Work Paper WPSCGNRAP170103

**Revision 0**

**SoCalGas**

**Gas Dryer Modulating Valve: Commercial and Multi-Family**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | - Mod Nat Gas Valve Com App  - Mod Nat Gas Valve Hotel App  - Mod Nat Gas Valve Motel App  - Mod Nat Gas Valve Nursing Home App  - Mod Nat Gas Valve MFm App  - Mod Nat Gas Valve CoinOP App |
| **Measure Description** | A modulating gas valve that will replace OEM gas valve in natural gas dryers. Modulating valve provides two stages, high and low fire rates which are controlled in real time by a program and a temperature sensor. |
| **Base Case Description** | An existing gas dryer with no aftermarket alterations that effect natural gas use. |
| **Units** | Each |
| **Energy Savings** | -Mod Nat Gas Valve Com App: 511.20 Therms  -Mod Nat Gas Valve Hotel on site laundry: 344.06 Therms  -Mod Nat Gas Valve Motel on site laundry: 344.06 Therms  -Mod Nat Gas Valve Health Care on site laundry: 427.59 Therms  -Mod Nat Gas Valve Coin Operated Laundry: 67.52 Therms  -Mod Nat Gas Valve MFm: 28.06 Therms |
| **Full Measure Cost ($/unit)** | $2050 |
| **Incremental Measure Cost ($/unit)** | $2050 |
| **Effective Useful Life** | EUL ID: Com-GasDryer: 14 years  RUL: 4.67 years |
| **Measure Installation Type** | Retrofit Add-on (REA) |
| **Net-to-Gross Ratio** | 0.7 (DEER NTGR ID: All-Default<=2yrs) |
| **Important Comments** | 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** |
| 0 | 3/31/2017 | Julianna Colwell (SoCalGas) | * New workpaper. |
|  |  |  |  |

Contents

[At-a-Glance Summary 2](#_Toc484766188)

[Revision History 3](#_Toc484766189)

[Commission Staff and Cal TF Comments 3](#_Toc484766190)

[Section 1. General Measure & Baseline Data 5](#_Toc484766191)

[1.1 Measure Description & Background 5](#_Toc484766192)

[1.2 Technical Description 6](#_Toc484766193)

[1.3 Installation Types and Delivery Mechanisms 6](#_Toc484766194)

[1.4 Measure Parameters 7](#_Toc484766195)

[1.4.1 DEER Data 7](#_Toc484766196)

[1.4.2 Codes and Standards Analysis 8](#_Toc484766197)

[1.5 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information 8](#_Toc484766198)

[1.5.1 Nicor Gas Commercial Dryer Modulation Retrofit 8](#_Toc484766199)

[1.5.2 PG&E Main Project: Hilton-600 Airport Blvd. Burlingame – Dryer Modulating Gas Valve 9](#_Toc484766200)

[1.5.3 On Premise Laundromat (OPL) Dryers Market Survey 9](#_Toc484766201)

[1.5.4 SCG Engineering Data Collection La Mirada 9](#_Toc484766202)

[1.5.5 PGECOAPP129 Residential Clothes Dryers 10](#_Toc484766203)

[1.5.6 Commercial Clothes Dryers 10](#_Toc484766204)

[1.6 Data Quality and Future Data Needs 10](#_Toc484766205)

[Section 2. Calculation Methodology 10](#_Toc484766206)

[Section 3. Load Shapes 15](#_Toc484766207)

[Section 4. Costs 16](#_Toc484766208)

[\* Regulators are required for large drummed dryers to operate a modulating unit properly. They are normally supplied with the modulating valve kits for an additional cost. 16](#_Toc484766209)

[4.1 Base Case Cost 16](#_Toc484766210)

[4.2 Measure Case Cost 16](#_Toc484766211)

[4.3 Full and Incremental Measure Cost 17](#_Toc484766212)

[Attachments 18](#_Toc484766213)

[References 19](#_Toc484766214)

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This measure applies to natural gas dryers in the commercial and residential multifamily sectors. For the commercial sector this measure will apply to the following building types: general commercial, hotels, motels, coin operated laundry and nursing homes. This measure will be offered as an REA type and will deliver substantial energy savings within the selected building types. This measure will not be available for dryers exceeding a capacity of 200 and less than 20Lbs and it is recommended that for capacities outside of this range a custom measure type is more appropriate.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Modulating replaces non modulating valve in a gas dryer and appropriate temperature probes are installed in the exhaust stack. |
| Existing Condition | Unmodified natural gas dryer with a single stage valve without required sensors. |
| Code/Standard | Title 20 defines the existing condition. The code is not applicable to this EE measure. |
| Industry Standard Practice | Unmodified natural gas dryer with a single stage valve. |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| TBD |  |  |  | Modulating Gas Valve with hi/low fires for natural gas dryers for on-site commercial dryers up to 200 Lb. capacity |

* **Eligibility requirements**: Natural gas dryers must not be modified by any technology that would reduce the natural gas consumption beyond the manufacturer’s specifications. The Dryers in this measure must have an accessible gas valve assembly and room to install the modulating device in the unit and on the unit’s exhaust. The Dryers must have a drum capacity ranging from 20-200 Lbs. No dryer that make use of a common or dedicated steam systems will qualify and all applicants must have their dryers on site. Natural gas must be supplied by a California Utility.
* **Implementation and installation requirements**: New and existing buildings of all vintages are eligible. The dryer being modified must be used in a commercial or multifamily sector.
* **Trained and Qualified Technician**: It is suggested that a professionally trained and qualified installer install this product as the inlet natural gas line will have to be removed and reattached during installation.
* **Other program restrictions and guidelines:** This work paper does not restrict the manufacturer of the device. Devices that are able to reduce the energy consumed by modulating the throughput of natural gas and monitor moisture/temperature of the unit qualify.

## 1.2 Technical Description

A modulating two stage unit replaces the single stage valve of an existing natural gas dryer with associated sensors in the flue exhaust. This device modulates the valve from low to high fire and is controlled by the feedback from the temperature sensor in the flue exhaust. This allows for a reduction of natural gas consumption per dryer load-cycle by the burner. It is considered that during the initial stages of a dryer cycle the moisture content is at maximum, therefore a high fire rate is needed to reduce the moisture. During the later stages of the cycle, the moisture content has been reduced and a higher fire rate creates more than necessary heat. This modulating valve allows for the lower fire rate to function when the moisture content has been reduced from maximum. Currently most standard dryers have a single fire rate and this modulating technology will make them consume less energy while performing the same function.

## 1.3 Installation Types and Delivery Mechanisms

This measure is a retrofit add-on as it modifies the existing dryer equipment, but does not replace the unit itself. This triggers the use of an RUL for the 1st baseline and no second baseline is needed. This will be offered to commercial and MFm customers through a down-stream incentive after proof of purchase and installation are verified.

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | RUL | N/A |

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** |
| 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** |
| Prescriptive Rebate  (PreReb) | 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. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

This measure has no applicable DEER data that could be used to estimate a Therm savings value.

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 | No |
| DEER Version | N/A |
| Reason for Deviation from DEER | Not an available DEER measure to allow for comparison |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG value was obtained using the DEER READI v.2.4.7 tool. The relevant NTG value for the measures in this work paper are in the table below. There is no default value for new commercial/residential programs in DEER, leaving the All-Default value as the most applicable to this measures.

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

**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 value was obtained using the DEER READI v.2.4.7 tool. The relevant IR value for these measures is 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**

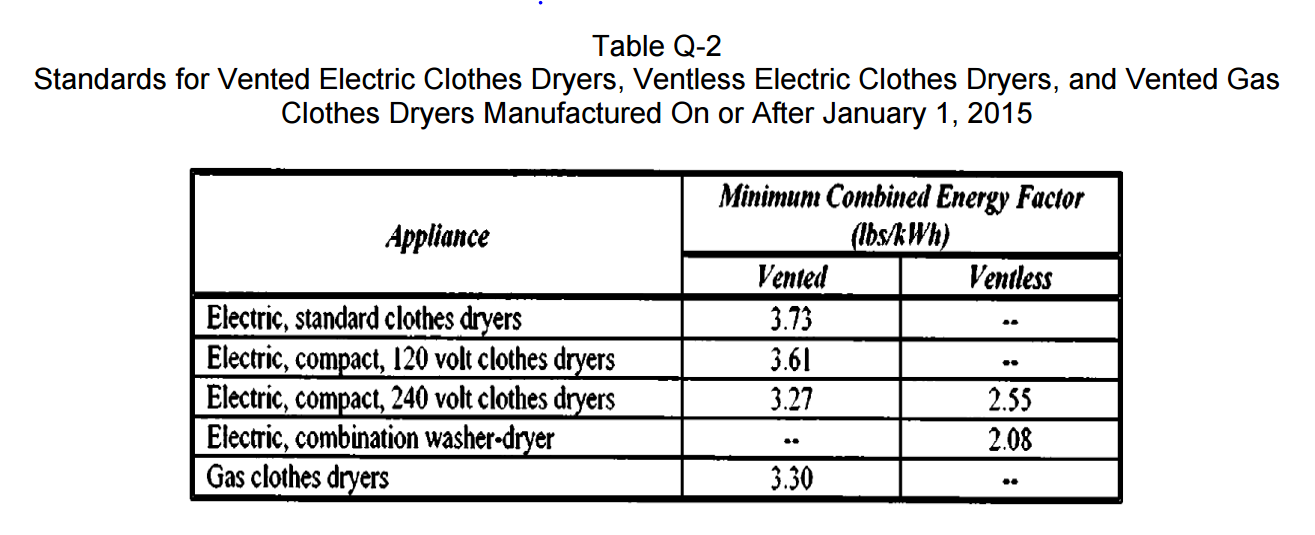
Due to this being an REA measure, the RUL value will be used in place of the EUL value when evaluating the measures. RUL is defined as 1/3 of the EUL of the technology being modified. In this case the technologies being modified are the Com and Mfm dryers. The EUL of the modulating gas unit itself is 10 years per manufacture specifications. There is no defined value in DEER for commercial dryers. Attachment F establishes as Dryer EUL, which is 14 years.

The RUL would then be 1/3 of the EUL of the Dryers (1/3\*14 = 4.7).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| Com-GasDryer | Commercial Use Natural Gas Dryers | Com | AppPlug | 14 | 4.7 |

### 1.4.2 Codes and Standards Analysis

Title 20 is the only applicable code to dryer manufacturing in the state of California. Currently there is no requirements for modulating technology per section 1605.1 (q) of Title 20. Tittle 20 requirements are presented below.



Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2016) | Section 1605.1(q) Clothes Dryers | December 31, 2016 |

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

There are six studies, surveys, data collection, and custom reports that have influenced this work paper.

### 1.5.1 Nicor Gas Commercial Dryer Modulation Retrofit

Attachment A

* Completed on September 16, 2014.
* There was a standardized test and a long term monitoring test conducted on the same equipment at 5 test locations, which totaled 11 dryer units. This yielding a percentage saving results from the addition of the modulating gas unit.
* Six months of data was collected for the long term study; 3 as a baseline and 3 as a measure case. A standardized test in “lab like” conditions was also performed. The market covered was laundromats, dry cleaning, hospitality, and healthcare.
* This study used monitoring equipment to gather dryer cycles, makeup air temp, and gas use that was then applied to gather Therm savings.
* Study concluded the modulation technology produces a 12.4% reduction in natural gas consumed by a dryer.
* More stringent studies could further validate and improve the savings accuracy.

### 1.5.2 PG&E Main Project: Hilton-600 Airport Blvd. Burlingame – Dryer Modulating Gas Valve

Attachment B

* Custom Rebate Project Report done by PG&E in 2015
* This is the project report for the custom rebate project for the installation of 2 modulating dryer units at a hotel. It explains the measured results and the costs and time frame associated.
* It covered 2 months’ time in the middle of 2015 at a large hotel with onsite laundry.
* The project used monitoring equipment to record actual gas usage during normal operation and during a standardized test period.
* This custom report is the basis for the cost data and validation of the technologies ability to provide savings.

### 1.5.3 On Premise Laundromat (OPL) Dryers Market Survey

Attachment C

* Market research study conducted by TRC Energy Services from 2014 to 2015
* The study provides a detailed market characterization of on premise laundry applications including large commercial and industrial applications.
* Phone surveys were conducted from October 2014 to January 2015 of 260 facilities with 98 quantitative responses in 11 sectors. The sectors are hospitality, in patient healthcare, fitness, correctional facilities, contract laundry, dry cleaners, education, fire stations, law enforcement, health care, restaurants.
* Phone surveys and email surveys.
* Study was used to develop the loads per day value used to estimate the savings for each sector.

### 1.5.4 SCG Engineering Data Collection La Mirada

Attachment D

* Data gathering study done by SoCalGas in December of 2011 and January of 2012
* Data of gas use of dryers was gathered at two locations in La Mirada; a nursing home and a hotel.
* The monitoring period was approximately three months.
* A flow meter and recording equipment were connected to each dryer unit to collect relative parameters.
* This data was used to substantiate the claim of an average of 0.95 Therm/load usage of commercial dryers. It was also used to confirm the cycles per day of general commercial, health care, and hospitality sectors.
* The dryer run time for each load was found to be 35-minute long with about 70% effective full load firing rate during the run time in both sites.

### 1.5.5 PGECOAPP129 Residential Clothes Dryers

Attachment E

* Workpaper written by PG&E in September of 2015.
* The workpaper was written to cover natural gas and electric residential clothes dryers.
* It was used to help establish a EUL for a commercial natural gas dryer for this paper.
* No concerns are noted with the workpaper.

### 1.5.6 Commercial Clothes Dryers

Attachment F

* Study completed by Yanda Shang and Julianna Wei of HMG in July 2013
* This study was performed during the first half of 2013 using the commercial clothes dryer markets
* Survey
* Establishes the EUL for commercial dryers used in this paper.
* No concerns noted

## 1.6 Data Quality and Future Data Needs

There is currently substantial data to create an estimate Therm savings from the installation of the modulating natural gas unit on a commercial and MFm dryers. However, further studies will help in acquiring a more accurate savings value. In addition, studies in smaller size unit (20 lb range) will help evaluate the modulating valve in the multifamily sector.

There is also a need for published material costs for this type of device. At this time the only manufacturer of a modulating gas valve unit, does not publish their cost data.

# Section 2. Calculation Methodology

The modulating gas dryer valve savings occur from the reduction of the high fire rate minutes per dryer load cycle; by creating two stages, low and high fire rates. A normal dryer burner will always perform at a high fire rate until a set point temperature is reached in the flue-stack, at that point the burner will shut off until a low temperature set point in the flue-stack triggers another high fire rate cycle. These baseline dryer cycles waste natural gas towards the end of a drying cycle, when the clothes do not require a high input rate of heat due to less moisture content in the drying cavity. Having the low fire rate will replace some of the high fire rate cycles of the baseline case and thus use less natural gas to dry the same load of clothing.

The gas modulation will directly affect the combustion parameter, equivalence ratio. The equivalence ratio is defined as followed.

Where,

From combustion chemistry we observe how the change in equivalence ratio will affect the flame temperature and therefore reduce the heat available for drying.

For Methane (), equation 2 becomes.

If,

Then equation 3 becomes,

This measure will alter the value of equation 1, by reducing the mass fuel rate of the numerator (actual mass of air to fuel ratio) and all other values are kept constant the numerator magnitude will decrease, as an effect the equivalence ratio magnitude will decrease. This will cause the value of “” to increase in magnitude. As “” increase, the flame temperature of combustion will decrease, thus providing a smaller heat rate during the low fire rate.

The adiabatic flame temperature derives from the following expression.

Where,

And,

Solving for

By observation, ), for each respective molecule. From equation 6, as ( increases, the magnitude of () decreases. This will occur due to the compounds ( having exothermic reactions therefore releasing heat and having a negative enthalpy of formation. To further prove this concept, the figure below from “Springer: Fundamentals of Combustion Processes, chapter 2”.

Shows the change of flame temperature due to the equivalence ratio.

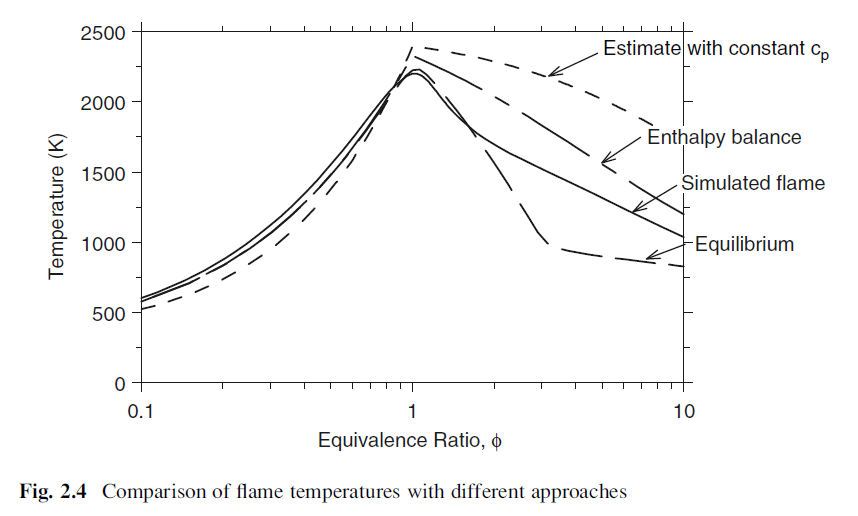
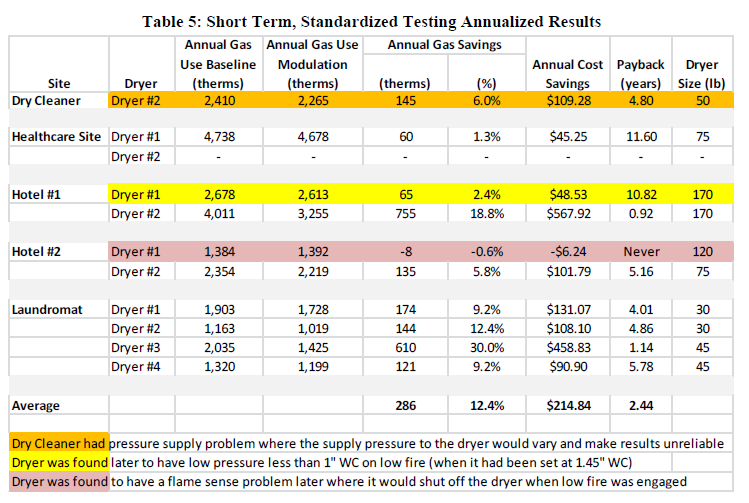


Figure : Adiabatic Flame Temperature Vs Equivalence Ratio

It is important to reiterate that as the mass flow rate of fuel in equation 1 is reduced, the magnitude of the equivalence ratio decreases. This will cause the magnitude of ) to increase. As these values increase, from equation 6, the magnitude of the flame temperature decreases. This is important for a lower flame temperature, decreases the temperature differential for heat transfer(ΔT), therefore providing a smaller heat rate.

The savings found in the Nicor Commercial Dryer Modulation Retrofit project (Attachment A), have a 12.4% natural gas consumption reduction. This result was adopted from Nicor “Standardize Test” in which a test was conducted at different sites with dryers in modulation and no modulation, drying the exact same laundry load. The image below extracted from Nicor’s study presents each test result and the derivation of a 12.4% gas reduction when annually extrapolated.



Nicor’s 12.4% reduction encompasses all the test results in the table above that are not shaded. The shaded values were found to have discrepancies and are not included in the calculation.

Nicor’s “Standardized Test” values were considered more conservative and more applicable to multiple sectors over the long term monitoring that was done in the study. In this report a baseline and measure gas consumption were established through the use of information gathered from current switches that measure the amount of time the burner was running in high or low fire rates during a drying cycle. The times found for each mode were multiplied by the high or low firing heat rate. The high fire heat rate and manifold pressure associated to it were acquired from the equipment name plate. The low fire heat rate was tabulated through equation 7 known as the “square root law” and associated manifold pressure was measured.

Where

**\*\*The manifold pressure was measured with a digital manometer at the gas valve\*\***

Equation 7 results from decreasing the mass fuel ratio during modulation mode, when there is less fuel flow, the adiabatic flame temperature as shown above will decrease thus decreasing the heat rate.

Savings values for each building sub sector’s typically sized dryer were calculated using a regression analysis. Attachment G is an excel sheet with the calculations for this regression and the subsequent savings values. Attachment G approach 1 starts with manufacturer data on the pound sizes of the dryer drums and their corresponding burner rates. These rates were then turned into therm/hr rates and multiplied by the estimated time a burner is on during a drying cycle; this “on” time was estimated from Attachment D and B. Which translates to a burner being run for 65% of the time a single load of laundry is drying. Attachment D establishes an average time of 35 min per drying cycle. Thus multiplying the percentage of time the burner is running in hours by the therms per hr rate of the burners for each dryer equates to a therms used per cycle of laundry. This does change based on dryer drum size as can be seen in column E Attachment G. This was graphed and used to create an equation that relates drum size to therms used to dry. The equation then easily created a set of values on 10 lb increments that yielded a therm used value. The Nicor savings value of 12.4% was then applied to each to establish a savings amount. Represented below. Approach 2 in Attachment G is for verification purposes only and is not the approach used to get the savings values for each measure in this paper.

Sample Calculation for Hotels:

Hotels were found to run each dryer for 4432 loads annually and the dryers were found to have an average capacity of 69Lbs. Using these values, the following baseline consumption was established,

Therms per load for a 69Lb capacity dryer is estimated by the following calculation.

based on regression analysis

The following table shows a summary of savings for each building type in this work paper.

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Annual Baseline Energy Consumption (Therm)** | **Energy Savings (Therm/Year)** |
| Hotel/Motel | 2774.71 | 344.06 |
| Nursing | 3448.34 | 427.59 |
| Commercial | 4122.61 | 511.20 |
| MFM | 226.30 | 28.06 |
| CoinOP | 544.53 | 67.52 |

**\*\*For more detailed calculations see Attachment G: Energy Analysis\*\***

Most dryers are operated inside a conditioned space with little to no variations in ambient conditions per climate zone. Thus the savings presented above apply to all California climate zones.

# 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.

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. There are no applicable load shapes to this gas measure because the price of gas is not dependent on the time-of-use.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| N/A | N/A | N/A |

# Section 4. Costs

Costs were based on the PG&E custom project report that was completed in 2015 at hotel (Attachment B). The customer paid $ 4,100.00 for 2 modulating gas valves to be installed on their on-site commercial dryer units. This price included labor and material costs for both units. The estimation is that exactly half of the total cost would be an appropriate estimate for the labor and material per unit installed. Which would be $2,050.00. A professional installer will be required for all installations of this product as the inlet natural gas line will have to be removed and reattached during installation.

Separate material costs are not available, as they are not advertised at the moment. Consultant Navigant had a verbal conversation with a manufacturer, that yielded the below information. Estimates for labor per installation is approximately 46-58% of the total measure cost. The last column in the table “Material Cost” shows an estimation of possible labor cost. This was gathered by using the Btu ratings of the dryers in Attachment B to find how much the materials should cost. In this case the dryers had a rating of 300,000 and 370,000 Btuh respectively, which by estimates set their materials cost to $850-$1100.00 per installation. The cost for material with a regulator was chosen as a reasonable estimate. $2050 minus $1100.00 yields a possible labor cost of $950.00 per installation.

**Materials Cost**

|  |  |  |  |
| --- | --- | --- | --- |
| **Burner Size (Btuh)** | **Material Cost (No Regulator)** | **Material Cost**  **with Regulator\*** | **Installation Cost**  **with Regulator** |
| Under 100,000 | $700.00 | $950.00 | - |
| Up to 400,000 | $850.00 | $1100.00 | $950.00 |
| Above 400,000 | N/A | $1,500.00 Starting | - |

## \* Regulators are required for large drummed dryers to operate a modulating unit properly. They are normally supplied with the modulating valve kits for an additional cost.

## 4.1 Base Case Cost

The base case is to not modify the dyer with the modulating gas measure. Which would result in a cost of $0.00.

## 4.2 Measure Case Cost

The measure case cost would be the full amount of labor and materials which is $2050.00 per installation. Labor is considered as a cost in this measure because the installation process requires a technician to complete and is not within the realm of “DIY” measures.

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Costs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| REA | $1,100 + $950 = $2,050 | $1,100 + $950 = $2,050 | N/A |

# Attachments

All files for the below referenced attachments are included in the work paper submission as a zip file.

Attachment A – Nicor Com Dryer Mod Retrofit

Attachment B – PG&E Mod Gas Dryer Custom Project

Attachment C – Commercial Dryer – OPL Market Survey

Attachment D – SCG Engineering Data Collection, Htl/Nrs

Attachment E – PGECOAPP129 RO Clothes Dryer

Attachment F – California IOUs Commercial Clothes Dryers

Attachment G – Energy Analysis

# References

(PG&E), J. H. (2015). *PGECOAPP129 R0 Clothes Dryers.* San Francisco: PG&E.

Ez-Efficiency. (2017, January 9). *Ez-Efficiency*. Retrieved from Ez-Efficiency: http://ez-efficiency.com/

p.k.cman. (2017, April 1). *Basic Understanding of Flow Calculations and Estimates Makes Sizing Valves Simpler*. Retrieved from p.k.cman: http://www.rkstat.com/Downloads/article-FlowCalculationsforValveSizing.pdf