**Work Paper PGECOAPP123**

**Ozone Laundry Nonresidential**

**Revision # 4**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Ozone Laundry Nonresidential**

**Measure Codes B85**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | **B85** |
| **Measure Description:** | Installation of an ozone generator on an existing or new residential laundry facility |
| **Energy Impact Common Units:** | Total on-site washer capacity [pounds] |
| **Base Case Description:** | The base case is a conventional washing machine without an ozone generator with a hot water boiler meeting minimum regulated thermal efficiency standards.  i.e. 80% thermal efficiency as required by Title 20. |
| **Base Case Energy Consumption:** | Source: Engineering calculations  45.7 therms/year/lbs-capacity (washer capacity) |
| **Measure Energy Consumption:** | Source: Engineering calculations  6.4 therms/year/lbs-capacity (washer capacity) |
| **Energy Savings**  **(Base Case – Measure):** | Source: Engineering calculations  39.3 therms year/lbs-capacity (washer capacity) |
| **Costs Common Units:** | Total on-site washer capacity [pounds] |
| **Base Case Equipment Cost ($/unit):** | $0 |
| **Measure Equipment Cost ($/unit):** | Source: Engineering calculations  $75.73 |
| **Gross Measure Cost ($/unit)** | Source: Engineering calculations  $75.73 |
| **Measure Incremental Cost ($/unit):** | Source: Engineering calculations  $75.73 |
| **Effective Useful Life (years):** | 10 Years |
| **Measure Application Type:** | Retrofit Add On (REA)  New Construction (NC) |
| **Net-to-Gross Ratios:** | Source: DEER 2014, READI version 1.0.4  NTG = 0.60[[1]](#endnote-1) Com-Default>2yrs index 47 |
| **Important Comments:** |  |

# Work Paper Approvals

The following Manager(s) approved this workpaper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
|  |
| **Grant Brohard**  Manager, Technical Product Support |
| **Carolyn Weiner**  Manager, Core Products |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| **Revision 1** | **9/3/09** | **Original work paper**  **Ozone Laundry Nonresidential**  **PGECOAPP123 R0** | **Tim Minezaki (kW Engineering)** |
| **Revision 2** | **3/8/10** | **Updated NTG** | **Andrew Wieszczyk (PG&E)** |
| **Revision 3** | **5/21/12** | **Ozone Laundry PGECOAPP123 R3.doc**  **NTG updated and DEER tech type table added** | **Jenny Roecks (PG&E)** |
| **Revision 3** | **8/24/12** | **Ozone Laundry PGECOAPP123 R3.doc**  **Adjustments made for ED directives** | **Steve Blanc(PG&E)** |
| **Revision 4** | **5/2/2014** | **Ozone Laundry PGECOAPP123 R4.doc**  **Updated with new template.** | **Jia Huang (PG&E)** |

# Table of Contents

[At-a-Glance Summary ii](#_Toc386803553)

[Work Paper Approvals iii](#_Toc386803554)

[Document Revision History iv](#_Toc386803555)

[Table of Contents v](#_Toc386803556)

[List of Tables vi](#_Toc386803557)

[List of Figures vi](#_Toc386803558)

[Section 1. General Measure & Baseline Data 1](#_Toc386803559)

[1.1 Product Measure Description & Background 1](#_Toc386803560)

[1.2 Product Technical Description 2](#_Toc386803561)

[1.3 Measure Application Type 2](#_Toc386803562)

[1.4 Product Base Case and Measure Case Data 3](#_Toc386803563)

[1.4.1 DEER Base Case and Measure Case Information 3](#_Toc386803564)

[1.4.2 Codes & Standards Requirements Base Case and Measure Information 3](#_Toc386803565)

[1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information 4](#_Toc386803566)

[1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases 4](#_Toc386803567)

[Section 2. Calculation Methods 5](#_Toc386803568)

[2.1 Electric Energy Savings Estimation Methodologies 5](#_Toc386803569)

[2.2. Demand Reduction Estimation Methodologies 6](#_Toc386803570)

[2.3. Gas Energy Savings Estimation Methodologies 6](#_Toc386803571)

[*Calculating Gas Energy Intensity for Hot Water (therms / gallon of hot water)* 6](#_Toc386803572)

[*Determining Washer Utilization Factor (annual laundry / lbs laundry capacity)* 7](#_Toc386803573)

[*Determining Hot Water Usage Factor (gallons of hot water / lb of clothes)* 7](#_Toc386803574)

[*Determining Hot Water Reduction Factor (% reduction in hot water)* 8](#_Toc386803575)

[2.4 Water Savings Estimation Methodologies 9](#_Toc386803576)

[*Section 3. Load Shapes* 10](#_Toc386803577)

[3.1 Base Case Load Shapes 11](#_Toc386803578)

[3.2 Measure Load Shapes 11](#_Toc386803579)

[Section 4. Base Case & Measure Costs 11](#_Toc386803580)

[4.1 Base Case(s) Costs 11](#_Toc386803581)

[4.2 Measure Case Costs 11](#_Toc386803582)

[4.3 Incremental & Full Measure Costs 12](#_Toc386803583)

[4.3.1 Full Measure Cost 12](#_Toc386803584)

[4.3.2 Incremental Measure Costs 13](#_Toc386803585)

[References 14](#_Toc386803586)

# List of Tables

[Table 1 Market Potential 2](#_Toc386803146)

[Table 2 Measure Application Type 3](#_Toc386803147)

[Table 3 DEER Net-to-Gross Ratios 3](#_Toc386803148)

[Table 4 TOU Adjustment Factors 4](#_Toc386803149)

[Table 5 Baseline by Measure Application Type 5](#_Toc386803150)

[Table 6 Washer Utilization Rate 7](#_Toc386803151)

[Table 7 Hot Water Use Factor 8](#_Toc386803152)

[Table 8 Hot Water Reduction Factor 8](#_Toc386803153)

[Table 9 Water Usage and Reduction Factors 10](#_Toc386803154)

[Table 10 Measure Costs 12](#_Toc386803155)

# List of Figures

**No table of figures entries found.**

# 

# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description –***

The ozone laundry system(s) is a piece of equipment that is added-on to new or existing commercial washing machine(s). The system generates ozone (O3), a naturally occurring molecule, which helps clean fabrics by chemically reacting with soils in cold water. Adding an ozone laundry system(s) will reduce the amount of chemicals, detergents, and hot water needed to wash linens. Using ozone also reduces the total amount of water consumed, saving even more in energy. Purchase and install ozone laundry system(s) on or after November 1, 2009 to be eligible for this rebate.

***Requirements:***

* Customer must have a natural gas-fired boiler or natural gas water heater that supplies hot water to the on-premise laundry equipment.
* This incentive only applies to the following facilities with on-premise laundry operations:
  + Hotels/motels with fewer than 250 guest rooms.

or

* + Fitness and recreational sports centers.
* The ozone laundry system(s) must be a new purchased product and installed with a new or existing commercial washing machine(s).
* The ozone laundry system(s) must transfer ozone into the water through:
  + Venturi Injection

or

* + Bubble Diffusion

***Application Process:***

* For hotel customers: The total number of guest rooms must be included on the invoice.
* Must include a manufacturer’s specification sheet documenting manufacturer name, equipment model, and ozone laundry system’s serial number(s).
* Must include total washer capacity in pounds for operating washer units with ozone laundry system(s) connected.

***Program Restrictions and Guidelines***

***Terms and Conditions:***

The rebate is downstream provided to the customer at the time of sale upon receipt of application and invoice. This is not a Direct Install program.

***Market Applicability:***

This measure is applicable for hotels with less than 250 guest rooms as well as all health centers. Data for health centers from three NRR applications show gas savings consistent with that of hotels. However, it will currently be assumed that health centers will use the same measure energy savings that are calculated for hotels. This measure is not applicable to residential or multi-family facilities.

Table 1 below shows the market potential savings from ozone across a variety of market sectors. Detailed calculations regarding the market potential calculations can be found in the appendix.

Table 1 Market Potential

|  |  |  |  |
| --- | --- | --- | --- |
| **Market Sector** | # of Facilities in California | Water Savings [Gal/year] | Gas Savings [Therms/year] |
| Hospitality [hotels/motels] [[2]](#endnote-2) | 5,480 | 774,138,346 | 10,904,499 |
| Nursing Homes [[3]](#endnote-3) | 1,274 | 170,266,358 | 2,398,369 |
| State Prisons [[4]](#endnote-4) | 33 | 251,445,378 | 3,541,855 |
| County Jails [[5]](#endnote-5) | 58 | 130,146,869 | 1,833,247 |
| Gymnasiums [[6]](#endnote-6) | 3,337 | n/a | n/a |
| Total Market Potential: | | 1,325,996,950 | 18,677,970 |

## 1.2 Product Technical Description

This work paper provides an estimate of energy savings associated with retrofitting a conventional commercial laundry system with an ozone generator. Ozone is a powerful oxidant and disinfectant which can reduce odors and remove organic contaminants. Ozone cleans fabrics by chemically reacting with soils. Ozone removes electrons from the soils, causing the soils to break down into smaller molecules that become water soluble and are released from the linen by ordinary agitation. Because of its properties, it is a good alternative to conventional detergents and bleach. The use of ozone allows laundry machines to operate effectively in cold water. Natural gas energy savings will be achieved at the hot water heater/boiler as they will be required to produce less hot water to wash each load of laundry. The decrease in hot water usage will increase cold water usage, but overall water usage at the facility will decrease.

The most common method of producing ozone for laundry applications is via corona discharge. Simply put, dry air is passed through an electrical field. The electric field causes some of the oxygen molecules to split into separate oxygen atoms. Individual oxygen atoms are unstable and attach to other oxygen molecules, forming ozone molecules. Ozone is rarely generated and then stored, but instead is generated and/or while the washer-extractor is in operation. Different manufacturers of ozone equipment for laundry operations use a variety of techniques to apply or introduce the ozone gas into the washer-extractor. The four most common methods are:

1. Recirculation injection – Wash water is continuously circulated between the washer and ozone system. As a result, the wash water is continuously re-oxidized and ozone-enriched.
2. Diffusion – Ozone is continuously injected directly into the sump of the washer throughout each step of the wash cycle.
3. Direct water injection – A venturi injects ozone into the cold-water supply line leading to the washer.
4. Charge system – Ozone is mixed with cold water and then continually recycled between a contact vessel and the ozone system to maintain a predetermined ozone level in the water. The water containing ozone is delivered to the washer on demand and the ozone-enriched water is not recharged once it enters the washer.

## 1.3 Measure Application Type

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

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

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

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ER | Early retirement | *Measure is more efficient than code/std; Dual baseline, full measure costs required* |
| ROB | Replace on Burnout | *Single baseline (above code), incremental or full costs* |
| NC | New Construction | *Single baseline (above code), incremental or full costs* |
| REA | Retrofit Add On | *Single baseline (above pre-existing), full measure costs required* |

This measure is identified as either Retrofit Add On or New Construction.

## 1.4 Product Base Case and Measure Case Data

## 1.4.1 DEER Base Case and Measure Case Information

This measure is not included in the Database for Energy Efficient Resources (DEER).

**Net-to-Gross Assumption:**

Table 3 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

Table 3 DEER Net-to-Gross Ratios

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **DEER Spreadsheet** | |
| Program Approach | NTG | File name | Cell Number |
| Com-Default>2yrs:  All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | 0.6 | SupportTable\_NTGR.csv1 | D52 |

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

***Title 20:*** This measure does not fall under Title 20 of the California Energy Regulations. However, water heating equipment is regulated under the Title 20 Appliance Standard of the California Energy Regulations (October 2012). Section 1605.1.f.1 (Table F-3) requires that gas hot water supply boilers have a minimum thermal efficiency of 80%.[[8]](#endnote-8)

***Title 24:*** This measure does not fall under Title 24 of the California Energy Regulations.

***Federal Standards:*** This measure does not fall under Federal DOE or EPA Energy Regulations.

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

***1.4.3.1 The Benefits of Ozone in Hospitality On-Premise Laundry Operations[[9]](#endnote-9)***

PG&E’s Emerging Technologies Program developed a paper highlighting the potential therm savings of ozone washers at a hospitality site in Emeryville, California. The value of the natural gas saved due to the replacement of hot water with cold was the leading component of total savings. The value of the electricity savings was minor, but the value of the water and sewer savings was larger than expected. Total savings resulted in a simple payback of 7.5 months.

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

**Energy Savings Assumption (ΔW, ΔTherms):** A number of ozone washing machine projects have received incentives under PG&E’s Non-Residential Retrofit-Demand Response (NRR-DR) incentive program. The data gathered from those incentive reviews has been utilized to calculate run-time factors, measure cost data, and base case efficiency factors.

**Base Case Costs and Measure Case Costs:** An average measure cost per unit capacity was generated using data collected from ozone laundry projects that received incentives under PG&E’s Non-residential Retrofit-Demand Response program (NRR-DR).

**Effective Useful Life:** The measure equipment effective useful life (EUL) is estimated at 10 years based on the typical life of the ozone generator’s corona discharge unit.

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

We are required by CPUC decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since this is not an A/C measure, the TOU adjustment factor is 0.

The specific values and results are summarized in Table 4

Table 4 TOU Adjustment Factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | ***kWAC*** | ***kWTotal*** | **%** |
| Ozone Generator | 0 | 0 | 0 |

***1.5 Summary of Inputs for Savings Calculations***

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | Any | -- | *--* | *--* |  |
| **Gas Savings** | Any | -- | -- | 39.3 therms | *Section 2.3* |
| **Hours of operation** | Any | -- | -- | -- |  |
| **Full Cost** | REA, NC | -- | -- | $75.73 | *Section 4.3.1* |
| **Incremental Cost** | REA, NC | -- | -- | $75.73 | *Section 4.3.2* |
| **EUL /RUL** | REA, NC | -- | -- | 10 years | *Section 1.4.4* |
| **NTG** | One | -- | -- | 0.6 | *Section 1.4.1* |
| **ISR** | No | -- | -- | -- |  |
| **TOU Factor** | *A/C projects only* | *--* | *--* | *--* |  |

# 

# Section 2. Calculation Methods

Table 5 Baseline by Measure Application Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period: Energy Savings Baseline** | **Second Baseline Period: Energy Savings Baseline** |
| ***ER* (early retirement)** | **EUL** | Customer Average Baseline | Code Baseline |
| ***ROB* (replace-on-burnout)** | **EUL** | Code Baseline | N/A |
| ***NC* (new construction)** | **RUL/EUL-RUL** | Code Baseline | N/A |
| ***REA (retrofit add on)*** | **EUL** | Code Baseline | N/A |

Notes:

* For ROB and REA measures, First Baseline is the baseline for the full EUL. There is no second baseline.
* For ER measures, First Baseline Period is the period for the RUL(remaining useful life),defined by the CPUC as RUL=1/3 EUL. Second baseline period for ER is Code baseline for the period EUL-RUL.

## 2.1 Electric Energy Savings Estimation Methodologies

Based on data and analysis provided by the Emerging Technologies Report6 and several ozone generator manufacturers, we recognize that in addition to the natural gas savings from ozone generation, there are potential impacts to site electrical energy use. The potential impacts are discussed below; however, there is currently insufficient data to accurately quantify the net magnitude of the impacts for this analysis.

* **Hot Water Pump(s)** [kWh]: reduced hot water consumption may result in additional electrical savings by reducing the pumping load.
* **Clothes Washer** [kWh]: retrofitting existing washer to utilize ozone can reduce the total washer cycle length saving electrical energy for each cycle.
* **Clothes Dryer** [kWh and therms]: the reduced washer cycle length may decrease the dampness of the clothes when they move to the dryer. This can result in shorter runtimes which result in gas and electrical savings.
* **Ozone Generator** [kWh]: the ozone generator uses electricity to generate ozone and thus will add to the site energy use.

As this technology matures and becomes more widely adopted, further data may be available to quantify the net electrical energy impacts.

## 2.2. Demand Reduction Estimation Methodologies

There is no anticipated demand reduction associated with this measure.

## 2.3. Gas Energy Savings Estimation Methodologies

Gas savings calculations for this measure were based solely on the reduction in hot water use. In calculating therm savings based on hot water use, four main components are needed:

1. Gas Energy Intensity for Hot Water (a measure of boiler efficiency)
2. Washer Utilization Factor (a measure of washer use rate)
3. Hot Water Usage Factor (a measure of how efficient a baseline machine is)

Hot Water Reduction Factor (a measure of how well the ozone system reduced hot water from the base case).

### *Calculating Gas Energy Intensity for Hot Water (therms / gallon of hot water)*

In order to estimate savings normalized per unit of washer capacity [lbs of laundry], average gas energy intensity is needed [therms/gallon]. This factor is a measure of the typical boiler efficiency and is translated into a quantity of hot water used.

Engineering calculations were developed based on assumptions about the boiler, incoming municipal water temperature, and hot water temperature for the boilers. The base case boiler efficiency is the regulated minimum efficiency (80%), per Title 20 Appliance Standard of the California Energy Regulations (October 20012). Section 1605.1.f.1 (Table F-3) requires that gas hot water supply boilers have a minimum thermal efficiency of 80%.6 The incoming municipal water temperature is assumed to be 60 °F with the hot water supply temperature assumed to be 135 °F. These temperatures were based on default test procedures on clothes washers set by the Department of Energy’s Office of Energy Efficiency and Renewable Energy[[10]](#endnote-10). Enthalpies for these temperatures were obtained from ASHRAE Fundamentals[[11]](#endnote-11).

The gas energy intensity is based on the difference in enthalpy between the incoming municipal water and the boiler supply temperature multiplied by the density of water and divided by the boiler efficiency:







This value represents the amount of thermal energy required to raise one gallon of water from 60 ºF to 135 ºF.

### *Determining Washer Utilization Factor (annual laundry / lbs laundry capacity)*

In order to estimate savings normalized per unit of washer capacity [lbs of laundry], an average washer utilization factor is needed. That is, the average annual quantity of clothes washed [lbs of laundry] per unit of washer capacity [lbs of laundry] is needed. This factor is a measure of the runtime of a typical laundry facility in terms of the common unit [lbs of laundry capacity].

Average utilization factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. The median value was used to prevent limited data points from skewing the washer utilization factor. Table 6 summarizes data gathered from several NRR-DR projects:

Table 6 Washer Utilization Rate



Note:

- 4,380 lbs/lb-capacity approximates to an average washer use rate of 12 cycles/day.

- The shaded rows in Table 6 represent projects that did not have washer utilization data. This is due to differing calculation methods.

### *Determining Hot Water Usage Factor (gallons of hot water / lb of clothes)*

In order to estimate savings, a typical hot water use per unit of laundry is needed. This factor represents how efficiently a typical conventional washing machine utilized hot water normalized per unit of clothes washed.

Average hot water usage factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. Table 7 summarizes data gathered from several NRR-DR projects:

Table 7 Hot Water Use Factor



Note:

- The shaded rows in Table 7 represent projects that did not have hot water data available. This is due to differing calculation methods.

### *Determining Hot Water Reduction Factor (% reduction in hot water)*

In order to calculate the savings resulting from installation of an ozone generator, an average hot water reduction factor is needed. This factor represents how much more efficient an ozone injection washing machine is compared to a typical conventional washing machine as a rate of hot water reduction.

Average hot water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 8 summarizes data gathered from several NRR-DR projects:

Table 8 Hot Water Reduction Factor



Note:

- The shaded rows in Table 8 represent projects that did not have total water data available. This is due to differing calculation methods.

***Annual Gas Savings:***

Finally, the average annual gas savings for the measure is calculated below:

Annual Gas Savings [therms/Unit] = Annual Base Gas Usage – Annual Measure Gas Usage

  








## 2.4 Water Savings Estimation Methodologies

Water savings are presented here for information only and not as a basis of energy impacts. The savings calculations listed here account for the combination of hot and cold water used. Savings calculations for this measure were based on the reduction in total water use from implementing an ozone washing system to the base case. There are three main components in obtaining this value:

1. Water Usage Factor (a measure of how water efficient a base case machine is)
2. Water Reduction Factor (a measure of how well the ozone system reduced water from the base case)
3. Washer Utilization Factor (a measure of washer use rate)

Average water usage and water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 9 summarizes data gathered from several NRR-DR projects:

Table 9 Water Usage and Reduction Factors



Note:

- The shaded rows in Table 9 represent projects that did not have total water data available or did not have washer utilization data available. This is due to differing calculation methods.

The Washer Utilization Factor is also based on data collected from the NRR-DR program and is calculated above in the Gas Savings Calculations.

Finally, the average annual water savings for the measure is calculated below:





# *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

Load shapes are not applicable to gas measures because the price of gas is not dependent on time-of-use.

## 3.2 Measure Load Shapes

Load shapes are not applicable to gas measures because the price of gas is not dependent on time-of-use.

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **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 |
| ***REA (retrofit add on)*** | EUL | Calculated as Full Gross Measure Cost | N/A |

## 4.1 Base Case(s) Costs

Load shapes are not applicable to gas measures because the price of gas is not dependent on time-of-use.

## 4.2 Measure Case Costs

Average costs per unit of capacity were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 10 summarizes data gathered from several NRR-DR projects:

Table 10 Measure Costs



## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Full Measure Cost**  **(RUL Period/First Baseline)** | **Full Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ER | Measure Equipment Cost  +Measure Labor Cost | (-1)x(Base Equipment Cost  + Base Labor Cost) | Measure Equipment Cost  – Base Case Equipment Cost |
| ROB | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |
| NC | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |
| REA | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |

## 4.3.1 Full Measure Cost

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

The Measure Application Types are: **NC** or **ROB**, so the Full Measure Cost (FMC) is represented by the equation below:

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

(Base Case Equipment Cost + Base Case Labor Cost)

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

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

*FMC = $75.73 per (unit) - $0 per (unit) = $75.73 per unit*

## 4.3.2 Incremental Measure Costs

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

The Measure Application Types are: **REA,** and **NC** so the Incremental Measure Cost (GMC) is represented by the appropriate equation below:

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

(Base Case Equipment Cost + Base Case Labor Cost)

\*Note: Unless stated otherwise the measure case and base case labor costs are typically the same, reducing the equation to the following:

IMC = Measure Equipment Cost – Base Case Equipment Cost

*IMC = $75.73 per (unit) -- $0 per (unit) = $75.73 per (unit)*

**Summary Table for Section 4**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Measure Application Types** | **Base Case Total Cost** | **Measure Case Total Cost[[12]](#endnote-12)** | **Full Measure Case Cost** | **Incremental Measure Cost** |
| B85 | REA | $0 | $75.73 | $75.73 | $75.73 |
| B85 | NC | $0 | $75.73 | $75.73 | $75.73 |

# 

# References

1. California Public Utilities Commission (CPUC), Database for Energy Efficient Resources (DEER) v. 2014, Table Name: *NTGR*, NTG\_ID: *Com-Default>2yrs*, extracted from READI\_v1.0.4.zip, downloaded from [www.deeresources.com](http://www.deeresources.com). [↑](#endnote-ref-1)
2. "Lodging Report", December 2008, California Travel & Tourism Commission, <http://tourism.visitcalifornia.com/media/uploads/files/editor/Research/CaliforniaTourism_200812.pdf> [↑](#endnote-ref-2)
3. "Health, United States, 2008" Table 120, U.S. Department of Health & Human Services, Centers for Disease Control & Prevention, National Center for Health Statistics, <http://www.cdc.gov/nchs/data/hus/hus08.pdf#120> [↑](#endnote-ref-3)
4. [Fourth Quarter 2008 Facts and Fictures, California Department of Corrections & Rehabilitation (CDCR)](http://www.cdcr.ca.gov/Divisions_Boards/Adult_Operations/docs/Fourth_Quarter_2008_Facts_and_Figures.pdf), <http://www.cdcr.ca.gov/Divisions_Boards/Adult_Operations/docs/Fourth_Quarter_2008_Facts_and_Figures.pdf> [↑](#endnote-ref-4)
5. [Jail Profile Survey (2008), California Department of Corrections & Rehabilitation (CDCR)](http://www.cdcr.ca.gov/Divisions_Boards/CSA/FSO/Docs/2008_4th_Qtr_JPS_full_report.pdf), <http://www.cdcr.ca.gov/Divisions_Boards/CSA/FSO/Docs/2008_4th_Qtr_JPS_full_report.pdf> [↑](#endnote-ref-5)
6. Ozone in Laundry Facilities, Prepared by Global Energy Partners, LLC / 02 April 2007 [↑](#endnote-ref-6)
7. The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls.* [↑](#endnote-ref-7)
8. California Code of Regulations, Title 20, Section 1605.1.f.1 (Table F-3), October 2012. [↑](#endnote-ref-8)
9. The Benefits of Ozone in Hospitality On-Premise Laundry Operations, PG&E Emerging Technologies Program, Application Assessment Report #0802, April 2009. [↑](#endnote-ref-9)
10. Federal Register, Vol. 52, No. 166 [↑](#endnote-ref-10)
11. 2009 ASHRAE Handbook – Fundamentals, Thermodynamic Properties of Water at Saturation, Section 1.1 (Table 3), 2009 [↑](#endnote-ref-11)
12. SCE, Measure Cost Revision 5 revised for PG&E by S.L. Blanc 2012

     [↑](#endnote-ref-12)