**Work Paper PGE3PREF115**

**Chilled Glycol Tank Insulation**

**Revision # 1**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Chilled Glycol Tank Insulation**

**Measure Codes MBZ, MC0**

**CLEAResult**

# At-a-Glance Summary

|  |  |  |
| --- | --- | --- |
| **Applicable Measure Codes:** | **MBZ** | **MC0** |
| **Measure Description:** | This measure is for insulating chilled glycol storage tanks in both indoor and outdoor applications for a refrigeration process end-use. | |
| **Energy Impact Common Units:** | Per square foot of chilled glycol tank insulation. | |
| **Base Case Description:** | Un-insulated glycol tank. | |
| **Base Case Energy Consumption:** | Source: Base Case kW and kWh energy consumption varies based on climate zone installed. | |
| **Measure Energy Consumption:** | Source: Measure kW and kWh energy consumption varies based on climate zone installed. | |
| **Energy Savings**  **(Base Case – Measure):** | Source: Energy Savings kWh energy consumption varies based on climate zone installed. | |
| **Costs Common Units:** | Per square foot of chilled glycol tank insulation. | |
| **Base Case Equipment Cost ($/unit):** | Source: Actual Projects. The base case for this measure assumes no existing tank insulation. Base case cost is $0.00 | |
| **Measure Equipment Cost ($/unit):** | Source: Actual Projects. The measure equipment cost assumes the full cost of the tank insulation. Measure Equipment Cost is $3.21/sq ft | |
| **Gross Measure Cost ($/unit)** | Source: Actual Projects. The measure equipment cost assumes the full cost of the tank insulation plus labor. Gross Measure Cost is $3.21/sq.ft. See Section 4 for explanation. | |
| **Measure Incremental Cost ($/unit):** | Source: Actual Projects. See above explanation  REA = measure equipment cost – base case equipment cost. | |
| **Effective Useful Life (years):** | Source: DEER 2014. 15 years. | |
| **Measure Application Type:** | This measure is a REA measure type. | |
| **Net-to-Gross Ratios:** | Source: DEER 2011. Agricultural Custom Default. NTG is 0.70. | |
| **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 |
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# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| Revision 0 | 06/22/2012 | Chilled Glycol Tank Insulation | Danny Ng and Michael Corbett (Resource Solutions Group) |
| Revision 1 | 05/15/2014 | New Workpaper Format, Updated Weather Data | Sarah Schiller and Mike Diep (CLEAResult) |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description –*** This measure is for insulating previously uninsulated chilled glycol tanks in both indoor and outdoor process cooling end-use applications. Indoor installations are only applicable in unconditioned spaces, which is typical. This measure requires that there be no existing tank.

***Program Restrictions and Guidelines***

*This measure is only applicable to the winery and dairy industry for process refrigeration process end-use applications. Application of this measure is for the addition of tank insulation on the existing chilled glycol storage tanks. This equipment is considered a REA measure as defined by the utility. The existing condition must be* previously uninsulated *chilled glycol storage tanks*

***Terms and Conditions:***

* *The installed insulation must be at least ¾ inch in thickness.*
* *The rebate is based on the square footage of the installed insulation for both indoor and outdoor chilled glycol storage tanks..*
* *Other installations can be considered assuming that the overall insulating value exceeds the requirements of this work paper. The rebate is based on the square footage of the installed insulation for both indoor and outdoor chilled glycol tanks.*
* *Chilled fluid, other than glycol, can be considered assuming that the savings is consistent or exceeds the savings of this work paper. Product specifications and cut sheets must be provided in order to document that the product meets requirements.*

***Market Applicability:***

*This measure is to primarily serve PG&E’s Third Party Wine Industry Efficiency Solutions (WIES) Program and Dairy Industry Resource Advantage (DIRA) customers who have electricity distributed to the installation site by PG&E. These customers are associated with the wine and operators of wineries within the PG&E service territories. The intent of offering Chilled Glycol Tank Insulation within the program is to help these PG&E customers reduce energy usage through a streamlined, cost-effective delivery. Winery and dairy customers and the vendors that serve them are able to access rebates for this energy efficiency measure without the complication and delay associated with a custom incentive process.*

*The installation of new insulation on chilled glycol storage tanks is intended to capture energy savings from process load cooling of winery product. Winery and dairy customers serviced by PG&E in climate zones 1, 2, 3, 4, 5, 11, 12, 13, and 16 can apply for the rebate. Qualifying rebates will be paid downstream based the installation of new tank insulation on chilled glycol storage tanks with a customer provided proof of payment from a manufacturer or vendor.*

## 1.2 Product Technical Description

Refrigeration systems typically use a glycol/water mixture as the heat transfer medium to provide the desired cooling. Often times, a glycol storage tank is used in the system to account for changes in the total volume of the glycol needed as valves are opened and closed. While it is in the storage tank, heat transfer will occur to the glycol from the surrounding environment when the external temperature is greater than the glycol temperature. As a result, the chiller will have to provide extra work to chill the glycol. Installing insulation to the glycol tank will reduce the amount of heat gain from the environment, thus saving energy otherwise needed for additional cooling.

The glycol in the tank gains heat mostly through conductive and convective heat transfer. The amount of heat that is gained is dependent on the thermal conductivity of the insulation material, the ambient temperature, the glycol temperature, the surface area, number of hours the chiller is used and the location of the tank (indoor vs. outdoor). Solar radiation is ignored in outdoor tanks as they are typically located next to buildings and within a refrigeration system. This results in minimal exposure to solar radiation as it is shaded the majority of the time. There are no codes or standards that require wineries and dairies to install insulation on their glycol process tanks and are the reason it is common to see uninsulated glycol tanks as the industry standard.

Since no two facilities are exactly the same, calculated savings will be based on an average of what is most commonly seen in the field with variables leaning towards the more conservative side.

## 1.3 Measure Application Type

*This section discusses the effective useful life of both the base equipment and the measure.*

The DEER Ex Ante Database Format defines the terms as follows:

Table 1: Measure Application Type

*I Identifies the measure application type in the Measure Implementation table in DEER2011.*

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| REA | Retrofit Add On | Single baseline (above pre-existing), full measure costs required |

*Chilled Glycol Tank Insulation is considered an REA measure and therefore qualifies under the Retrofit Add On (REA) application type. Since the base case assumes that the existing chilled glycol storage tanks are not insulated, this measure is for the addition of new insulation in order to achieve electricity savings.*

## 1.4 Product Base Case and Measure Case Data

### *1.4.1 DEER Base Case and Measure Case Information*

The DEER2011 database does not contain the appropriate information for this measure.

### *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.

***Title 24:*** This measure does not fall under Title 24 of the California Energy Regulations. Exception II of Section 150(j)2 excludes process applications for tank insulation. There are no requirements specific to the chilled glycol storage tank.

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

Because this is for a refrigeration process application, there are no applicable codes or standards that govern this application of insulation on refrigeration process chilled glycol tanks.

**Hours of Operation:**

Hours of operation are based on the specific process for this measure: process cooling. There are no applicable codes or standards for hours of operation.

**Base Case Costs and Measure Case Costs**

**Costs:** There are no costs related to codes and standards. All cost estimates for this measure come from actual projects and can be found in Section 4 of this work paper. Because this measure is a REA measure, there are no baseline costs associated.

**Effective Useful Life:** The effective useful life is taken from DEER 2014[[1]](#endnote-1). Though there is no measure for glycol tank insulation, the closest measure available is wine tank insulation. This has an Effective Useful Life of 15 years.

**Net to Gross Value:** Table 2 below summarizes all applicable Codes and Standards-based Net-to-Gross ratios for programs that may be used by this measure.

Table 2: Codes and Standards Net-to-Gross Ratios

|  |  |  |  |
| --- | --- | --- | --- |
| **Program Approach** | **NTG** | **Code or Standard** | |
| **Code or Std** | **Reference** |
| Third Party Approach | 0.70 | N/A | NonRes-sAg-mCust-ci |

The NTG Ratios in Table 2 are appropriate for the measure(s) because:

* There are no applicable codes or standards which define the NTG of this measure, therefore we are using the Agriculture rate of 0.70 for all custom either electric or natural gas measures.[[2]](#endnote-2)

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

As of 5/21/2014, there were no M&V or other studies which apply to these measures.

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

As of 5/21/2014, there were no further data or calculations provided for the support of the measures in this work paper.

### *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.

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

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

Table 3: Calculation Inputs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | Insulation Thickness [inch] | 0 | N/A | 0.75 | *Section 2.1* |
| **Gas Savings** | N/A | 0 | N/A | 0 | N/A |
| **Hours of operation** | BT | 8,400 | N/A | 8,400 | Section 2.1 |
| **Full Cost** | REA | $0.00 | N/A | $3.21 | Section 4 |
| **Incremental Cost** | REA | $0.00 | N/A | $3.21 | Section 4 |
| **EUL /RUL** | REA | N/A | N/A | 15 | Section 1.4.2 |
| **NTG** | One | 0.70 | N/A | 0.70 | Section 1.4.2 |
| **TOU Factor** | *A/C projects only* | N/A | N/A | N/A | *Section 1.4.5* |

\*Values are average of all measures

**\*\***Average hours taken across all applicable Climate Zones and for all hours when outdoor air temperature (dry-bulb) is greater than glycol temperature.

# Section 2. Calculation Methods

Table 4: Baseline by Measure Application Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period: Energy Savings Baseline** | **Second Baseline Period: Energy Savings Baseline** |
| **REA (retrofit add on)** | **EUL** | Code Baseline | N/A |

Notes:

*Chilled Glycol Tank Insulation is considered a REA and therefore qualifies under the Retrofit Add On (REA) application type. Since the base case assumes that the existing chilled glycol storage tanks are not insulated, this measure is for the addition of new insulation in order to achieve electricity savings.*

## 2.1 Electric Energy Savings Estimation Methodologies

The baseline system in this case is the un-insulated glycol storage tank. Many of the baseline assumptions were derived by actual glycol tank insulation projects completed by participants in the Wine Industry Efficiency Solutions (WIES) program. The baseline performance assumptions are as follows:

1. The heat transfer coefficient of outdoor air is 4.0 BTU/(hr.\*ft.2\*F). The heat transfer coefficient of indoor air is 1.4 BTU/(hr.\*ft.2\*F). This is an estimate based on the range of 0.5 to 4.4 for the free convection of air.[[3]](#endnote-3)
2. Radiation effects are ignored. Solar radiation values drop off during other hours of the day and on average is only ½ of the maximum solar radiation value. In addition, the tank is rarely in the middle of an open space, but instead typically receives shading from buildings. The variation on outside glycol tanks leads to greater uncertainty and inaccuracy in the calculation when trying to take into account radiation effects on the heat transfer (than if these effects were ignored). In addition, by ignoring solar radiation, the savings estimates are more conservative as a result especially because uninsulated tanks typically have an equal or higher emissivity value than insulated ones.
3. The refrigeration system is designed to control and maintain the temperature of the glycol in the tank to within a few degrees. Since the demand for process cooling is highest during periods that this workpaper claims savings, this scenario results in higher turnover rates in the tank. Because of the higher turnover rates and the temperature control, the tank is assumed to be isothermal.
4. The heat transfer coefficient of the glycol inside the tank is 150 BTU/(hr.\*ft.2\*F). This number takes into account both the forced convection and free convection of glycol, where the range of the heat transfer coefficient for the forced convection of glycol can range typically from 9 to 1,761, and for the free convection of glycol ranges from 3 to 176.When glycol is being pumped into and out of the tank, forced convection would be expected to take place. When the chiller is not running, free convection would be take place. On average, an estimated value of 150 BTU/(hr.\*ft.2\*F) was taken to account for both situations.2 Note: Assuming a 50/50 mix of ethylene glycol and water mixture, the heat transfer coefficient of the glycol mixture would be in the range of 6 to 1,255 (thermal conductivity of water is approximately 0.609 and thermal conductivity of glycol is 0.258; average thermal conductivity for the two is 0.434, which is a 71% reduction factor on the thermal conductivity of water alone).
5. There is convection and conduction radial heat transfer in this model.
6. The thermal conductivity for polypropylene plastic (typical tank material) is 0.10 BTU\*ft./(hr.\*ft.2\*F).[[4]](#endnote-4)
7. The glycol tank is modeled with the dimensions of 4.5ft diameter and 3.5ft height. Actual variations within tank sizes only change the results by plus or minus 3% and thus are taken to be negligible. The tank thickness is assumed to be on average ¼”.
8. Wineries typically set up their glycol to be at two different temperatures. During cold stabilization, when the wine needs to be cooled down to approximately 30ºF (on average), the glycol is set to 20ºF. During the normal conditions, the glycol is then set to 40ºF to keep the wine cool during normal fermentation. Cold stabilization typically occurs in the winter time and is assumed to occur during the months of January and February for this work paper. The rest of the months consist of normal glycol temperatures. The average glycol temperature is thus 36.0ºF during the year.
9. The chiller has an efficiency rating of 1.0 kW/ton. This is based on an average of the efficiencies of the chillers (1.2 kW/ton for air cooled chillers and 0.8 kW/ton for water cooled chillers estimated). These values are conservative with industrial refrigeration systems in the field.[[5]](#endnote-5)
10. Ambient temperature comes from weather data and is based on each climate zone[[6]](#endnote-6).

The proposed system is an insulated glycol storage tank. The proposed performance assumptions are as follows:

1. The insulation is ¾” inches thick. This is a conservative estimate for insulation thickness of a glycol storage tank (as typical insulation thicknesses range from ¾” to 1.5”). Beyond ¾” of thickness, additional energy savings increases are only marginal, so the lower limit of insulation thickness is set to ¾”.
2. The insulation k-factor is conservatively set at 0.215 (BTU\*in/(hr.\*ft.2\*F)). This is the average of the various types of tank insulation that have been installed in the WIES program.[[7]](#endnote-7)
3. The rest of the performance assumptions are the same as those listed above for the baseline assumptions.

Calculations of the energy savings follow the methodology described below:

The calculation for heat gain by the glycol storage tank is broken down into two parts. The first part is for the cylindrical shape in which radial analysis is used to calculate the heat gain. The second part is for the flat surface at the top of the tank in which a linear analysis is used to calculate heat gain.

**Part 1: Heat gain through the cylindrical surface.**

The overall heat flow is given by the equation:

 (BTU/hr. lost)

Where,

UA = overall thermal conductance (and its inverse is the overall thermal

resistance)

The overall thermal resistance without insulation is given by the equation:

 (BTU/hr.- ºF)

The overall thermal resistance with insulation is given by the equation:

 (BTU/hr.- ºF)

Where,

hair = heat transfer from air to tank

1.4 BTU/hr.-ft.2-F for still air, 4.0 BTU/hr.-ft.2-F for moving air

hglycol = heat transfer from glycol to tank

150 BTU/hr.-ft.2-F

ktank = thermal conductivity of tank

0.10 BTU/hr.-ft.-F for polypropylene from baseline assumptions

kinsulation = thermal conductivity of insulation

0.215 BTU-in/hr.-ft.2-F from proposed system assumptions

L = Height of Tank, ft.

r1 = inner radius of tank cylinder, ft.

r2 = outer radius of tank cylinder, ft.

r3 = outer radius of tank cylinder, ft. (outer tank radius plus insulation thickness)

kWh/year Reduction: After the amount of heat that is absorbed by the glycol is calculated for, the amount of energy used by the chiller to remove this heat can be calculated by the following equation:

kWhused = BTU/hr. lost / 12,000 BTU/hr./Ton x Effchiller x Hours

Where,

BTU/hr. lost = Overall heat flow (as calculated in the above section)

Effchiller = Average Chiller Efficiency, kW/ton

Hours = Hours when ambient temperature is greater than the desired glycol temperature, otherwise no load is assumed to be added to the chiller. These are the effective hours of heat load being added to the chiller that the chiller will need to reject. While the hours for the baseline (uninsulated pipe) and proposed (insulated pipe) are unchanged, the rate of heat transfer that is occurring is changed. This reduction in heat transfer rate is where the savings in energy comes from.

The energy savings for this measure is calculated by subtracting the total amount of energy lost from insulated tank by the total amount of energy lost by un-insulated tank.

kWhsaved = kWhused un-insulated – kWhused insulated

**Part 2: Heat gain through the flat surface**

The overall heat flow is given by the equation:

 (BTU/hr lost)

Where,

UA = overall thermal conductance (and its inverse is the overall thermal

resistance)

The overall thermal resistance without insulation is given by the equation:

 (BTU/hr.- ºF)

The overall thermal resistance with insulation is given by the equation:

 (BTU/hr.- ºF)

Where,

hair = heat transfer from air to tank

1.4 BTU/hr.-ft.2-F for still air, 4.0 BTU/hr.-ft.2-F for moving air

Hglycol = heat transfer from glycol to tank

150 BTU/hr.-ft.2-F

ktank = thermal conductivity of tank

0.10 BTU/hr.-ft.-F for polypropylene from baseline assumptions

kinsulation = thermal conductivity of insulation

0.215 BTU-in/hr.-ft.-F from proposed system assumptions

r = radius of circular tank top

ttank = thickness of flat tank wall

tinsulation = thickness of insulation

kWh/year Reduction: After the amount of heat that is absorbed by the glycol is calculated, the amount of energy used by the chiller to remove this heat can be calculated by the following equation:

kWhused = BTU/hr. lost / 12,000 BTU/hr./Ton x Effchiller x Hours

Where,

BTU/hr lost = Overall heat flow (as calculated in the above section)

Effchiller = Average Chiller Efficiency, kW/ton

Hours = Hours when ambient temperature is greater than the desired glycol temperature, otherwise no load is assumed to be added to the chiller. These are the effective hours of heat load being added to the chiller that the chiller will need to reject. While the hours for the baseline (uninsulated pipe) and proposed (insulated pipe) are unchanged, the rate of heat transfer that is occurring is changed. This reduction in heat transfer rate is where the savings in energy comes from.

The energy savings for this measure is calculated by subtracting the total amount of energy lost from insulated tank by the total amount of energy lost by un-insulated tank.

kWhsaved = kWhused un-insulated – kWhused insulated

**Part 3: Total kWh savings**

The total kWh savings are the sum of the kWh savings for each of the first two parts calculated above.

This kWh/year savings are then divided by the total square footage of tank insulated in order to get the kWh/sqft savings.

These parameters are inputted into calculators for each specific climate zone and energy savings are calculated for each case.[[8]](#endnote-8)

## 2.2. Demand Reduction Estimation Methodologies

The peak kW is calculated by taking the average ambient temperatures during the peak hours. The DEER peak dates[[9]](#endnote-9) for each climate zone are as follows:

Table 5: DEER Peak Loads

|  |  |
| --- | --- |
| **Climate Zone** | **Peak Dates** |
| 1 | Sep 30 to Oct 2 |
| 2 | Jul 22 to Jul 24 |
| 3 | Jul 17 to Jul 19 |
| 4 | Jul 17 to Jul 19 |
| 5 | Sep 3 to Sep 5 |
| 6 | Jul 9 to Jul 11 |
| 7 | Sep 9 to Sep 11 |
| 8 | Sep 23 to Sep 25 |
| 9 | Aug 6 to Aug 8 |
| 10 | Jul 8 to Jul 10 |
| 11 | Jul 31 to Aug 2 |
| 12 | Aug 5 to Aug 7 |
| 13 | Aug 14 to Aug 16 |
| 14 | Jul 9 to Jul 11 |
| 15 | Jul 30 to Aug 1 |
| 16 | Aug 6 to Aug 8 |

Using the average temperature within the time range for each DEER peak period, the peak kW is calculated using the following equation:

kW = BTU/hr. lost / 12,000 BTU/hr./Ton x Effchiller

Where,

BTU/hr. lost = Overall heat flow (as calculated in the above section except using the DEER peak period average temperature)

Effchiller = Average Chiller Efficiency, kW/ton

Therefore, the DEER peak demand savings represent the savings that occur during the DEER peak period that result from the difference in temperature between the glycol line and the average outside air dry-bulb temperature taken during that DEER peak period.

The peak kW savings for each measure is calculated by subtracting the total amount of power required with an insulated tank from the total amount of power required by an un-insulated tank.

kWsaved = kWun-insulated – kWinsulated

## 2.3. Gas Energy Savings Estimation Methodologies

There is no gas energy savings associated with this measure.

# *Section 3. Load Shapes*

For purposes of the net benefits estimates in the E3 calculator, what is required is the demand load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is called the Measure Load Shape and is the preferred load shape for use in the net benefits calculations. The measure equipment and controls may alter the typical end use profile, making it difficult to select a single demand profile to represent the measure category. The measure demand profile is expected to follow the same typical end use profile as the base case equipment, although slightly lower in overall demand.

The E3 Calculator contains a fixed set of load shapes selections that are the combination of the hourly avoided costs and whatever load shape data were available at the time of the tool’s creation. In this case the measure load shape “Industrial Refrigeration” is most appropriate to show the possibility that the equipment could be run at any time during the year.

## 3.1 Base Case Load Shapes

The closest load shape chosen for this measure is the 13 = Industrial Refrigeration load shape. See Table 6 for a list of all Building Types and Load Shapes.

Table 6: Base Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Manufacturing - Light Industrial | Industrial (wineries) | 13 = Industrial Refrigeration |
| Manufacturing - Light Industrial | Agricultural (dairies) | 14 = Agricultural |

## 3.2 Measure Load Shapes

There are no measure case load shapes applicable to this measure in the DEER2011 database. The base case shapes shown below are to be used in the cost avoidance calculation.

Table 7: Measure Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Manufacturing - Light Industrial | Industrial (wineries) | 13 = Industrial Refrigeration |
| Manufacturing - Light Industrial | Agricultural (dairies) | 14 = Agricultural |

# Section 4. Base Case & Measure Costs

Table 8: Base Case EUL/RUL

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| REA (retrofit add on) | EUL | Calculated as Full Gross Measure Cost | N/A |

## 4.1 Base Case(s) Costs

There are no base case costs as this measure is REA and applies to existing chilled glycol storage tanks that are un-insulated.

## 4.2 Measure Case Costs

The following Measure Application Type is appropriate to this measure. The Measure Case Costs are:

Table 9: Equipment and Labor Costs

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| MBZ, MC0 | REA | Un-insulated Chilled Glycol Storage Tank | N/A | Included in Total Cost | N/A | $3.21/sqft |

*\*All costs are noted as U.S. Dollar $ per square foot installed. Note: Labor costs could not be broken out based on project invoices.*

The measure costs above are taken from various projects that have come through the WIES program.[[10]](#endnote-10) This cost includes both cost for equipment and labor but not maintenance/other.

## 4.3 Incremental & Full Measure Costs

Table 10: Incremental Cost

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Full Measure Cost**  **(RUL Period/First Baseline)** | **Full Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| REA | $3.21/sqft | N/A | $3.21/sqft |

### *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.

This Measure Application Type is: **REA** 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 = $3.21/sq.ft.- $0.00/sq.ft.

FMC = $3.21/sq.ft.

### *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.

This Measure Application Types is: **REA** so the Incremental Measure Cost (IMC) 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 = $3.21/sq.ft.- $0.00/sq.ft.

IMC = $3.21/sq.ft.

Table 11: Summary Table for Section 4

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Measure Application Types** | **Base Case Total Cost** | **Measure Case Total Cost** | **Gross Measure Case Cost** | **Incremental Measure Cost** |
| MBZ, MC0 | REA | $0 | $3.21/sq.ft. | $3.21/sqft | $3.21/sq.ft. |

# Index

# References

1. DEER 2014 EUL Spreadsheet : “*Input\_1\_DEER 2014-EUL- table-update\_2014-02-05*”

   [↑](#endnote-ref-1)
2. DEER 2011 NTGR Spreadsheet : “*Input\_2\_DEER2011\_NTGR\_2012-05-16*” [↑](#endnote-ref-2)
3. Mills, A.F., Basic Heat & Mass Transfer Second Edition, Prentice Hall, New Jersey (1999), “Table 1.4: Orders of magnitude of average convective heat transfer coefficients”. p. 22 [↑](#endnote-ref-3)
4. Thermal Conductivity of some common materials:

   <http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html> [↑](#endnote-ref-4)
5. Statewide Manual Appendix C: Minimum Equipment Efficiency (p. 6) : “*Input\_5\_App C Min Equipment Efficiency*” [↑](#endnote-ref-5)
6. DEER Weather File Comparison from deeresources.com: “DEER2013-Weather-Data-Comparison” [↑](#endnote-ref-6)
7. Sample project data from 2010-2012 program cycle: “*Input\_6\_RSG\_Pipe\_Tank\_Insulation\_Verificeation\_K\_factor*” [↑](#endnote-ref-7)
8. Savings Calculation Spreadsheets

   Indoor: *“Input\_7\_Calculation\_Template\_PGE\_2013\_2014\_Indoor\_Chilled\_Glycol\_Tank\_Insulation\_UPDATED”*

   Outdoor : *“Input\_7\_Calculation\_Template\_PGE\_2013\_2014\_Outdoor\_Chilled\_Glycol\_Tank\_Insulation\_UPDATED”* [↑](#endnote-ref-8)
9. Statewide Manual Section 1.4.9: DEER Peak Permanent peak demand reduction Calculations table (p. 1-17) : “*Input\_8\_Customized\_1.0\_Policy*”

   [↑](#endnote-ref-9)
10. Actual project cost data : “*Input\_9\_Glycol Tank Insulation Actual Costs*”

    [↑](#endnote-ref-10)