Work Paper PGECOAPP127

**Revision 4**

**Program Administrator**

**Clothes Washers**

# At-a-Glance Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure Codes** | PG&E: AP002  SCE: AP-58952  SCG:  ApgClw003,  ApgClw004,  ApgClw009,  ApgClw010  SDG&E: N/A | PG&E: AP003  SCE: AP-70168  SCG:  ApgClw005,  ApgClw006,  ApgClw013,  ApgClw014  SDG&E: N/A | PG&E: CWME,  CWMEF  SCE:  AP-12634  SCG:  ApgClw007, ApgClw008  SDG&E: N/A | PG&E:  AP004, CWWA  SCE: AP-73704  SCG: ApgClw011,  ApgClw012  SDG&E: N/A | PG&E: AP001  SCE:  AP-61333,  AP-75192 |
| **Measure Description** | Energy Star Residential Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 | Energy Star Residential Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 | Energy Star Most Efficient Clothes Washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 | CEE Tier 3 Clothes Washer with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 3.2 | Energy Star Commercial Clothes Washer with a minimum Modified Energy Factor\_J2 of 2.2 and maximum Water Factor of 4.1 |
| **Base Case Description** | Title 20 compliant top-loading standard clothes washer with IMEF of 1.57 and IWF of 6.5 | Title 20 compliant front-loading standard clothes washer with IMEF of 1.84 and IWF of 4.7 | Title 20 compliant top-loading and front-loading standard clothes washer weighted by market share | Title 20 compliant top-loading and front-loading standard clothes washer weighted by market share | Title 20 compliant top-loading and front-loading standard clothes washer weighted by market share |
| **Units** | each | Each | each | each | each |
| **Energy Savings** | Varies | Varies | Varies | Varies | Varies |
| **Full Measure Cost ($/unit)** | N/A | N/A | N/A | N/A | N/A |
| **Incremental Measure Cost ($/unit)** | $19.10 | $23.17 | $31.86 | $34.76 | $573.96 |
| **Effective Useful Life** | Source: DEER 2011  11 years | Source: DEER 2011  11 years | Source: DEER 2011  11 years | Source: DEER 2011  11 years | Source: DEER 2011  11 years  5 years (leased) |
| **Measure Installation Type** | ROB | ROB | ROB | ROB | ROB |
| **Net-to-Gross Ratio** | Source: DEER 2011  NTG: 0.31  Res-sAll-mCW  NTG: 0.60  Com-Default>2yrs | Source: DEER 2011  NTG: 0.31  Res-sAll-mCW  NTG: 0.60  Com-Default>2yrs | Source: DEER 2011  NTG: 0.55  Res-Default>2  NTG: 0.60  Com-Default>2yrs | Source: DEER 2011  NTG: 0.55  Res-Default>2  NTG: 0.60  Com-Default>2yrs | Source: DEER 2011  NTG: 0.60  Com-Default>2yrs |
| **Important Comments** |  |  |  |  |  |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| Superseded |  | PGECOAPP114 R3 Clothes Washers Res.doc, PGECOAPP115 R3 Clothes Washers Comm.doc, PGECOAPP120 R3 Clothes Washers MF.doc | These separate workpapers were all superseded by the new Revision 0. |
| Revision 0 | 02/10/2014 | PGECOAPP127 R0 Clothes Washers.docx | Jia Huang (PG&E) |
| Revision 1 | 05/19/2015 | PGECOAPP127 R1 Clothes Washers.docx  Updated calculations for March 2015 federal code change for residential clothes washers. Changed NTG. Statewide workpaper: includes measures Energy Star, Energy Star Most Efficient, and CEE Tier 3 measures for PG&E, SCE, SCG, and SDG&E. Added PG&E and SCE measures for Energy Star commercial clothes washers.  Superceeded SCG workpapers:  WPSCGREAP111222A Chan Paek (SCG)  WPSCGREAP140211A Justin Westmoreland (AESC) | Jia Huang (PG&E) |
| Revision 2 | 12/23/2015 | PGECOAPP127 R2 Clothes Washers.docx  Revised energy savings impacts and costs per DEER 2016 update. | Jia Huang (PG&E) |
| Revision 3 |  | Sunset measure codes CWME and CWMEF | Jia Huang (PG&E) |
| Revision 3 v2 |  | DEER 2017 updates retroactively effective 1/1/2017 | Jia Huang (PG&E) |
| Revision 4 |  | DEER 2018 code update for residential top-loading clothes washers. Federal code update to commercial clothes washers. | Jia Huang (PG&E) |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
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Cal TF website: <http://www.caltf.org/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Efficient clothes washer that meets minimum criteria for Energy Star, Energy Star Most Efficient, or CEE Tier 3. |
| Existing Condition | N/A |
| Code/Standard | Title 20 compliant top-loading or front-loading clothes washer |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| PG&E | SCE | SCG | SDG&E |
| AP002 | AP-58952 | ApgClw003 (gas DHW), ApgClw004 (electric DHW),  ApgClw009 (gas DHW, commercial setting),  ApgClw010 (electric DHW, commercial setting) | N/A | Energy Star Residential Top-Loading Clothes Washer |
| AP003 | AP-70168 | ApgClw005 (gas DHW), ApgClw006 (electric DHW)  ApgClw013 (gas DHW, commercial setting),  ApgClw014 (electric DHW, commercial setting) | 463338 | Energy Star Residential Front-Loading Clothes Washer |
| ~~CWME,~~  ~~CWMEF (MFM common area)~~ | AP-12634 | ApgClw007 (gas DHW), ApgClw008 (electric DHW) | 463339 | Energy Star Most Efficient Clothes Washer, >2.5 cubic ft |
| AP004,  CWWA (water agencies) | AP-73704 | ApgClw011 (gas DHW),  ApgClw012 electric DHW) | 463340 | CEE Tier 3 Clothes Washer |
| AP001 | AP-61333 | N/A | N/A | Energy Star Commercial Clothes Washer |
| N/A | AP-75192 | N/A | N/A | Energy Star Commercial Leased Clothes Washer |

***SCE Measure Requirements –***

SCE offers downstream incentives for Energy Star, Energy Star Most Efficient, and CEE Tier 3 residential sized clothes washers installed in single-family, multifamily, domestic mobile home, and commercial building types. SCE also offers downstream incentives for Energy Star commercial sized clothes washers in commercial building types.

**Energy Star Eligibility Requirements**

* The clothes container volume must be ≥ 1.6 and ≤ 6.0 cubic ft.
* Configurations other than a front-loading or top-loading design do not qualify.
* Combination washer-dryers and residential clothes washers with an optional dry cycle do not qualify.
* Note that this work paper only offers the ESME measure for residential models greater than 2.5 cubic ft.

**SCE measure AP-75192 : Energy Star Commercial Lease Clothes Washer**

The SCE Multifamily Energy Efficiency Rebate (MFEER) Program offers rebates on a wide variety of energy-saving products and services to motivate the multifamily property owners/managers to install energy efficient products in both common and dwelling areas of multifamily complexes. The MFEER addresses the ongoing concern with “split incentives”, where the residents are not the owners of the property, so they lack incentive to improve their energy usage. Similarly, the property owners do not live on-site and pay higher utility expenses due to inefficient appliances, thus lack any incentive to upgrade. The MFEER is designed to drive this customer segment toward participation by offering property owners a variety of energy efficiency measures and services.

It is estimated that approximately 70% of all laundry equipment in multifamily properties are owned and operated by third party multi-housing laundry operators. Multi-housing laundry operators install and maintain common area laundry rooms, deliver laundry solutions to multifamily properties which include apartment complexes, condominiums, co-ops, military and public housing properties. The market penetration of high-efficiency vended clothes washers into the multifamily market segment has been challenging. As such, there is largely untapped opportunity for energy savings through adoption of high-efficiency clothes washers by this market segment.

Lease agreements, which are typically 5 to 7 years, are constructed around a revenue share based on laundry equipment profits with the multifamily property owner paying all the utilities and leasing out the laundry facility space. Thus, creating a market inefficiency in the form of a “split-incentive” between the route operator (who purchases and owns the equipment) and the property owner (who pays the utility bills). This activity has created a barrier for motivating the manufacture and sale of higher efficiency commercial coin-operated clothes washers. This arrangement which is predominant in this market segment does not drive laundry operators to improve the energy usage of the equipment they own and operate since they do not pay the energy costs.

***SCG Measure Requirements –***

SCG offers Energy Star, Energy Star Most Efficient, and CEE Tier 3 residential sized clothes washers in single-family and commercial building types

**Measure Description**

1. ApgClw003 applies to Energy Star Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 using a natural gas water heater in their single family home.
2. ApgClw004 applies to Energy Star Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 using an electric water heater in their single family home.
3. ApgClw005 applies to Energy Star Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 using a natural gas water heater in their single family home.
4. ApgClw006 applies to Energy Star Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 using an electric water heater in their single family home.
5. ApgClw007 applies to Energy Star Most Efficient Clothes washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 using a natural gas water heater in their single family home.
6. ApgClw008 applies to Energy Star Most Efficient Clothes washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 using an electric water heater in their single family home.
7. ApgClw009 applies to Energy Star Top-Loading Clothes Washers of residential size being used in a commercial setting with a natural gas water heater. These settings could include but are not limited to restaurants, nail salons, spas, ect.
8. ApgClw010 applies to Energy Star Top-Loading Clothes Washers of residential size being used in a commercial setting with an electric water heater. These settings could include but are not limited to restaurants, nail salons, spas, ect.
9. ApgClw011 applies to CEE Tier 3 washers with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 4.5 using a natural gas water heater in their single family home
10. ApgClw012 applies to CEE Tier 3 washers with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 4.5 using an electric  water heater in their single family home
11. ApgClw013 applies to Energy Star Front-Loading Clothes Washers of residential size being used in a commercial setting with a natural gas water heater. These settings could include but are not limited to restaurants, nail salons, spas, ect.
12. ApgClw014 applies to Energy Star Front-Loading Clothes Washers of residential size being used in a commercial setting with an electric water heater. These settings could include but are not limited to restaurants, nail salons, spas, ect.

**Implementation Requirements**

1. The rebate applies to gas-for-gas equipment replacements on burnout or to new installations in existing buildings.

2. The rebate does not apply to new construction (NC).

3. Applicable to single family residential and some commercial applications

**Documentation Requirements**

1. Proof of purchase must be provided and can include all or any one of the following: the manufacturer’s name and equipment make and model number, retailer information, equipment cost, and invoice/receipt with payment in full.

2. Must provide IMEF and IWF identification as well as the cubic feet of the model.

3. The date purchased and the date installed.

**Terms and Conditions**

1. Single family residential clothes washer cannot be used in commercial applications.

2. No more than one unit can be rebated per household.

3. General terms and conditions for SCG measures can be found at [http://www.socalgas.com/for-your-home/rebates/terms-conditions.shtml](https://urldefense.proofpoint.com/v2/url?u=http-3A__www.socalgas.com_for-2Dyour-2Dhome_rebates_terms-2Dconditions.shtml&d=AwMFAg&c=hLS_V_MyRCwXDjNCFvC1XhVzdhW2dOtrP9xQj43rEYI&r=zzJFJ8zpcKvH-UuuNn1ZrQ&m=CCwDhAI5fJPWOvPne6r_LhdrPMc_fZF5Imlgs9twbTs&s=4YwhwAy4P_4FC6sySJhVdjePtxjFYIpgasUMvxfmd0c&e=)

***SDG&E Measure Requirements –***

SDG&E offers CEE Tier 1 (using savings estimated for Energy Star front-loading), Energy Star Most Efficient, CEE Tier 1, and CEE Tier 3 residential sized clothes washers in residential and commercial building types.

## 1.2 Technical Description

Over 80% of households in the U.S. have clothes washers[[1]](#endnote-1). A significant amount of the energy used for clothes washing is used for heating the water, so machines that use less water are usually more energy-efficient. Horizontal-axis clothes washers tumble clothes through a much smaller pool of water than conventional models, saving up to 50 percent of energy consumed in the washing process. High-efficiency machines also have more efficient motors, spinning clothes two to three times faster than the conventional machines. This removes more water from the clothes which reduces the amount of time and energy required to dry them.

## 1.3 Installation Types and Delivery Mechanisms

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |
| New Construction (NEW/NC) | Above Code or Standard | N/A | EUL | N/A |
| Retrofit or Early Replacement (RET/ER) | Above Customer Existing | Above Code or Standard | RUL | EUL-RUL |
| Retrofit First Baseline Only (REF) | Above Customer Existing | N/A | EUL | N/A |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | EUL | N/A |

These measures are identified as ROB, or replace on burnout.

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Appliance Turn-in and Recycling | The program motivates customers, through financial incentives, to recycle appliances that are functional but inefficient. This prevents the continued use of those appliances, by both the current owner and potential future owners. |
| Audit/Information/Testing Services | The program performs a free assessment of a customer’s facility and provides the customer with information and guidance on energy efficiency opportunities. |
| Commissioning and Retrocommissioning | The program modifies or repairs existing equipment to ensure that it works as intended. |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Innovative Design | The program funds new ideas that meet reasonable scientific scrutiny for potential energy savings. These innovative measures typically have small market penetration (less than 5%) or are targeted toward relatively unreached market segments. |
| New Construction | The program offers financial incentives and/or design assistance to customers involved with new building construction. This is intended is to motivate customer to exceed Title 24 building energy efficiency requirements (residential or nonresidential). |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |
| Performance Based | The program offers financial incentives that vary based on the energy efficiency performance of specific projects. |
| Up-Stream Programs | See Up-Stream Incentive and Up-Stream Buy Down in the Incentive Method table. |

The delivery method is financial support in the form of incentives given to the customer.

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Incentive | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, to encourage the manufacture, provision, or distribution of an efficient measure. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Buy Down | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, with specific requirements to pass down the incentive to the end use customer. Such an incentive buys-down the cost of an efficient measure for the end-use customer by at least the amount of the financial incentive. |
| Giveaway | The program provides customers with energy efficiency equipment or services for free. |
| Exchange/Replacement | The utility program holds events where customers can trade functional equipment for similar but more energy efficient equipment, free of charge. |
| On-bill Finance/Loan | The program offers financing for the cost an efficient measure as part of the utility bill. This can be an add-on option to an existing program or can serve as an organizing principle for its own program. |

All measures in this workpaper have down-stream incentive programs. ENERGY STAR commercial-sized clothes washers are also delivered through direct install.

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | Yes |
| Scaled DEER measure | Yes |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER 2016, READI v2.3.0 |
| Reason for Deviation from DEER | DEER does not contain measures for commercial-sized clothes washers. IOU calculation methodology was used to calculate savings for commercial-sized washers. DEER impacts only apply to washers in individual residences. Impacts for washers in multifamily common area and nonresidential locations are scaled from DEER impacts. |
| DEER Measure IDs Used | RB-Appl-EffCW-med-Tier1-Top  RB-Appl-EffCW-med-Tier2-Top  RB-Appl-EffCW-med-Tier1-Front  RB-Appl-EffCW-med-Tier2-Front  RB-Appl-EffCW-med-Tier3-Front |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** | **Applicable Measure** |
| Res-sAll-mCW | Clothes washer MEF 10% > Energy Star | Res | Any | Any | 0.31 | Residential Energy Star |
| Res-Default>2 | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Res | Any | Any | 0.55 | Energy Star Most Efficient, CEE Tier 3 |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.6 | Commercial Energy Star |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| Appl-EffCW | High Efficiency Clothes Washer | Res | AppPlug | 11 | 3.7 |
| ComLau-EffCW | High Efficiency Clothes Washer (CEE Tiers 1,2,3) | Com | AppPlug | 11 | 3.7 |
| Proposed: ComLau-EffCW-Leased | High Efficiency Commercial Lease Clothes Washer | Com | AppPlug | 5 | N/A |

### 1.4.2 Codes and Standards Analysis

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2017) | Section 1605.1, Table P-2: Standards for Residential Clothes Washers | March 7, 2015 |
| Title 20 (2017) | Section 1605.1, Table P-3: Standards for Commercial Clothes Washers | January 1, 2018 |
| DOE | Code of Federal Regulations, 10 CFR 430.32(g)(3) | March 7, 2015 |
| DOE | Code of Federal Regulations, 10 CFR 431.156 | January 1, 2018 |

***Title 20:*** These measures fall under Title 20 of the California Energy Regulations. Under this regulation, the following is required:

The California Appliance Efficiency Regulations (Title 20)[[2]](#endnote-2) require that all residential and commercial clothes washers manufactured on or after the dates indicated below must meet the minimum efficiency requirements for MEF/IMEF and WF/IWF.

|  |  |  |  |
| --- | --- | --- | --- |
| **Residential Clothes Washers** | **Clothes Container Compartment Capacity (ft3)** | **Minimum Integrated Modified Energy Factor**  **(Effective January 1, 2018)** | **Maximum Integrated Water Factor (Effective January 1, 2018)** |
| **Compact Top-Loading Clothes Washers** | ˂ 1.6 ft3 | 1.15 | 12 |
| **Standard Top-Loading Clothes Washers** | ≥ 1.6 ft3 | 1.57 | 6.5 |
| **Compact Front-Loading Clothes Washers** | ˂ 1.6 ft3 | 1.13 | 8.3 |
| **Standard Front-loading clothes washers** | ≥ 1.6 ft3 | 1.84 | 4.7 |
| **Commercial Clothes Washers** | **Clothes Container Compartment Capacity (ft3)** | **Minimum Modified Energy Factor tested under Appendix J2 (Effective January 1, 2018)** | **Maximum Integrated Water Factor (Effective January 1, 2018)** |
| **Top-Loading Clothes Washers** | Any | 1.35 | 8.8 |
| **Front-Loading Clothes Washers** | Any | 2.00 | 4.1 |

***Title 24:*** These measures do not fall under Title 24 of the California Energy Regulations.

***Federal Standards:*** These measures fall under Federal DOE Energy Regulations. Title 20 minimum standards for residential and commercial clothes washers follow DOE federal minimum efficiency requirements. Federal standards match the requirements cited in Title 20 in the table above.

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

### 1.5.1 2009 Residential Appliance Saturation Survey (RASS)[[3]](#endnote-3)

In 2009, the California Energy Commission funded and administered a Residential Appliance Saturation study that was implemented across the territories of the large investor-owned utilities. The study was implemented as a mail survey with an option for respondents to complete it online. The survey requested households to provide information on appliances, equipment, and general consumption patterns. Data collection was completed in early 2010.

**Energy Savings Assumption (ΔW, ΔTherms):**

The 2009 RASS study was utilized to estimate the residential electric and gas water heater and dryer combinations for statewide residential homes. This distribution was used to weight various water-heating and drying energy source combinations to obtain a weighted average savings for kW, kWh and therms for this clothes washer measure. The residential distribution from RASS was used for multifamily common area and nonresidential units because no other comparable source was available for those applications. See section 2 for analysis details.

## 1.6 Data Quality and Future Data Needs

Clothes washers are well documented by technical support documents published by the U.S. Department of Energy, so we believe that currently available data is sufficient for the purposes of this workpaper.

# Section 2. Calculation Methodology

The following table indicates which measures are taken directly from or created with the DEER READI tool. The most recent version is DEER 2017, D17 v3.

READI Data Used

|  |  |  |
| --- | --- | --- |
| **Measure Code** | **Measure Name** | **READI Data** |
| AP002 | Energy Star Residential Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 | RB-Appl-EffCW-med-Tier1-Top |
| AP003 | Energy Star Residential Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 | RB-Appl-EffCW-med-Tier1-Front |
| CWME | Energy Star Most Efficient Clothes Washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 | RB-Appl-EffCW-med-Tier2-Front |
| AP004, CWWA | CEE Tier 3 Clothes Washer with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 3.2 | RB-Appl-EffCW-med-Tier3-Front |

The DEER measure IDs in the table above are only applicable to residential clothes washers installed in single-family, domestic mobile home, and multi-family in-unit locations. The IOUs also provide incentives for residential clothes washers installed in commercial facilities (ie. laundromats) and multi-family common areas. We’ve scaled to these building types using clothes washer cycles per year values available in the DOE residential and commercial clothes washers technical support documents.

|  |  |  |
| --- | --- | --- |
| cycles per year | | Scaling Factor |
| Single Family | 295 |  |
| Multi Family Common Area | 1095 | 3.71 |
| Nonresidential Commercial Facility | 1497 | 5.07 |

# We propose the following measure IDs to be added for the new scaled measures:

|  |  |
| --- | --- |
| **Measure Name** | **Proposed Measure ID** |
| Energy Star Residential Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 in multi-family common area | RB-Appl-EffCW-med-Tier1-Top-MFmCmn |
| Energy Star Residential Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 in multi-family common area | RB-Appl-EffCW-med-Tier1-Front-MFmCmn |
| Energy Star Most Efficient Clothes Washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 in multi-family common area | RB-Appl-EffCW-med-Tier2-Front-MFmCmn |
| CEE Tier 3 Clothes Washer with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 3.2 in multi-family common area | RB-Appl-EffCW-med-Tier3-Front-MFmCmn |
| Energy Star Residential Top-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.06 and maximum Integrated Water Factor of 4.3 in nonresidential building | RB-Appl-EffCW-med-Tier1-Top-NonRes |
| Energy Star Residential Front-Loading Clothes Washer with a minimum Integrated Modified Energy Factor of 2.38 and maximum Integrated Water Factor of 3.7 in nonresidential building | RB-Appl-EffCW-med-Tier1-Front-NonRes |
| Energy Star Most Efficient Clothes Washer with a minimum Integrated Modified Energy Factor of 2.74 and maximum Integrated Water Factor of 3.2 in nonresidential building | RB-Appl-EffCW-med-Tier2-Front-NonRes |
| CEE Tier 3 Clothes Washer with a minimum Integrated Modified Energy Factor of 2.92 and maximum Integrated Water Factor of 3.2 in nonresidential building | RB-Appl-EffCW-med-Tier3-Front-NonRes |

See the file *Calculations\_Res\_PGECOAPP127 R4.xlsx* for residential clothes washer calculations derived from DEER.

**Commercial Clothes Washers**

Commercial clothes washers are not in DEER. The following documents the methodology for calculating energy savings for ENERGY STAR commercial clothes washers.

The 2014 commercial clothes washers TSD (chapter 9) contains baseline market share saturations for commercial clothes washers. Baseline market saturations for CCWs are currently about 70% top-loaders and 30% front-loaders. The DOE identified the maximum technologically feasible level (“max-tech”) for top-loading commercial clothes washers to be 1.85 MEF, which is substantially lower than the 2.2 MEF minimum efficiency level required by the Energy Star CCW spec. Currently, <1% of washers in the Energy Star CCW qualifying products list are top-loaders. Therefore, the measure case for Energy Star commercial clothes washers is assumed to be comprised entirely of front-loaders.



DOE conducted testing on a representative sample of five top-loading and five front-loading commercial clothes washers using both appendix J1 and appendix J2. DOE used the results from these tests to determine each model’s appendix J2 MEF\_J2/IWF ratings in relation to its appendix J1 MEF/WF ratings. The results, including an energy use breakdown between machine energy, dryer energy, and water heater energy, are provided below (from 2014 CCW TSD).

Top-Loading Commercial Clothes Washers: Per-Cycle Energy Use by Efficiency Level

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **MEF** | **MEF\_J2** | **Energy Use (kWh/cycle)** | | |
| **Machine** | **Dryer** | **Water Heat** |
| 1.60 | 1.15 | 0.220 | 2.08 | 0.391 |
| 1.70 | 1.35 | 0.210 | 1.58 | 0.506 |
| 1.85 | 1.55 | 0.100 | 1.62 | 0.408 |

Front-Loading Commercial Clothes Washers: Per-Cycle Energy Use by Efficiency Level

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **MEF** | **MEF\_J2** | **Energy Use (kWh/cycle)** | | |
| **Machine** | **Dryer** | **Water Heat** |
| 2.00 | 1.65 | 0.110 | 1.26 | 0.325 |
| 2.20 | 1.80 | 0.080 | 1.19 | 0.337 |
| 2.40 | 2.00 | 0.100 | 1.16 | 0.190 |
| 2.60 | 2.20 | 0.070 | 1.30 | 0.267 |

The figure below shows a trend of increasing washer capacity and decreasing number of cycles. Efficient washers also tend to have a larger capacity than their less efficient counterparts. In order to prevent these factors from skewing savings estimates we assume the total volume of clothes washed to be constant between the base and measure cases. A washer capacity of 3.1 cubic foot is used for all calculations. This corresponds to 295 cycles per year, which is the same frequency we assume for residential single family applications.



The energy usage estimates in taken from the DOE technical support documents assume the use of an electric dryer and electric DHW. Because the energy usage is expressed exclusively in kWh, the dryer and water heat energy values were converted to therms for the domestic hot water and dryer combinations that include gas as a fuel source. Energy savings estimates were developed for the following domestic hot water and dryer combinations: electric DHW / electric dryer, gas DHW / electric dryer and gas DHW / gas dryer. Per RASS 2009, 0% of California IOU customers have electric DHW / gas dryer combinations in their homes. RASS distributions are considered separately for PG&E, SCE, SCG, and SDG&E customers. Because gas dryers and gas-fired water heaters have a lower Energy Factor than electric dryers and electric water heaters, correction factors must be applied to facilities with gas dryers and/or gas DHW. According to the 2012 Clothes Washers TSD, for gas dryers, a Gas Dryer Correction Factor equal to 1.12 should be multiplied to the electric dryer usage. Likewise, for gas DHW, a Gas Water Heater Correction Factor of 1.33 is applied to the electric DHW usage. The Gas Water Heater Correction Factor is a ratio of the efficiency of an electric storage water heater to the efficiency of a gas storage water heater (1 for an electric water heater and 0.75 for a gas water heater according the 2012 residential clothes washer TSD).

Because interactive effects specific to clothes washers were unavailable, the HVAC interactive effects factors for CFLs were applied to the clothes washer measures. The interactive effect factors were selected for “IOU territory” (weighted by climate zone) and the “Existing” building vintage. The factors for PG&E, SCE, SCG, and SDG&E were used for the appropriate service territory. The “small office” building type was used for the commercial and multifamily common area measures.

The attached excel workbook in the Appendix titled *Clothes Washers Calculations\_PECOAPP127 R4.xlsx* details the calculations for commercial clothes washers in this workpaper.

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| RES weighted | DEER:Res\_ClothesDishWasher | RES |

# Section 4. Costs

The base case and measure costs for residential clothes washers are based on the results from the 2010-2012 Ex Ante Measure Cost Study (WO17). The IMC values in the measure cost study are not directly applicable to these measures because the code minimum and measure efficiency levels in the workpaper are higher than those in the cost study. The research analyzed costs for top-loading and front-loading clothes washers and developed coefficients using hedonic price modeling. The MEF coefficients are 38.91 for top-loaders and 28.9 for front-loaders. The base case cost for a Title 20 compliant clothes washer is derived by using the MEF coefficients to calculate the IMC associated with the delta of the code minimum MEF and the reference MEF and adding it to the reference cost from the measure cost study. The measure case cost for each measure is derived by using the MEF coefficients to calculate the IMC associated with the delta of the measure case MEF and the reference MEF and adding it to the reference cost from the measure cost study.

The base case and measure case costs for commercial clothes washers are based on the 2014 Commercial Clothes Washers TSD. The baseline and incremental manufacturing costs for both top- and front-loading CCWs are obtained from Chapter 5. The sum of the production cost and material cost is the total manufacturing cost. The base case 70%/30% top-/front-loading market saturation is applied to obtain a weighted base and measure manufacturing costs. Chapter 6 contains manufacturer and distributor markups that can be applied to the manufacturing cost to derive the cost to the consumer. Multiplying the base case manufacturing cost by the manufacturer markup of 1.285 and baseline distributor markup of 1.37 gives the price that the consumer pays for the clothes washer.

## 4.1 Base Case Cost

The base case costs are:

|  |  |  |  |
| --- | --- | --- | --- |
| ***Measure*** | **Measure Application Type** | **Baseline** | **Equipment Cost** |
| Energy Star Top-Loading | ROB | Code | $595.82 |
| Energy Star Front-Loading | ROB | Code | $682.14 |
| Energy Star Most Efficient | ROB | Code | $682.14 |
| CEE Tier 3 | ROB | Code | $682.14 |
| Energy Star Commercial | ROB | Code | $1642.26 |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Cost

The measure case costs are:

|  |  |  |  |
| --- | --- | --- | --- |
| ***Measure*** | **Measure Application Type** | **Baseline** | **Equipment Cost** |
| Energy Star Top-Loading | ROB | Code | $614.92 |
| Energy Star Front-Loading | ROB | Code | $705.32 |
| Energy Star Most Efficient | ROB | Code | $714.01 |
| CEE Tier 3 | ROB | Code | $716.90 |
| Energy star Commercial | ROB | Code | $2216.23 |

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |
| REF | (MEC + MLC) – (BEC + BLC) | MEC + MLC | N/A |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| Energy Star Top-Loading | ROB | $30.02 | $19.10 | N/A |
| Energy Star Front-Loading | ROB | $23.17 | $23.17 | N/A |
| Energy Star Most Efficient | ROB | $31.86 | $31.86 | N/A |
| CEE Tier 3 | ROB | $34.76 | $34.76 | N/A |
| Energy Star Commercial | ROB | $545.58 | $573.96 | N/A |

# References

1. U.S. Energy Information Administration. *2009 RECS Survey Data.* [*http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=characteristics*](http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=characteristics) [↑](#endnote-ref-1)
2. California Energy Commission, *Appliance Efficiency Regulations* (Title 20), Section 1605.1, October 2017. [↑](#endnote-ref-2)
3. Residential Appliance Saturation Survey, Volume 2, October 2010. Interactive query of 2009 RASS data done through KEMA RASS website. <http://websafe.kemainc.com/rass2009/>. Accessed June 2012. [↑](#endnote-ref-3)