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POOLS

HEATER FOR POOL OR SPA, COMMERCIAL

SWRE003-01

CONTENTS

MEASURE NAME

Pool & Spa Heater, Commercial

STATEWIDE MEASURE ID

SWRE003-01

TECHNOLOGY SUMMARY

Natural Gas (methane) heaters are a popular system for heating swimming pools (indoor and outdoor). Gas is burned in a combustion chamber; the heat is then transferred to water circulated from the pool. The thermal efficiency of a gas pool heater directly translates to the operating cost of that pool.

This measure specifies the replacement of a gas-fired pool water heater with a higher efficiency unit. This measure is eligible for heated pools installed in commercial and multifamily facilities, such as schools, colleges, universities, YMCA/YWCA, public facilities, hotels/motels, health clubs, spas, homeowner association properties, and multifamily properties.

The Pacific Gas and Electric (PG&E) Commercial Pool Pilot Program implemented in 2006 and 2007 revealed that commercial pools can be classified into two size segments: those smaller than 60,000 gallons and those larger than 60,000 gallons. Commercial pools smaller than 60,000 gallons typically use residential style pool equipment, featuring one or more heaters in the 300 to 400 kBtu/h size range.

MEASURE CASE DESCRIPTION

This measure is defined as the replacement of a gas-fired pool water heater with a thermal efficiency (TE) rating of at least 85%.

BASE CASE DESCRIPTION

The base case is defined as a pool heater that meets the code-minimum thermal efficiency (82% TE), as required by the Federal Code of Regulations effective April 16, 2013. See Code Requirements.

CODE REQUIREMENTS

This measure is regulated by state and federal regulations, as specified below.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 2016	Section 1605.1.g.1	January 1, 2017
CA Building Energy Efficiency Standards – Title 24 2016	Section 110.4	January 1, 2017
Federal Standards	10 CFR Part 430.32	April 16, 2013

The California Appliance Efficiency Regulations (Title 20).[1] Section 1605.1.g.1 requires:

> *(g) Pool Heaters, Portable Electric Spas Residential Pool Pump and Motor Combinations, and Replacement Pool Pump Motors.*
>
> > *(1) Energy Efficiency Standard for Gas-Fired Pool Heaters and Oil-Fired Pool Heaters. The thermal efficiency of gas-fired pool heaters and oil-fired pool heaters shall be not less than 78 percent.*

The thermal efficiency (TE) values are determined by the required test method outlined in the standard, Section 1604(g). This section requires that test method ANSI Z21.56-1998 be followed for gas-fired pool heaters.

This measure is similarly regulated under the California Building Energy Efficiency Standards (Title 24)[2] which refers to the above Title 20 Appliance Standard, reprinted in Appendix B of the Title 24 Nonresidential Compliance Manual.

Federal regulations of commercial pool heaters require that gas-fired pool heaters manufactured on or after April 16, 2013 shall have a TE ≥ 82%.[3]

NORMALIZING UNIT

Cap-kBTUh

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility for Investor-Owned Utilities

Measure Application Type	Delivery Type	Sector
Normal replacement	DnDeemed	Com
Normal replacement	DnDeemed	Res

[1] California Energy Commission (CEC). 2016. *California Code of Regulations Title 20.* CEC-140-2016-001-REV3.

[2] California Energy Commission (CEC). 2015. *2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.* CEC-400-2015-037-CMF.

[3] Code of Federal Regulations at 10 CFR 430

Eligible Products

This measure is available for swimming pool heating and the unit must replace pre-existing pool heater.

The commercial pool heater must be certified to meet the following requirements:

- The heater must have a thermal efficiency (TE) rating ≥ 84%, and
- The heater must have an ON/OFF switch and no pilot light

This measure is applicable to all pool sizes to accommodate the energy savings opportunity associated with the significant number of smaller and larger heated commercial pools.

Eligible Building Types and Vintages

This measure is applicable to all heated pools installed in commercial facilities, such as schools, colleges, universities, YMCA/YWCA, public facilities, hotels/motels, health clubs, and spas. This measure is also applicable for multifamily properties, such as homeowner associations and other multifamily complexes.

Eligible Climate Zones

This measure is applicable in any California climate zones.

PROGRAM EXCLUSIONS

Single-family residences (residential homeowners) are not eligible for this measure.

DATA COLLECTION REQUIREMENTS

Data requirements are to be determined.

USE CATEGORY

Recreate

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (kW)

Not applicable.

GAS SAVINGS (Therms)

The U.S. Department of Energy (DOE) produced a software tool for estimating pool energy consumption as part of their Reduce Swimming Pool Energy Costs! Program (RSPEC!). The RSPEC! software tool (Energy Smart Pools Version 2.0a)[4] was used to evaluate the typical energy savings for this measure. The software was run 35 times to estimate annual gas usage for various conditions.

Sandia National Laboratories evaluated various pool energy estimation software packages for a study of solar pool heating. They concluded that the RSPEC! tool produced the best load predictions as noted in the following excerpt:

> *Sizing the solar collector requires knowledge of how much heat is required to maintain a pool at the desired temperature. We used the* **RSPEC!** *software as our load estimating tool; we also compared RSPEC to these other tools and found considerable variation in the predicted load. We evaluated the various load predictions and came to the conclusion that the best load predictions are obtained using either the RSPEC! software tool or the RetScreen tool.*[5]

Pacific Gas and Electric (PG&E) undertook a study in early 2012 to evaluate another online software tool to estimate pool energy consumption, Energy Experts, developed by the Washington State University Extension Energy Program. The testing of this software showed that it estimates far higher energy use than the DOE Energy Smart Pools tool, especially for outdoor pools. To evaluate the accuracy of each tool, results were compared with four case study pools for which metered data was available. While this sample was small, the results indicated very clearly that Energy Experts over-estimates energy use of outdoor pools; the Energy Experts usage estimates were on average 439% of the metered usage. Thus, the DOE Energy Smart Pools tool was determined to be the best available for pool energy use analysis.

The Energy Smart Pools software includes many inputs used to estimate energy use. Conditions with the highest sensitivity were selected for variation including indoor/outdoor, climate zone, and types of covering. The following table lists the program inputs, assumptions, and notes regarding the sensitivity of energy use to each input.[6]

Energy Smart Pools Software Inputs

Input	Assumption	Notes	Sensitivity
General			
Owner Type	Unknown	Averages all types	
Indoor/Outdoor	Indoor 50%, Outdoor 50%	Assumed average	Very high (outdoor increases gas use by 100-150%)
Schedule	Year-round, 8 a.m.-8 p.m., 7 days per week	Assumed average	
Pool Data			

[4] R.L. Martin & Associates, Inc. "Energy Smart Pools Software (RSPEC!)." (n.d.) Accessed July 4, 2012 at: http://www.rlmartin.com/rspec/software.htm.

[5] Sandia National Laboratories. 2007. "Large Scale Municipal and Commercial Solar Pools– Engineering Tools and Heating Loads", Last modified May 4, 2007. http://energy.sandia.gov/engineeringtools.htm

[6] Pacific Gas and Electric. (n.d.) "PGECOPRO105.3 EnergySmart Software Runs and Results.docx"

Input	Assumption	Notes	Sensitivity
Surface Area	1,000 ft^2	Easily scalable	
Pool Temperature	80 °F	Typ 78 °F to 82 °F	Medium (higher pool temp increases gas use 5% to 6% per 1 °F)
Activity Level	High	(High or Low) - Commercial pools assumed to be busy	Medium (Low activity lowers gas use by 11% to 15%)
Outdoor Conditions (Apply to outdoor cases only)			
Location	Sacramento (Central Valley), San Francisco (North Coastal), San Diego/LA (South Coastal), Las Vegas NV (Desert proxy)	Limited selection in software	Medium (Sacramento lower gas use by 20% vs SF for outdoor pools)
Wind Speed %	15%	Program default	Very High (higher wind coefficient increases gas use 19% to 24% per 10% wind)
Shading %	30%	Program default	Medium (gas use higher 6-9% per 10% higher shading)
Indoor Conditions (Apply to indoor cases only)			
Room Temperature	72 °F		Medium (Higher room temp reduces gas use 3% per °F)
Room Relative Humidity	60% RH	Assumed average	High (lower room RH increases gas use 14% per 10% RH)
Pool Cover Data			
Cover	None	Assumed most common	Very High
Vinyl Cover, as below:			Use of vinyl cover reduces gas use 35% to 38%
-Cover R-Value	0.2	Program allows 0.1 – 0.5	
-Cover Coverage	95%	Assumed average	
Insulated Cover, as below:			Use of insulated cover reduces gas use 43% to 56%
-Cover R-Value	2	Program default	
-Cover Coverage	95%	Assumed average	
Bubble/Solar Cover, as below:			Use of bubble/solar cover reduces gas use 40% to 42%
-Cover R-Value	1.5	Program default	
-Cover Coverage	95%	Assumed average	
Other Inputs			
Vent heaters	Ignored		
Pumps - all	Ignored		
Solar Heating	None		

Hours of Operation. Typical commercial pool hours of operation were assumed as 8 a.m. to 8 p.m., seven days per week, 365 days per year.

Pool Heater Sizing. Typical pool heater sizing is important for normalizing gas use savings by heater size (i.e. therms per kBtuh heater rated input). A survey of vendor literature[7] indicates that commercial pool heaters are mainly sized based on:

- Pool surface area
- Indoor versus outdoor installation
- Temperature difference between pool temperature and worst-case ambient temperature (e.g., average for coldest month of pool use)
- Required rate of temperature change (i.e., for initial heat-up) may also be considered where relevant. This may be rated as required temperature change per 24 hours
- Local conditions, including wind and sun exposure and typical humidity levels, can also be important

Based on published vendor general recommendations, typical pool heater sizes are:

- 100 kBtuh per 200-400 square feet (average 300) of surface area for outdoor pools
- 100 kBtuh per 400-800 square feet (average 600) of surface area for small to large commercial indoor pools

The above average values were used to convert gas savings from therms per square foot of pool area to therms per kBtuh heater input rating.

Base Case and Measure Case Thermal Efficiency. The gas energy savings was calculated based on the efficiency improvement from a base case pool heater with thermal efficiency (TE) of 82% to a measure case pool heater with TE of 87.09%. Data extracted from the California Energy Commission (CEC) Modernized Appliance Efficiency Database was used to determine the average pool heater thermal efficiency for the measure case.[8] Listings in the database were narrowed to include only eligible pool heaters models for heating water using natural gas fuel with no pilot light and having an accessible on/off switch. The resultant listing was sorted by rated efficiency. Finally, a simple average of TE values was calculated for all models with efficiency of at least 84%, the program-minimum efficiency specified for this measure, including very high efficiency condensing models. The resultant average TE for the measure case is equal to 87.09%.

Gas Unit Energy Savings. Gas unit energy savings (UES) was calculated as the different between the annual base case and measure case unit energy consumption (UEC). Results were normalized to annual therms per kBtuh heater input rating.[9] Note that when normalized by heater size, savings are similar for indoor and outdoor pools.

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[7] Pacific Gas and Electric (PG&E). 2012. "Commercial Pool Heater Sizing Literature .pdf"

[8] Pacific Gas and Electric (PG&E). 2012. "CEC Database export_Gas+Oil Pool Heaters_all natgas_20120607 with costing.xlsx"

[9] Pacific Gas and Electric. (n.d.) "PGECOPRO105.3 EnergySmart Software Runs and Results.docx"

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for the pool and spa heater measure are presented below. This EUL was adopted for the 2006-2008 program cycle and is based upon manufacturer estimates.[10]

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	5.0	California Public Utilities Commission (CPUC), Energy Division. 2008. "EUL_Summary_10-1-08.xls."
RUL (yrs)	n/a	

BASE CASE MATERIAL COST ($/UNIT)

Costs for a wide range of eligible pool heaters were obtained from equipment supplier online catalogues in 2018.[11] A pool heater model listing downloaded from the California Energy Commission (CEC) Modernized Appliance Efficiency Database was used to identify qualifying heater models. A total of 54 models met the qualifying criteria - with an average input rating of 422 kBtuh (median 366 kBtu/h) and an average thermal efficiency (TE) of 83.4% (median 84.0% TE).[12]

Prices were obtained for 80 heater models including the models in the CEC data extract. These 80 pool heater models were sorted based on eligibility for this measure. The final base case cost was calculated as the average of 35 models with TE > 82%.

MEASURE CASE MATERIAL COST ($/UNIT)

Costs for a wide range of eligible pool heaters were obtained from equipment supplier online catalogues in 2018. A pool heater model listing downloaded from the California Energy Commission (CEC) Modernized Appliance Efficiency Database was used to identify qualifying heater models. A total of 54 models met the qualifying criteria - with an average input rating of 422 kBtuh (median 366 kBtuh) and an average thermal efficiency (TE) of 83.0% (median 84.0% TE).[13]

[10] California Public Utilities Commission (CPUC), Energy Division. 2008. "EUL_Summary_10-1-08.xls."

[11] Pacific Gas and Electric (PG&E). 2019. "Pool Heater Costs_2019.03.13.xlsx"

[12] Pacific Gas and Electric (PG&E). 2012. "CEC Database export_Gas+Oil Pool Heaters_all natgas_20120607 with costing.xlsx"

[13] Pacific Gas and Electric (PG&E). 2012. "CEC Database export_Gas+Oil Pool Heaters_all natgas_20120607 with costing.xlsx"

Prices were obtained for 80 heater models including the models in the CEC data extract. These 80 pool heater models were sorted based on eligibility for this measure. The final measure case cost was calculated as the average of 29 models with TE ≥ 85%.

BASE CASE LABOR COST ($/UNIT)

The labor installation costs to install a high efficiency pool heater are assumed to be the same as the installation costs for a standard pool heater, and thus not needed for the incremental cost calculation for this normal replacement measure.

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NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial and agriculture programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs ("default NTGs") are applicable to all energy efficiency measures that have been offered through commercial and residential sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
NTG – residential	0.55	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.
NTG – commercial	0.60	

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current "default" rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment

Parameter	GSIA	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY IMPACTS

Non-energy benefits for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based. There is no DEER measure for commercial or multifamily pool heaters.

DEER Difference Summary

DEER Item	Comment / 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	There is no DEER measure for commercial or multifamily pool heaters.
DEER Measure IDs Used	n/a
NTG	Source: DEER. The NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs*. The NTG of 0.55 is associated with NTG ID: *Res-Default>2yrs*
GSIA	Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER. The value of 5 years is associated with EUL ID: *WtrHt-GPoolHtr*.

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	06/30/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOPRO105 Revision 3 (January 1, 2016) Consensus reached among Cal TF members.
			Updates to reflect new cost data/methodology
	03/29/2019	Jennifer Holmes Cal TF Staff	Revisions for submittal of version 01