

KEMA. (2010). *2009 California Residential Appliance Saturation Study, Volume 2: Results.* California Energy Commission.

Kema, Inc. (2013, April 15). *Impact Evaluation Report: Business and Consumer Electronics Program (WO34).* Retrieved January 27, 2015, from CALMAC: http://www.calmac.org/publications/WO34_BCE_Impact_Evaluation_Report_-_Phase_1_FINAL_2013-04-15.pdf

Kisch, T., Rubin, E., Richter, C., & Peter, B. (2015). *Memorandum for Analysis of Incremental Measure Costs for the Retail Products Platform.* Pacific Gas and Electric Company.

Morris, W. (2004). *Report to California Energy Commission: Analysis of Energy Efficiency of Room Air Cleaners.* Retrieved May 5, 2015, from California Energy Commission: http://www.energy.ca.gov/appliances/2003rulemaking/documents/public_comments/2004-8-13_AHAM.PDF

Navigant Consulting and LBNL. (2011). *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Clothes Dryers and Room Air Conditioners.*

Navitas Partners. (2013). *PG&E Retail Plug-Load Portfolio (RPP) Trial Plan.* Pacific Gas and Electric.

Prahl, R., & Keating, K. (2014). *Building a Policy Framework to Support Energy Efficiency Market Transformation in California.* California Public Utilities Commission, Energy Division.

Research Into Action, Inc., & DeHoratius, N. (2014, July 9). *Consumer Electronics Television Initiative Market Progress Evaluation Report #3.* Retrieved January 27, 2015, from NEEA: http://neea.org/docs/default-source/reports/consumer-electronics-television-initiative-market-progress-evaluation-report-3.pdf?sfvrsn=7

Residential Clothes Dryers. (n.d.). (U.S. Department of Energy, Energy Efficiency & Renewable Energy, Building Technologies Office) Retrieved January 21, 2015, from Appliances and Commercial Equipment Standards: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/36

Residential Clothes Washers. (n.d.). (U.S. Department of Energy, Energy Efficiency & Renewable Energy, Building Technologies Office) Retrieved December 18, 2015, from Appliances and Commercial Equipment Standards: http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0019-0047

Residential Refrigerators and Freezers. (n.d.). (U.S Department of Energy, Energy Efficiency & Renewable Energy, Building Technologies Office) Retrieved January 2015, 21, from Appliances and Commercial Equipment Standards: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43

Ridge, R., & Chen, C. (2012). *Spillover Estimates for Selected 2013-2014 Energy Efficiency Programs.* Pacific Gas & Electric Company, Southern California Edison Company, Southern California Gas Company, and San Diego Gas and Electric Company.

Roth , K. W., & McKenney, K. (2007, December). *Energy Consumption by Consumer Electronics in U.S. Residences.* Retrieved January 21, 2015, from Consumer Electronics Association: http://www.ce.org/CorporateSite/media/Government-Media/Green/Energy-Consumption-by-Consumer-Electronics-in-U-S-Residences.pdf

Sebold, F. D., Alan, F., Skumatz, L., Feldman, S., Goldberg, M., Keating, K., et al. (2001). *A Framework for Planning and Assessing Publicly Funded Energy Efficiency: Study ID PG&E-SW040.* Pacific Gas and Electric Company.

Singh, H., Rider, K., & Babula, J. (2015). *2015 Title 20 Appliance Efficiency Regulations.* California Energy Commission.

Soundbar. (n.d.). (Wikimedia Foundation) Retrieved January 26, 2015, from Wikipedia: http://en.wikipedia.org/wiki/Soundbar

Southern California Edison. (2014). *Work Paper SCE13HC001, Revision 1: ENERGY STAR Room Air Conditioners.*
The Cadmus Group, Inc.; Itron, Inc.; Jai J. Mitchell Analytics; KEMA; PA Consulting Group; Summit Blue Consulting, LLC. (2010). *Residential Retrofit High Impact Measure Evaluation Report.* California Public Utilities Commission, Energy Division.

The U.S. Appliance Industry: Market Value, Life Expectancy & Replacement Picture 2013. (2013, December). *Appliance Magazine*.

Title 10: Energy, Part 430 - Energy Conservation Program for Consumer Products. (2015, February 2). (U.S. Government Publishing Office) Retrieved February 4, 2015, from ECFR — Electronic Code of Federal Regulations: http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=ab47f0d87e4d2e34334fc7be6b62f468&n=pt10.3.430&r=PART&ty=HTML#ap10.3.430_127.d1

U.S. Department of Energy. (2012, March). Energy Conservation Standards Rulemaking - Battery Chargers and External Power Supplies, Market Assessment and Product Price Determination Workbook.

U.S. Department of Energy. (2014). *Technical Support Document: Energy Efficiency Program For Consumer Products And Commercial And Industrial Equipment: Commercial Clothes Washers.*

U.S. Department of Energy, Energy Efficiency & Renewable Energy. (2013, January 2). *2013-01-02 Energy Conservation Program: Test Procedures for Residential Clothes Dryers; Notice of Proposed Rulemaking*. Retrieved January 21, 2015, from Regulations.gov: http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-TP-0054-0006

U.S. Department of Energy, Energy Efficiency & Renewable Energy. (2015, February 1). *Compliance Certification Database*. Retrieved February 11, 2015, from Compliance Certification Management System: http://www.regulations.doe.gov/certification-data/

U.S. Environmental Protection Agency. (n.d.). *Air Purifiers (Cleaners)*. Retrieved January 21, 2015, from Energy Star: http://www.energystar.gov/products/certified-products/detail/air-purifiers-cleaners

U.S. Environmental Protection Agency. (n.d.). *ENERGY STAR Program Requirements Product Specification for Room Air Conditioners Eligibility Criteria Version 4.0.* Retrieved from ENERGY STAR: https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air%20Conditioners%20Program%20Requirements.pdf

U.S. Environmental Protection Agency. (2013). *National Awareness of ENERGY STAR® for 2012: Analysis of 2012 CEE Household Survey.* Retrieved from CEE: http://library.cee1.org/sites/default/files/library/10550/National_Awareness_of_ENERGY_STAR_2012.pdf

U.S. Environmental Protection Agency. (2014, May). Savings Calculator for ENERGY STAR-Qualified Appliances.

U.S. Environmental Protection Agency. (2013, September). Savings Calculator for ENERGY STAR-Qualified Consumer Electronics.

Urban, B., Shmakova, V., Lim, B., & Roth, K. (2014, June). *Energy Consumption of Consumer Electronics in U.S. Homes in 2013.* Retrieved January 21, 2015, from Consumer Electronics Association: http://www.ce.org/CorporateSite/media/environment/Energy-Consumption-of-Consumer-Electronics.pdf

Young, D., McGaraghan, M., Dewart, N., Hopper, D., Borocz, P., Kaser, F., et al. (2014). *Leveraging Big Data to Develop Next Generation Demand Side Management Programs and Energy Regulations.* Retrieved February 6, 2015, from Energy Solutions: http://energy-solution.com/wp-content/uploads/2015/01/Leveraging-Big-Data-to-Develop-Next-Generation-Demand-Side-Management-Programs-and-Energy-Regulations_EnergySolutions_ACEEE-2014.pdf

Zhengrui, J., Bass, F. M., & Isaacson Bass, P. (2006). Virtual Bass Model and the Left-hand Data-truncation Bias in Diffusion of Innovation Studies. *International Journal of Research in Marketing , 23* (1), 93-106.