Work Paper PGECOFST126

**Revision # 0**

**Pacific Gas & Electric Company**

**Energy Efficient Door-Type Commercial Dishwashers**

**For Work Paper Reviewer Use Only**

**List all major comments that occurred during the review. This table may only be removed during management review.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major Comment** | **Reviewer Name** | **Date** | **Outcome/Resolution** |
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# At-a-Glance Summary

|  |  |  |
| --- | --- | --- |
| **Measure Codes** | ApgDsw001, FS-67513, FS004 (High Temp) | ApgDsw002, FS-85137, FS005 (High Temp) |
| **Measure Description** | Tier 1- Energy Star Minimum Speciation for Energy Efficient High Temperature Door-Type Commercial Dishwashers with water usage ≤0.89 gal/rack and idle energy rate ≤0.7 kW | Tier 2- 15% below Energy Star Minimum Speciation for Energy Efficient High Temperature Door-Type Commercial Dishwashers with water usage ≤0.76 gal/rack and idle energy rate ≤0.7 kW |
| **Base Case Description** | Minimum Energy Star specification averaged with High Temperature Door-Type Commercial Dishwasher monitored data | Minimum Energy Star specification averaged with High Temperature Door-Type Commercial Dishwasher monitored data |
| **Units** | Door-Type Dishwasher | Door-Type Dishwasher |
| **Energy Savings** | Source: PG&E Calculations 1,124 kWh & 95 Therms | Source: PG&E Calculations 2,421 kWh & 206 Therms |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Source: PG&E Calculations $1,923 | Source: PG&E Calculations $4,087 |
| **Effective Useful Life** | 15 years -- Source:  Energy Star | 15 years -- Source:  Energy Star |
| **Measure Installation Type** | Replace on Burnout (ROB), or New Construction (NC). | Replace on Burnout (ROB), or New Construction (NC). |
| **Net-to-Gross Ratio** | Source: 2014 DEER Com Default >= 2 yrs.  0.7 | Source: 2014 DEER Com Default >= 2 yrs.  0.7 |
| **Important Comments** | Measured Water Savings of 10,983 Gallons/year  This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). | Measured Water Savings of 23,648 Gallons/year  This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# At-a-Glance Summary (Continued)

|  |  |  |
| --- | --- | --- |
| **Measure Codes** | ApgDsw003, FS-82265, FS006 (Low Temp) | ApgDsw004, FS-54161, FS007 (Low Temp) |
| **Measure Description** | Tier 1 - Energy Star Minimum Speciation for Energy Efficient Low Temperature Door-Type Commercial Dishwashers with water usage ≤1.18 gal/rack (low temperate unit) and idle energy rate ≤ 0.60 kW | Tier 2 - 15% below Energy Star Energy Efficient Low Temperature Door-Type Commercial Dishwashers with water usage ≤1.00 gal/rack (low temperate unit) and idle energy rate ≤ 0.60 kW |
| **Base Case Description** | Minimum Energy Star specification averaged with Low Temperature Door-Type Commercial Dishwasher monitored data | Minimum Energy Star specification averaged with Low Temperature Door-Type Commercial Dishwasher monitored data |
| **Units** | Door-Type Dishwasher | Door-Type Dishwasher |
| **Energy Savings** | Source: PG&E Calculations 142 kWh & 193 Therms | Source: PG&E Calculations 206 kWh & 280 Therms |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Source: PG&E Calculations $382 | Source: PG&E Calculations $3,561 |
| **Effective Useful Life** | 15 years -- Source:  Energy Star | 15 years -- Source:  Energy Star |
| **Measure Installation Type** | Replace on Burnout (ROB), or New Construction (NC). | Replace on Burnout (ROB), or New Construction (NC). |
| **Net-to-Gross Ratio** | Source: 2014 DEER Com Default >= 2 yrs.  0.7 | Source: 2014 DEER Com Default >= 2 yrs.  0.7 |
| **Important Comments** | Measured Water Savings of 22,716 Gallons/year  This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). | Measured Water Savings of 33,052 Gallons/year  This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Rev | Date | Author | Summary of Changes |
| 0a | 2/10/2015 | Kong Sham (Fisher Nickel) | * New 2014 template. * Updated Energy savings methodology and consolidated previous measures for different dining operations. * Updated Demand Reduction Estimates |
| 0b | 10/28/2015 | Miguel Urrea (SoCalGas) | * Update to statewide template |
| 0c | 11/13/2015 | Miguel Urrea (SoCalGas) | * Addressed IOU comments * Updated low temp cost data |

# Commission Staff and Cal TF Comments

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| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
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# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This work paper documents the inputs for the Energy Efficient Door-Type Commercial Dishwashers measure. Of the many types of commercial dishwashers available, including under-counter and conveyor-types, door-type units account for approximately 65% of the market share.

This work paper addresses both low temperature and high temperature door-type dishwasher units. Low temperature units meet the National Sanitation Foundation (NSF) mandated sanitation criteria via a final rinse chemical sanitizing solution that follows the wash cycle. High temperature units achieve sanitation via a high temperature booster of 180°F water for the final rinse. These differences in sanitizing methods affect the division of energy consumption of low versus high temperature units. For low temperature machines, 90% of energy used is associated with primary water heating, with the remaining 10% attributed to auxiliary components and standby energy. For high-temperature machines, only 71% of the total energy consumption is for primary water heating 29% is for booster water heating, and the remaining 12% is attributed to the motor, wash tank heater, controls, and standby energy. It is assumed that the motors and controls components do not vary significantly between standard and high-efficiency dishwasher units. However, water consumption, and therefore water heating requirements, does vary significantly between standard and high-efficiency units and constitutes the measure energy savings.

High efficiency commercial dishwashers reduce water heating requirements while maintaining cleaning performance by reducing heat losses, improving mechanical soil removal, and/or increasing component efficiencies. By using strategies such as waste air heat recovery, drain heat recovery, rinse water re-use, double-walled insulated construction, high efficiency anti-clogging nozzles, continuous filtering, and efficient boost heaters, water consumption can be reduced from as high as 4 or 5 gallons/rack to less than 0.5 gallons/rack, depending on the type of dishwasher

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Energy Efficient Door-Type Commercial Dishwashers |
| Existing Condition | Existing Door-Type Commercial Dishwashers |
| Code/Standard | Not Applicable |
| Industry Standard Practice | Existing Door-Type Commercial Dishwashers |

Measures and Codes/Catalog Description

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| ApgDsw001 |  | FS-67513 | FS004 | Tier 1 - Energy Star Minimum Speciation for Energy Efficient High Temperature Door-Type Commercial Dishwashers with water usage ≤0.89 gal/rack and idle energy rate ≤0.7 kW |
| ApgDsw002 |  | FS-85137 | FS005 | Tier 2 - 15% below Energy Star Minimum Speciation for Energy Efficient High Temperature Door-Type Commercial Dishwashers with water usage ≤0.76 gal/rack and idle energy rate ≤0.7 kW |
| ApgDsw003 |  | FS-82265 | FS006 | Tier 1 - Energy Star Minimum Speciation for Energy Efficient Low Temperature Door-Type Commercial Dishwashers with water usage ≤1.18 gal/rack (low temperate unit) and idle energy rate ≤ 0.60 kW |
| ApgDsw004 |  | FS-54161 | FS007 | Tier 2 - 15% below Energy Star Minimum Speciation for Energy Efficient Low Temperature Door-Type Commercial Dishwashers with water usage ≤1.00 gal/rack (low temperate unit) and idle energy rate ≤ 0.60 kW |

* **Eligibility requirements**: This measure includes new commercial low temperature or high temperature door-type dishwashers that meet the qualifications listed in Table 1. Consult with the manufacturer or manufacturer’s representative to determine if a model meets the efficiency requirements in Table 1. Used or rebuilt equipment is not eligible. Customers must provide proof that the appliance has the gallons per rack (gal/rack) and idle energy rate that meets the requirements.
* **Implementation and installation requirements**: The rebate is downstream, midstream, and upstream. This is not a Direct Install program. This measure is applicable to any commercial application, including (but not limited to) casual dining and quick service restaurants, hotels, motels, schools, colleges and recreational facilities.
* **Other program restrictions and guidelines:** An early post-rebate study will be implemented by the program administrators by surveying the program participants in order to validate the assumptions such as type of facilities, facility operating hours/days, racks per day, and peak usage hours.

**Table 1 Energy Efficiency Requirements for Commercial Door-Door Type Dishwashers.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Code** | **Dishwasher Type** | **Gallons per Rack (gal/rack)** | **Idle Energy Rate** |
| ApgDsw001, FS-67513, FS004 | High Temperature, Tier 1 | <0.89\* | ≤ 0.70 kW\* |
| ApgDsw002, FS-85137, FS005 | High Temperature, Tier 2 | <0.76\*\* | ≤ 0.70 kW\* |
| ApgDsw003, FS-82265, FS006 | Low Temperature, Tier 1 | <1.18\* | ≤ 0.60 kW\* |
| ApgDsw004, FS-54161, FS007 | Low Temperature, Tier 2 | <1.00\*\* | ≤ 0.60 kW\* |

\*ENERGY STAR Test Method for Commercial Dishwashers (Rev.June-2012)

\*\*15% below ENERGY STAR Test Method for Commercial Dishwashers (Rev.June-2012)

## 1.2 Technical Description

Commercial dishwashers are used in almost all establishments that use non-disposable dishes, glassware, and utensils, such as restaurants, bars, schools, hospitals, nursing homes, churches, and institutional cafeterias. The commercial dishwasher is able to clean and sanitize a high quantity of kitchen wares in a very short time by utilizing hot water, soap, rinse chemicals, and significant amounts of energy. Size requirements for commercial dishwashing machines can be calculated by estimating the number of individuals served by the food service establishment. This information is a key determinant of the type of dishwasher that is most suited for a facility.

Commercial dishwashers that have earned the ENERGY STAR are on average 40 percent more energy efficient and 40 percent more water-efficient than standard models. [[1]](#endnote-1)

High and low temp stationary door-type dishwashers are eligible for the ENERGY STAR. Qualified models must meet maximum water consumption requirements and use less energy while idling between wash cycles.

## 1.3 Installation Types and Delivery Mechanisms

Since there are no EM&V studies on the useful life of dishwashers and it is standard practice in the commercial foodservice industry to purchase equipment only when it is needed (e.g., replacement or additional capacity), this measure is focused on ROB and NC applications only.

**Installation Type Descriptions[[2]](#endnote-2)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 |

As noted in Section 1.1, the rebate is downstream, midstream, and upstream. This is not a Direct Install program.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| 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. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | No |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | N/A. Applicable to all restaurant & kitchen facilities. |
| DEER Version | N/A |
| Reason for Deviation from DEER | The 2014 DEER database does not contain information on energy use or savings or equipment costs for an energy-efficient commercial dishwasher.  There was no specific Effective Useful Life (EUL) found in the DEER database for commercial dishwashers. This work paper adopts the Energy Star typical product lifetime of 15 years for door-type units. |
| DEER Measure IDs Used | N/A |

**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.[[3]](#endnote-3)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| All Com-Default<=2yrs | All other EEM with no evaluated NTGR; new technology in program for 2 or fewer years | All | Any | Any | 0.7 |

**Spillage Rate**

Spillage rates are not tracked in work papers.

**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**

There was no specific Effective Useful Life (EUL) found in the DEER database for commercial dishwashers. This work paper adopts the Energy Star typical product lifetime of 15 years for door-type units[[4]](#endnote-4).

The EUL and RUL values were obtained using Energy Star. 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-DW-DtU | Energy Star typical product lifetime for door-type units. This EUL ID is specific to Dishwashers only. | Com | AppPlug | 15 | 5 |

### 1.4.2 Codes and Standards Analysis

This measure is not governed by either state or federal codes and standards.

The Energy Star Test Method for Commercial Dishwashers uses the ASTM F1696-07 Standard Test Method for Energy Performance Single-Rack, Door-Type Commercial Dishwashing Machines[[5]](#endnote-5) to estimate the energy and water consumption of both the base and measure case.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2013) | This measure does not fall under Title 20 of the California Energy Regulations. |  |
| Title 20 (2014) | This measure does not fall under Title 20 of the California Energy Regulations. |  |
| Federal Standards | These measures do not fall under Federal DOE or EPA Energy Regulations. |  |

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

The EPA relies on its Energy Star Partner organizations to provide shipment data to the EPA to estimate the market share of Energy Star commercial cooking equipment via a survey. Among the 20 responding manufacturers in 2013, 63% of units shipped in 2013 meet the Energy Star 2.0 specification. However, these Energy Star Partner manufacturers make up only 50% of the total market share of manufacturers in the commercial dishwashing market, and as a result, skew the data collected toward the efficient segment of the total market.

# Section 2. Calculation Methodology

## 2.1 Assumptions and Calculations from other sources—Base and Measure Cases

The base case for this measure is determined by averaging field data collected from five different commercial food service sites and the minimum Energy Star commercial door-type dishwasher specification shown in Table 2. The measure case is an energy efficient (Energy Star) commercial door-type dishwashing machine shown in Table 3.

This work paper includes both low temperature and high temperature units, to be replaced by low or high temperature units, respectively. Low-temperature commercial dishwashers are assumed to use water that is solely heated by an external gas or electric water heater. High-temperature units reuse wash water from the dishwashing water tank for the wash cycle and then additional clean water for the rinse cycle that is raised to 180°F via a gas or electric booster heater. Rinse water is then collected and used to overflow the wash water tank providing heat recovery and a fresh water stream.

The basis for energy savings is the difference between the water heating energy required for the base case versus the energy efficient measure case. Because energy efficient units consume considerably less water, less energy will be required to heat less water, thus saving energy. For both low and high temperature machines, base case energy consumption (therms and kWh) is based on the energy required to heat water for the dishwashing and sanitizing cycles. The high temperature units water heating energy components further split into primary and booster water heating.

Motor energy and standby losses are assumed to be the same for both the base case and the measure case, and are therefore not considered in the energy savings calculations. Idle energy rate to maintain a wash tank temperature for both high and low temperature washing machines is included in the calculation for annual energy consumption. However, due to current lack of research data, idle energy rate is assumed to be the same for both the base and measure case.

**Gallons per Rack**

The NSF provides a database of commercial dishwashers which reports the manufacturers’ calculated water consumption in gallons per rack.[[6]](#endnote-6) The database includes models that are no longer manufactured, as well as models that meet the Energy Star performance criteria for reduced water consumption (1.18 gal/rack for low temperature units, and 0.95 gal/rack for high temperature units[[7]](#endnote-7)), but may not have applied for the Energy Star label. For this work paper, models that are no longer manufactured have been excluded from the calculations.

**Table 2 Base Case Commercial Door-Door Type Dishwashers**

|  |  |  |
| --- | --- | --- |
| **Dishwasher Type** | **Gallons per Rack (gal/rack)** | **Idle Energy Rate** |
| High Temperature | <1.07\* | ≤ 0.70 kW |
| Low Temperature | <1.50\* | ≤ 0.60 kW |

\* Average between minimum Energy Star specification and monitored dishwasher data

**Table 3 Measure Case for Commercial Door-Door Type Dishwashers.**

|  |  |  |
| --- | --- | --- |
| **Dishwasher Type** | **Gallons per Rack (gal/rack)** | **Idle Energy Rate** |
| High Temperature Tier 1 | <0.89\* | ≤ 0.70 kW |
| High Temperature Tier 2 | <0.76\*\* | ≤ 0.70 kW |
| Low Temperature Tier 1 | <1.18\* | ≤ 0.60 kW |
| Low Temperature Tier 2 | <1.00\*\* | ≤ 0.60 kW |

\* Based on Energy Star 2.0 Qualified Dishwasher

\*\* Based on 15% below Energy Star 2.0 Qualified Dishwasher

**Racks per Day**

The racks-per-day variable is based on FSTC monitored data from five different restaurant sites and dishwasher leasing companies who regularly track the racks/month as part of their lease agreements. This data is included in the embedded calculation sheet.

FSTC monitored data from five different food service facilities including fast casual, fine dining, cafes, and quick service restaurants yielded an average of 141 racks per day. This value coincides with value by the dishwasher leasing companies of estimated at 4000 racks per month, or approximately 133 racks per day.

**Hours of Operation:**

This measure would follow the hours of operation for quick serve and full serve restaurants as noted in Attachment A. For this measure the annual hours of operation are considered 4,380.

12 hrs/day \* 365 day/yr = 4,380 hr/year

Survey data collected from 54 restaurants supports 365 days/year operation of typical restaurants. Data is included in embedded calculation sheet.

**Energy Consumption (therms or kWh) per Gallon**

The energy consumption per gallon of water is based on the increase in water temperature required for a wash cycle, the specific heat of water (the energy required to raise one gallon of water by one degree), the weight of water, and the equipment efficiency.

**Equation 1 - Energy Consumption per Gallon of Water**

Where:

Temperature rise in degrees Fahrenheit (°F)

Specific Heat

Density

Heating equipment efficiency

The following energy conversions are used to determine kWh and therms consumption:

1kWh

The specific heat of water and the density of water are constants and will not vary. The other two inputs are variable as based on the following assumptions.

The temperature rise in degrees Fahrenheit (°F) assumes an average inlet water temperature in the PG&E territory of 57.9° F [[8]](#endnote-8) and needs to be raised to 140°F to meet the minimum supply water temperature at the dishwasher. This is equivalent to an increase of 82.1°F for basic water heating in the building. This basic, or primary, water heating applies to both low and high temperature machines. For high temperature machines, there is an extra sanitizing rinse that increases the water temperature via a dishwasher booster water heater another 40°F, to 180°F to meet the NSF sanitation standards. (The low temperature machines meet this standard via a chemical rinse).

Heating equipment efficiency varies between electric and gas units, as well as between external primary water heating and internal booster heating. The efficiency of a building’s electric water heater is assumed to be 95%, while gas water heaters are assumed to have an efficiency of 77%[[9]](#endnote-9). These efficiencies are used to determine energy consumption of the primary water heating in both low and high temperature units. Electric booster heating units are assumed to have an efficiency of 95%, and gas booster heating units are assumed to have an efficiency of 80%. These efficiencies are used to determine the additional energy consumption of the booster water heating in high temperature units. These engineering assumptions are consistent with those used by Energy Star.[[10]](#endnote-10)

The following equation calculates the energy required to raise the primary water from 70°F to 140°F in a building with gas water heating.

**Equation 2 – Base Case Primary Gas Water Heating Energy Consumption per Gallon**

Converting to therms results in:

If this unit was a high temperature unit, using a higher temperature sanitizing rinse, the same methodology would be used to determine the additional energy required for the booster water heating. The booster heater will be needed to increase the 100% of the water from a temperature of 140°F to 180°F. The additional booster water heating energy is shown in the following equation.

**Equation 3 - Base Case Booster Gas Water Heating Energy Consumption per Gallon**

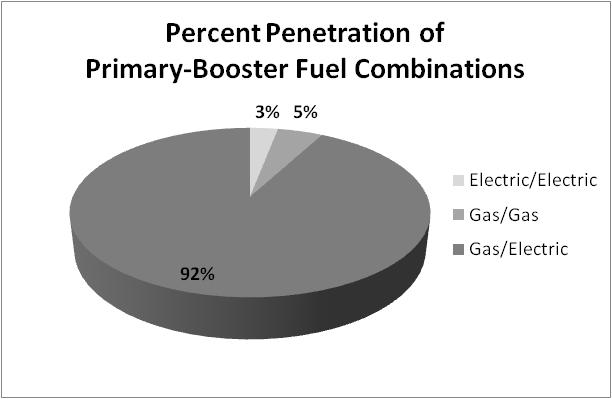
Converting to therms results in:

This same methodology is used to determine electric energy consumption, utilizing the electric water heating equipment efficiencies and the electric energy conversions. Because door-style dishwashers can accommodate both gas and electric water heating for primary and booster heating, the energy requirements for both gas and electric water heating per gallon are supplied in Table 4.

|  |  |  |
| --- | --- | --- |
| **Table 4 Energy Consumption per Gallon Usage** | | |
| Gas Water Heater | 0.00926 | Therms/Gal |
| Gas Booster Heater | 0.00426 | Therms/Gal |
| Electric Water Heater | 0.220 | kWh/Gal |
| Electric Booster Heater | 0.101 | kWh/Gal |

High temperature units attain energy savings via primary water heating and booster water heating. It is assumed that restaurants with electric primary heating will only install electric dishwashers with electric booster heating. While it is assumed that the vast majority of restaurants with gas primary water heating will install electric dishwashers with electric booster heating, gas booster heating is available and is installed a very small percentage of the time, assumed at approximately 5%.[[11]](#endnote-11) The weighted average must account for three primary water heating and booster water heating categories: electric-electric, gas-gas, and gas-electric. The percentages for each category are summarized in Figure 1.

**Figure 1: Penetration of Primary Water Heating and Booster Water Heating Fuel Combinations**



These percentages were applied to the primary water heating energy savings for high and low temperature units as shown in Section 2.1 and 2.2.

## 2.2 Summary of Inputs for Savings Calculations

The following table provides references to sections that document the inputs for calculation for PG&E Territory. See the embedded calculation file for other climate zones and IOU territories :

**Table 5 Inputs for Savings Calculations for Measure – High Temp Tier 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | None | - | *1,124 kWh* | *Section 2.1* |
| **Gas Savings** | None | - | 95 Therms | *Section 2.4* |
| **Hours of operation** | None | 12 | 12 | Section 1.4.1 |
| **Full Cost** | None | $8,587 | $10,510 | Section 4.3.1 |
| **Incremental Cost** | None | - | $1,923 | Section 4.3.1 |
| **EUL /RUL** | None | 15 years | 15 years | Section 1.4.1 |
| **NTG** | None | 0.7 | 0.7 | Section 1.4.1 |
| **ISR** | No | 1 | 1 | Section 1.4.1 |
| **TOU Factor** | *A/C projects only* |  |  | *Section 1.4.5* |

**Table 6 Inputs for Savings Calculations for Measure – High Temp Tier 2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | None | - | *2,421 kWh* | *Section 2.1* |
| **Gas Savings** | None | - | 206 Therms | *Section 2.4* |
| **Hours of operation** | None | 12 | 12 | Section 1.4.1 |
| **Full Cost** | None | $8,587 | $12,674 | Section 4.3.1 |
| **Incremental Cost** | None | - | $4,087 | Section 4.3.1 |
| **EUL /RUL** | None | 15 years | 15 years | Section 1.4.1 |
| **NTG** | None | 0.7 | 0.7 | Section 1.4.1 |
| **ISR** | No | 1 | 1 | Section 1.4.1 |
| **TOU Factor** | *A/C projects only* |  |  | *Section 1.4.5* |

**Table 7 Inputs for Savings Calculations for Measure – Low Temp Tier 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | None | - | 142 kWh | *Section 2.1* |
| **Gas Savings** | None | - | 193 Therms | *Section 2.4* |
| **Hours of operation** | None | 12 | 12 | Section 1.4.1 |
| **Full Cost** | None | $3,825 | $4,207 | Section 4.3.1 |
| **Incremental Cost** | None | - | $382 | Section 4.3.1 |
| **EUL /RUL** | None | 15 | 15 | Section 1.4.1 |
| **NTG** | None | 0.7 | 0.7 | Section 1.4.1 |
| **ISR** | No | 1 | 1 | Section 1.4.1 |
| **TOU Factor** | *A/C projects only* |  |  | *Section 1.4.5* |

**Table 8 Inputs for Savings Calculations for Measure – Low Temp Tier 2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | None | - | 206 kWh | *Section 2.1* |
| **Gas Savings** | None | - | 280 Therms | *Section 2.4* |
| **Hours of operation** | None | 12 | 12 | Section 1.4.1 |
| **Full Cost** | None | $3,825 | $7,386 | Section 4.3.1 |
| **Incremental Cost** | None | - | $3,561 | Section 4.3.1 |
| **EUL /RUL** | None | 15 | 15 | Section 1.4.1 |
| **NTG** | None | 0.7 | 0.7 | Section 1.4.1 |
| **ISR** | No | 1 | 1 | Section 1.4.1 |
| **TOU Factor** | *A/C projects only* |  |  | *Section 1.4.5* |

## 2.3 Electric Energy Savings Estimation Methodologies

**Table 9 Baseline by Measure Application Type**

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period: Energy Savings Baseline** | **Second Baseline Period: Energy Savings Baseline** |
| ***ROB*** (replace-on-burnout) | EUL | Code Baseline | N/A |
| ***NC*** (new construction) | RUL/EUL-RUL | Code Baseline | N/A |

Notes: For ROB measures, First Baseline is the baseline for the full EUL. There is no second baseline.

Using the market penetration percentages and the assumptions provided in Section 1.4.4, energy consumption can be calculated. The following equation shows the calculation for a high temperature electric fueled door-type dishwasher in a commercial food service that uses electric primary water heating. Low temperature dishwashers will not have booster heater energy as part of the calculation and can effectively be set to zero.

**Example Calculation for Base Case High Temperature Electric Dishwasher Annual Energy Consumption**

*where,*

The results for both low and high temperature door-type units are provided in 13 and 14, below. Detailed calculations are provided in an attached worksheet.

**Table 10 Commercial Electric High Temperature Door-Type Dishwasher Base Case and Measure Case Energy Consumption**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Base Case | Measure Case Tier 1 | Measure Case Tier 2 |
| Electric Water Heater Energy per Gallon (kWh/gal) | 0.208 | 0.208 | 0.208 |
| Electric Booster Heater Energy per Gallon (kWh/gal) | 0.101 | 0.101 | 0.101 |
| **Number of Racks per day (racks/day)** | **140.5** | **140.5** | **140.5** |
| **Number of Racks per year (racks/year)** | **51,283** | **51,283** | **51,283** |
| **Water Consumption (Gal/Rack)** | **1.06** | **0.85** | **0.60** |
| Daily Water Consumption (Gal) | 149 | 119 | 84 |
| Daily Booster Heater Water (Gal) | 149 | 119 | 84 |
| Wash time per rack (min/rack) | 1 | 1 | 1 |
| Idle Energy Rate (kW) | 0.7 | 0.7 | 0.7 |
| Operating Days/Year | 365 | 365 | 365 |
| Operating Hours/Day | 12 | 12 | 12 |
| Electric Cost ($/kWh) | 0.13 | 0.13 | 0.13 |
| Daily Water Heater Energy Consumption (kWh) | 31.00 | 24.76 | 17.55 |
| Daily Booster Heater Energy (kWh) | 15.11 | 12.06 | 8.55 |
| Daily Idle Energy (kWh) | 6.76 | 6.76 | 6.76 |
| **Market Penetration of Electric Water Heaters (%)** | 3 | 3 | 3 |
| **Market Penetration of Electric Booster Heaters (%)** | 95 | 95 | 95 |
| Weighted Annual Heater Energy Consumption (kWh/year) | 414 | 345 | 266 |
| Weighted Annual Booster Heater Energy (kWh/year) | 5,238 | 4,182 | 2,965 |
| Weighted Annual Energy Consumption (kWh) | 8,119 | 6,995 | 5.699 |
| **Estimated Energy Savings (kWh/yr)** | - | **1,124** | **2,421** |
| Average Peak Demand (kW) | 1.83 | 1.57 | 1.28 |
| Demand Coincidence Factor | 0.9 | 0.9 | 0.9 |
| **Demand Reduction (kW)** | - | **0.22** | **0.48** |
| Annual Energy Cost ($) | **1,055** | **909** | **741** |
| **Estimated Cost Savings ($/yr)** | - | **146** | **315** |
| Estimated Useful Life (EUL) | 15 | 15 | 15 |

**Table 11 Commercial Electric Low Temperature Door-Type Dishwasher Base Case and Measure Case Energy Consumption**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Base Case | Measure Case Tier 1 | Measure Case Tier 2 |
| Electric Water Heater Energy per Gallon (kWh/gal) | 0.208 | 0.208 | 0.208 |
| **Number of Racks per day (racks/day)** | **140.5** | **140.5** | **140.5** |
| **Number of Racks per year (racks/year)** | **51,283** | **51,283** | **51,283** |
| **Water Consumption (Gal/Rack)** | **1.50** | **1.06** | **0.86** |
| Daily Water Consumption (Gal) | 212 | 149 | 121 |
| Wash time per rack (min/rack) | 1 | 1 | 1 |
| Idle Energy Rate (kW) | 0.6 | 0.6 | 0.6 |
| Operating Days/Year | 365 | 365 | 365 |
| Operating Hours/Day | 12 | 12 | 12 |
| Electric Cost ($/kWh) | 0.13 | 0.13 | 0.13 |
| Daily Water Heating Energy (kWh) | 43.81 | 30.88 | 25.00 |
| Daily Idle Energy (kWh) | 0 | 0 | 0 |
| Average On Peak Demand (kW) | 0 | 0 | 0 |
| Estimated On Peak Demand Reduction (kW) |  | 0 | 0 |
| Market Penetration of Electric Water Heaters (%) | 3 | 3 | 3 |
| Weighted Annual Heater Energy Consumption (kWh/year) | 480 | 338 | 274 |
| **Estimated Energy Savings (kWh/yr)** | **-** | **142** | **206** |
| **Annual Energy Cost ($)** | **62** | **44** | **36** |
| **Estimated Cost Savings ($/yr)** | **-** | **18** | **27** |
| Estimated Useful Life (EUL) | 15 | 15 | 15 |

## 2.4 Demand Reduction Estimation Methodologies

A dishwasher actual contribution to a building’s peak demand may vary significantly depending on its usage pattern in relation to that of other electric equipment in the facility (operating schedule, appliance on time, etc.). However, it is generally known that the biggest water consuming appliance for any commercial food service is the dishwasher. Thus dishwasher water usage will be the largest contributor to overall usage and peak demand. The End-use Water Demand Profile study conducted on restaurants for the CPUC by Aquacraft documents hourly hot water demand.[[12]](#endnote-12) This study conducted on seven different restaurants concludes that 24.1% of total daily use occurs during the 3-hour peak demand period between 2:00pm and 5:00pm. Therefore, it has been assumed that the probable contribution to the building’s peak demand is equal to the appliance’s average demand during the peak times.

The demand estimation is based on estimated energy consumption savings divided over the peak demand hours of the unit. Applying a Coincidence Factor of 0.9 per the DEER methodology[[13]](#endnote-13)y, yields a Demand Savings of 0.22kW and 0.48kW for Tier 1 and Tier 2 high temperature machines respectively.

*Where,*

*And*

## 2.5 Gas Energy Savings Estimation Methodologies

Using the market penetration percentages and the assumptions provided in Section 1.4.4, energy consumption can be calculated. The following equation shows the calculation for a high temperature gas fueled door-type dishwasher in a commercial food service that uses gas primary water heater. Low temperature dishwashers will not have booster heater energy as part of the calculation and can effectively be set to zero.

**Example Calculation for Base Case High Temperature Gas Dishwasher Annual Energy Consumption**

*where,*

The results for both low and high temperature door-type units are provided in Table 13 and Table 14 below. Detailed calculations are provided in **Error! Reference source not found.**.

**Table 2**2 **Commercial Gas High Temperature Door-Type Dishwasher Base Case and Measure Case Energy Consumption**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Base Case | Measure Case Tier 1 | Measure Case Tier 2 |
| Gas Water Heater Energy per Gallon (Therms/gal) | 0.0087 | 0.0087 | 0.0087 |
| Gas Booster Heater Energy per Gallon (Therms/gal) | 0.0043 | 0.0043 | 0.0043 |
| **Number of Racks per day (racks/day)** | **140.5** | **140.5** | **140.5** |
| **Number of Racks per year (racks/year)** | **51,283** | **51,283** | **51,283** |
| **Water Consumption (Gal/Rack)** | **1.06** | **0.85** | **0.60** |
| Daily Water Consumption (Gal) | 149 | 119 | 84 |
| Daily Booster Heater Water (Gal) | 149 | 119 | 84 |
| Wash time per rack (min/rack) | 1 | 1 | 1 |
| Idle Energy Rate (Btu/hr) | 0 | 0 | 0 |
| Operating Days/Year | 365 | 365 | 365 |
| Operating Hours/Day | 12 | 12 | 12 |
| Natural Gas Cost ($/Therm) | 1.00 | 1.00 | 1.00 |
| Daily Water Heating Energy Consumption (Therms) | 1.31 | 1.04 | 0.74 |
| Daily Booster Heater Energy (Therms) | 0.64 | 0.51 | 0.36 |
| Daily Idle Energy (Therms) | - | - | - |
| **Market Penetration of Gas Water Heaters (%)** | **97** | **97** | **97** |
| **Market Penetration of Gas Booster Heaters (%)** | **5** | **5** | **5** |
| Weighted Annual Heater Energy Consumption (Therms/year) | 462 | 369 | 262 |
| Weighted Annual Booster Heater Energy (Therms/year) | 12 | 9 | 7 |
| Annual Energy Consumption (Therms/yr) | 474 | 378 | 268 |
| **Estimated Energy Savings (Therms/yr)** | **-** | **95** | **206** |
| Annual Energy Cost ($) | **474** | **378** | **268** |
| **Estimated Cost Savings ($/yr)** | - | **95** | **206** |
| Estimated Useful Life (EUL) | 15 | 15 | 15 |

**Table 13 Commercial Gas Low Temperature Door-Type Dishwasher Base Case and Measure Case Energy Consumption**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Base Case | Measure Case Tier 1 | Measure Case Tier 2 |
| Gas Water Heater Energy per Gallon (Therms/gal) | 0.0087 | 0.0087 | 0.0087 |
| **Number of Racks per day (racks/day)** | **140.5** | **140.5** | **140.5** |
| **Number of Racks per year (racks/year)** | **51,283** | **51,283** | **51,283** |
| **Water Consumption (Gal/Rack)** | **1.50** | **1.06** | **0.86** |
| Daily Water Consumption (Gal) | 211 | 149 | 120 |
| Wash time per rack (min/rack) | 1 | 1 | 1 |
| Idle Energy Rate (Btu/hr) | 0 | 0 | 0 |
| Operating Days/Year | 365 | 365 | 365 |
| Operating Hours/Day | 12 | 12 | 12 |
| Natural Gas Cost ($/Therm) | 1.00 | 1.00 | 1.00 |
| Daily Water Heating Energy (Therms) | 1.84 | 1.30 | 1.05 |
| Daily Idle Energy (Therms) | - | - | - |
| **Market Penetration of Gas Water Heaters (%)** | **97** | **97** | **97** |
| Weighted Annual Heater Energy Consumption (Therms/year) | 653 | 460 | 373 |
| Annual Energy Consumption (Therms/yr) | 653 | 460 | 373 |
| **Estimated Energy Savings (Therms/yr)** | **-** | **193** | **280** |
| **Annual Energy Cost ($)** | **653** | **460** | **373** |
| **Estimated Cost Savings ($/yr)** | - | **193** | **280** |
| Estimated Useful Life (EUL) | 15 | 15 | 15 |

**Table 14 Energy Savings for 16 Climate Zones and IOU Territories**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | High Temp | | High Temp | |  | Low Temp | | Low Temp | |
|  | Tier 1 | | Tier 2 | |  | Tier 1 | | Tier 2 | |
|  | Gas (Therm) | Elec (kWh) | Gas (Therm) | Elec (kWh) |  | Gas (Therm) | Elec (kWh) | Gas (Therm) | Elec (kWh) |
| CZ01 | **103** | **1,130** | **221** | **2,432** |  | **208** | **153** | **302** | **222** |
| CZ02 | **96** | **1,125** | **207** | **2,422** |  | **194** | **143** | **282** | **207** |
| CZ03 | **96** | **1,125** | **208** | **2,422** |  | **195** | **143** | **283** | **208** |
| CZ04 | **94** | **1,123** | **202** | **2,418** |  | **189** | **139** | **275** | **202** |
| CZ05 | **98** | **1,126** | **211** | **2,424** |  | **198** | **145** | **287** | **211** |
| CZ06 | **91** | **1,121** | **196** | **2,414** |  | **183** | **135** | **267** | **196** |
| CZ07 | **90** | **1,120** | **194** | **2,412** |  | **182** | **133** | **264** | **194** |
| CZ08 | **89** | **1,119** | **191** | **2,410** |  | **179** | **132** | **261** | **191** |
| CZ09 | **89** | **1,119** | **191** | **2,410** |  | **179** | **131** | **260** | **191** |
| CZ10 | **88** | **1,119** | **190** | **2,410** |  | **178** | **131** | **259** | **190** |
| CZ11 | **89** | **1,120** | **193** | **2,411** |  | **180** | **132** | **262** | **193** |
| CZ12 | **92** | **1,122** | **198** | **2,415** |  | **186** | **136** | **270** | **198** |
| CZ13 | **88** | **1,119** | **190** | **2,410** |  | **178** | **131** | **259** | **190** |
| CZ14 | **90** | **1,120** | **194** | **2,412** |  | **181** | **133** | **264** | **194** |
| CZ15 | **76** | **1,110** | **163** | **2,389** |  | **151** | **111** | **220** | **162** |
| CZ16 | **102** | **1,129** | **220** | **2,432** |  | **207** | **152** | **301** | **221** |
| **PG&E** | **95** | **1,124** | **206** | **2,421** |  | **193** | **142** | **280** | **206** |
| **SCG** | **90** | **1,121** | **195** | **2,413** |  | **182** | **134** | **265** | **195** |
| **SDGE** | **90** | **1,120** | **193** | **2,412** |  | **181** | **133** | **263** | **193** |
| **SCE** | **89** | **1,120** | **192** | **2,411** |  | **180** | **132** | **262** | **192** |

## 

## 2.6 Water Savings Estimation Methodologies

Water savings calculation is shown here as a reference.

*Where,*

*And*

**Table 35 Energy Savings for 16 Climate Zones and IOU Territories**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **High Temperature** | | |  | **Low Temperature** | | |
|  | **Base Case** | **Measure  Tier 1** | **Measure  Tier 2** |  | **Base Case** | **Measure  Tier 1** | **Measure  Tier 2** |
| Number of Racks per day  (racks/day) | 141 | 141 | 141 |  | 141 | 141 | 141 |
| Number of Racks per year  (racks/year) | 51,283 | 51,283 | 51,283 |  | 51,283 | 51,283 | 51,283 |
| Water Consumption  (Gal/Rack) | 1.06 | 0.85 | 0.60 |  | 1.50 | 1.06 | 0.86 |
| Daily Water Consumption  (Gal) | 149 | 119 | 84 |  | 211 | 149 | 120 |
| Annual Water Consumption  (Gallons/year) | 54,488 | 43,505 | 30,839 |  | 76,984 | 54,268 | 43,932 |
| **Annual Water Savings**  **(Gallons/year)** | - | **10,983** | **23,648** |  | - | **22,716** | **33,052** |

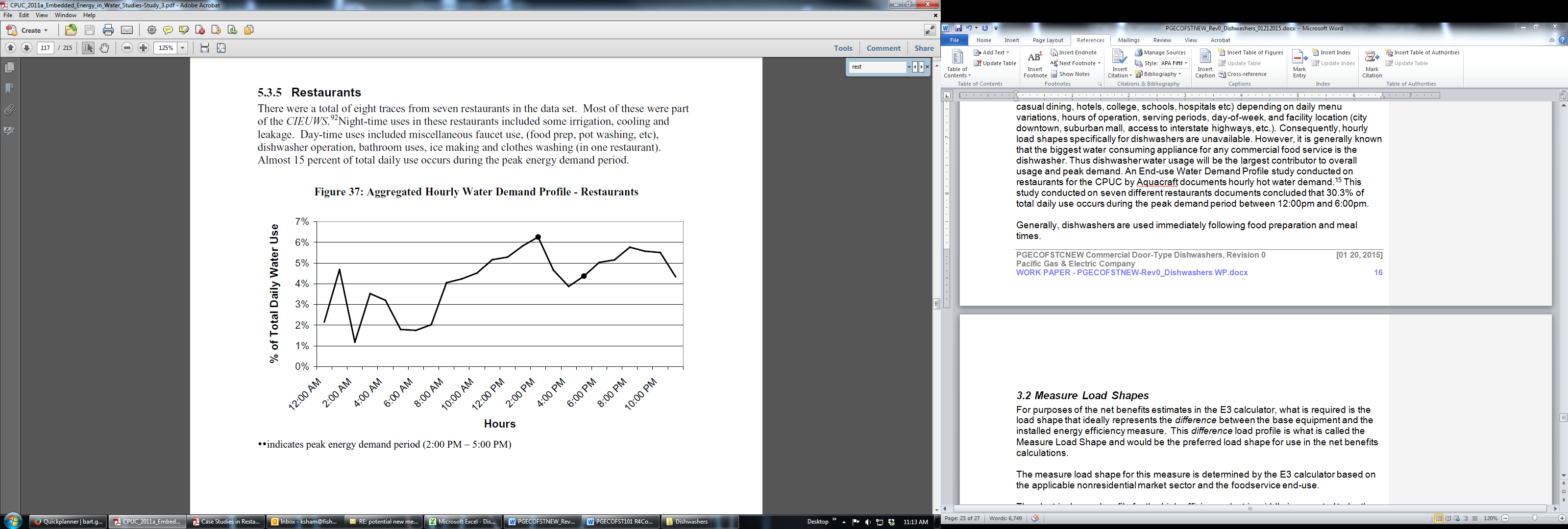
# Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure’s load shape. The measure’s load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure’s Total Resource Cost (TRC) benefit.

## 3.1 Base Case Load Shapes

Commercial dishwasher load shapes differ among food service facilities (quick service, casual dining, hotels, college, schools, hospitals, etc.) depending on daily menu variations, hours of operation, serving periods, day-of-week, and facility location (city downtown, suburban mall, access to interstate highways, etc.). Consequently, hourly load shapes specifically for dishwashers are unavailable. However, it is generally known that the biggest water consuming appliance for any commercial food service is the dishwasher. Thus dishwasher water usage will be the largest contributor to overall hot water usage and peak hot water demand. An End-use Water Demand Profile study conducted on seven different restaurants for the CPUC by Aquacraft documents hourly hot water demand.12 Of the 12 hour period that the dishwasher is typically in operation, between the hours of 10:00 am and 10:00 pm daily, three of the hours are on-peak from 2:00pm to 5:00pm. By summing the aggregated hourly water demand usage during each interval,24.1% of a dishwasher’s energy is consumed during on-peak hours. This data is included in the calculation file embedded at the end of this document.

**Figure 2: Aggregated Hourly Water Demand Profile - Restaurants**



Source: CPUC\_011a Embedded Energy in Water Studies – Study 3

## 3.2 Measure Load Shapes

The electric demand profile for the high-efficiency dishwasher is expected to be the same as the Base Case. The Measure Load Shape for the high-efficiency griddle will use less energy and have a slightly lower demand profile.

# Section 4. Costs

High-efficiency dishwashers typically have a higher list price than standard efficiency dishwashers. Equipment prices for these work papers were compiled from a number of sources including, Autoquotes, equipment sales reps and manufacturer sources. Since equipment pricing in food service is closely held information and prices vary widely according to buying volume and other factors, we cannot list the sources for prices specifically.

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

## 4.1 Base Case Cost

The following Measure Application Types are appropriate to these measures. The Base Case Costs are:

Table 16 Base Case Costs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| Base High Temp |  | $8,600 | $N/A | $N/A | $8,587 |
| Base Low Temp |  | $3,800 | N/A | N/A | $3,825 |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Cost

The following Measure Application Types are appropriate to these measures. The Measure Case Costs are:

Table 17 Measure Case Costs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| ApgDsw001, FS-67513, FS004 | NC, ROB | $10,500 | N/A | N/A | $10,510 |
| ApgDsw002, FS-85137, FS005 | NC, ROB | $12,700 | N/A | N/A | $12,674 |
| ApgDsw003, FS-82265, FS006 | NC, ROB | $4,200 | N/A | N/A | $4,207 |
| ApgDsw004, FS-54161, FS007 | NC, ROB | $7,400 | N/A | N/A | $7,386 |

*All costs are noted as $ per measure unit*

## 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**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB/NC | $1,923 | $10,510 | N/A |
| ROB/NC | $4,087 | $12,674 | N/A |
| ROB/NC | $382 | $4,207 | N/A |
| ROB/NC | $3,561 | $7,386 | N/A |

# Attachments

Attachment A - Commercial Door-Type Dishwasher Energy Calculation



# References

1. Energy Star, http://www.energystar.gov/products/certified-products/detail/commercial-dishwashers [↑](#endnote-ref-1)
2. 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. [↑](#endnote-ref-2)
3. READI v2.1.0 NTGR, Support Table [↑](#endnote-ref-3)
4. Energy Star Commercial Dishwasher Energy Savings Calculator Assumptions (See “Assumptions” tab, Door-Type Dishwashers) [www.energystar.gov/buildings/sites/default/uploads/files/commercial\_kitchen\_equipment\_calculator.xlsx?5da4-3d90&5da4-3d90](http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx?5da4-3d90&5da4-3d90) [↑](#endnote-ref-4)
5. ASTM F1696-07 Standard Test Method for Energy Performance Single-Rack, Door-Type Commercial Dishwashing Machines. Published July 2011. [↑](#endnote-ref-5)
6. NSF Commercial Dishwasher Certification Database

   [↑](#endnote-ref-6)
7. Energy Star Commercial Dishwashers Key Product Criteria available at:

   <http://www.energystar.gov/index.cfm?c=comm_dishwashers.pr_crit_comm_dishwashers> [↑](#endnote-ref-7)
8. CZ2010 Weather Files (weather files for 2013 Title-24)

    [↑](#endnote-ref-8)
9. Water heater fixture measure disposition: 2013-2014\_DHWFixtureMeasures\_Disposition-1March2013.docx, DEER-WaterHeater-Calculator-v1.0.xlsm [↑](#endnote-ref-9)
10. Energy Star Commercial Dishwasher Energy Savings Calculator http://www.energystar.gov/products/certified-products/detail/commercial-dishwashers [↑](#endnote-ref-10)
11. Personal communication with Boxer Northwest commercial dishwasher retailer. [↑](#endnote-ref-11)
12. Aquacraft, Inc., Embedded Energy in Water Studies. Study 3: End-use Water Demand Profiles. CALMAC STUDY ID CPU0052

    http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Water\_Appliances\_12-AAER-2C/California\_IOU\_Response\_to\_CEC\_Invitation\_to\_Participate-Lavatory\_Faucets\_and\_Faucet\_Accessories\_REFERENCES/CPUC\_2011a\_Embedded\_Energy\_in\_Water\_Studies-Study\_3.PDF [↑](#endnote-ref-12)
13. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, pp. 3-15 to 3-18. [↑](#endnote-ref-13)