Work Paper SCE17WP008

**Revision 1**

**Southern California Edison**

**Commercial Variable Speed Swimming Pool Pump**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | PM-12046 |
| **Measure Description** | A Variable Speed (VS) Pool Pump ≤ 3 horsepower (HP) in a commercial setting |
| **Base Case Description** | A Single-speed Pool Pump ≤ 3 HP in a commercial setting |
| **Units** | Per pump |
| **Energy Savings** | Refer to Excel Calculation Attachment 1 |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 3 |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 3 |
| **Effective Useful Life** | 10 years (EUL ID: OutD-PoolPump) |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | 0.60 (Com-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 | 12/9/16 | Theodore D’Williams/TRC | * This work paper is an update of SCE13WP008.0 * New Calculation template for 2017 program year * Base, Measure and Incremental Cost was updated * All (16) California Climate Zones have been added to the calculation template |
| 1 | 1/12/2018 | Andres Fergadiotti/SCE | * NTG Update; changed NTG\_ID from ET-Default (0.85) to Com-Default>2yrs (0.60) |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | A Variable Speed (VS) Pool Pump ≤ 3 horsepower (HP) in a commercial setting |
| Existing Condition | A Single-speed Pool Pump ≤ 3 HP in a commercial setting |
| Code/Standard | N/A |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  | PM-12046 |  | Variable Speed Pool Pump replacing Single Speed Pool Pump ≤ 3 HP |

The Direct Install Program is available to SCE small to medium size commercial customers with an active service account and monthly demand between 0 kW – 199 kW.  The commercial variable speed pool will be offered to eligible lodging hotel/motel that meets the base case description criteria.  Appropriate licensed contractors will install the measure according to manufacturer installation requirements, follow all applicable permitting requirement, health code requirements, and inspections.  The Program will be collecting information on existing condition of the measure, and new installed measure.  The Program has a 6% pre-inspection rate and a 10% to 20% post-inspection rate.  Installation contractor will provide information to the maintenance staff about the new installed measure, explain the energy efficiency benefits, and proper operation and maintenance practices to ensure sustained performance. Maintenance staff will be required to sign a form understanding the measure has been installed and set according to manufacturer installation requirements for optimized energy savings.

**Eligibility Requirements**

* Both base and measure case pool pumps must be ≤ 3 HP, but the VS pump does not have to have the same horsepower rating as the base case single-speed pump. For example, replacing a 1 HP single-speed pump with a 3 HP VS pump is acceptable. Some counties offer guidance on what size or model of pump to install based on site data.
* For this work paper, horsepower rating refers to the nameplate horsepower before service factor is applied.
* Only 1-for-1 pump replacements are eligible. Motor-only replacements are not eligible for this offer.
* Pool Pumps installed in a spa or Jacuzzi do not qualify for a rebate for this offer.
* All SCE climate zones are eligible.
* Only Hotel, and Motel building types are eligible.

**Implementation Requirements**

* Installation contractor will ensure health code requirements and inspections are successfully passed.
* Installation must be performed by a contractor approved by the SCE DI Program or one who has the appropriate licenses and training.
* Contractor must follow all manufacturer installation requirements.
* Equipment and materials must meet or exceed all applicable local, state and federal standards.
* VS pool pump must be a new, qualifying product installed in an existing in-ground swimming pool.

**Documentation Requirements**

* The Program will capture existing pool pump information such as the brand, model #, nameplate horsepower, in addition to start and end filtration setting, GPM, and wattage on an application form.
* The Program will capture new variable speed pool pump information such as brand, model #, nameplate horsepower, in addition to start and end filtration setting, GPM, and wattage on an application form.
* A fact sheet will be left behind regarding the optimal setting of the measure to help ensure current and future maintenance staff continue to keep its setting according to manufacturer’s spec for optimal energy savings.
* Installation contractor will provide permit# for each project on an application form.

## 1.2 Technical Description

Pool pumps are used to circulate swimming pool water through a filtration system in order to keep it clear and remove debris and disease-causing agents. Pumps are also used for pool cleaning sweeps, heating, and water features such as fountains and waterfalls. A pool pump motor in California is typically 0.5 to 3 horsepower (hp), single phase, alternating current (AC), and either a permanent split capacitor (PSC) or capacitor-start capacitor-run (CSCR) design [467]. Most run at a fixed single-speed of 3450 revolutions per minute (rpm) [468].

A VS pool pump uses a motor controller that can be programmed to modulate motor speed and flow rate. For VS pool pumps ≤ 3 HP, the controller and pump are integrated into a single unit as shown in Figure 1. Larger pumps typically use a VS control unit housed in a separate enclosure; these are not included in the scope of this work paper. VS pool pumps typically use electronically-commutated motors (ECMs), which offer higher efficiencies than PSC motors.



Figure 1 Variable Speed Pool Pump

Significant energy savings can be achieved by reducing flow rate when it is not necessary to operate at full flow. This is indicated by the Pump Affinity Law, which expresses the relationship between power (P), speed (n), and flow (Q):

Running the pump at half speed will theoretically reduce power draw to 1/8 of full power, but actual power draw will likely be higher due to lower motor efficiencies at part load. For this work paper, savings are derived from test data and not the Affinity Law.

Benefits of VS pool pumps are not limited to energy savings. They are quieter and need less maintenance than single-speed pumps. Lower flow rates allow the filter to more effectively remove debris, which improves water clarity. Reduced strain on the pump, filters, and plumbing prolong the useful life of the equipment [466]. Bundling VS pumps with other pool energy efficiency measures such as LED lighting should be considered.

## 1.3 Installation Types and Delivery Mechanisms

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |

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** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER does not have a measure for variable speed pool pumps. DEER did have a measure for two speed swimming pool pumps (2005: D03-967). This measure used an inefficient single speed pool pump as the base case and an efficient 1.5 hp two speed pool pump as the measure case. The savings were based on an average 25,000 gallon residential single family swimming pool, and the measure was limited to pool pumps used for filtration. These savings are not applicable to this measure because greater energy savings result from using a variable speed pump compared to a two-speed pump and the application has differing operation than a residence.

The most recent version of DEER (2017) does not include pool pump measures.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Work paper?** |
| 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 | N/A |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG value is obtained using the DEER READI tool v.2.4.7.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.60 |

**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 values were obtained using the DEER READI tool v.2.4.7. The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool v.2.4.7. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| OutD-PoolPump | High Efficiency Pool Pump | Res | Recreation | 10 | 3.3 |

### 1.4.2 Codes and Standards Analysis

**California Code of Regulations, Title 20, Public Utilities and Energy (2016) [508]:** Section 1605.3(g)(5) requires two-speed control for residential pool pumps ≥ 1 HP, effective January 1, 2010. This does not apply to commercial pool pumps.

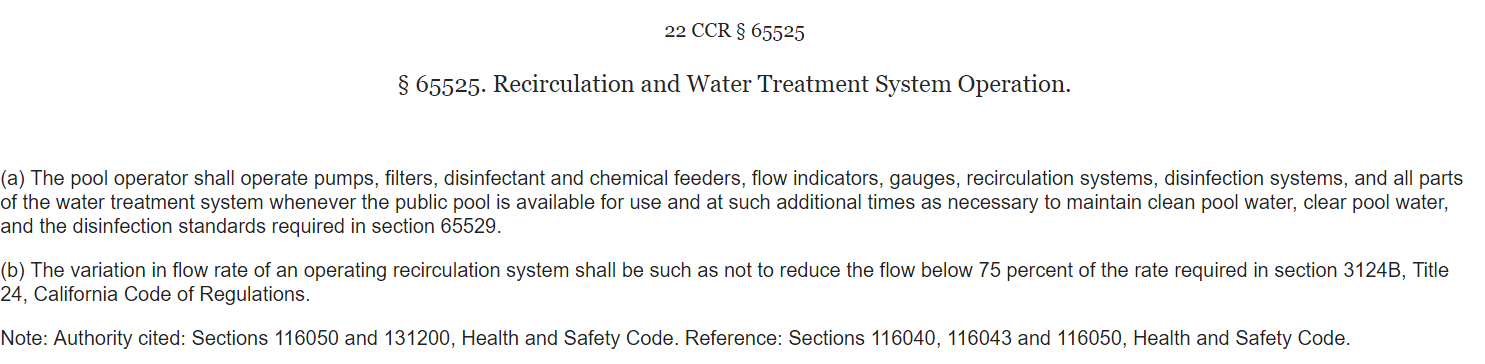
**Codes and Standards Enhancement (CASE) Initiative for Title 20, Pools and Spas [467]:** The CASE report recommendations, which have been proposed for Title 20, requires specific efficiency levels for single-speed, two-speed and VS pool pumps ≤ 5 HP. This does not apply to this work paper at this time, but will be incorporated when this CASE report is incorporated into upcoming Title 20 code updates.



**California Code of Regulations, Title 24, Building Standards Code (2016) [505]:** Chapter 31B “Public Pools,” Section 3124B provides capacity requirements for several types of pools. The pools eligible for this work paper fall under item 5, “other types of public pools.” The Title 24 language does not explicitly state that pool water must be turned over in 6 hours during pool open hours; it only states that the pump system must have the capability to do so. However, based on discussions with health inspectors and pool operators, the flow rate corresponding with a six hour turnover time is treated as the minimum flow rate during pool open hours. This minimum flow rate is site-specific and calculated from pool volume.



**California Code of Regulations, Title 22, Social Security (2016) [506]:** Chapter 20 “Public Swimming Pools,” Section 65525 states that during filtration, the flow rate shall not be lowered below 75% of that required by Title 24. This does not impact the work paper because this work paper assumes that the measure case VS pool pump will operate at 100% of the Title 24-required flow rate during filtration during pool open hours.



**Local Health Codes:** Health departments at the city, county, or other level may provide regulations and guidelines for public swimming pools. Most counties will cite the Title 24 turnover time requirements.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | Chapter 31B Section 3124B | January 1, 2017 |
| Title 22 (2016) | Division 4, Chapter 20, Article 3, Section 65525 | January 15, 2016 |
| Title 20 (2016) | Section 1605.3(g)(5) | November 1, 2016 |

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

### 1.5.1 Commercial Variable Speed Pool Pump Market Characterization and Metering Study ET13SCE1170/ET13SCE1171 [468]

This study assessed the energy savings benefits of installing pool pumps equipped with Variable Speed Drives (VSD) for commercial customers. To do this, market information was gathered from several sites across the Hotel/Motel, Education, and Assemblies market sectors to develop an estimate of operating characteristics that can be generalized across these market segments. In addition, five hotel/motel sites were selected to receive new VSD-equipped pool pumps for a metering study to measure the actual energy savings from a device to support and further validate energy savings estimates for potential inclusion into SCE incentive programs.

While three of the five field sites benefitted from energy savings by installing VSD-equipped pool pumps, it is clear from the comparison to the calculated energy savings that customer interference with the VSD controls during the metering phase did not allow for a true measurement of the savings potentials. This suggests a need to educate the customer to help them understand how to use the speed settings to achieve energy savings.

**Market Characterization Study**

The three commercial market segments identified as having the potential for the VS pool pump measure were:

* Lodging (hotels, motels)
* Schools (high schools, colleges, universities)
* Assemblies (fitness centers, sports clubs, recreational areas, other public pools)

For each market segment, an attempt was made to survey 50 randomly selected sites (in SCE service territory) for equipment and operational characteristics, including:

* Pool and pump operating schedule
* Pool system: Volume, filtration medium, pressure drop,
* Pool pump and motor: Size, service factor, age, efficiency, controls, nameplate, flow rate, speed, etc.
* Spot measurement of voltage, current, power factor (using a True RMS meter)
* Health code requirements, turnover rates

Key findings from the study:

* **Lodging:** Study results indicated that hotels and motels should be the primary target market for the VS pool pump measure. Most of the lodgings (33 of 50) use single-speed pool pumps ≤ 3 HP which operate 24/7. Lodging data were used in the savings calculations.
* **Schools:** Most pool pumps (37 of 42) are greater than 3 HP because they serve large, competitive-sized lap pools. Therefore the VS pool pump measure would not cover those pumps. Survey data from schools were used to inform the development of this work paper but not used in savings calculations.
* **Assemblies:** Operating schedules are similar to that of the lodging market segment, but more pumps are > 3 HP because fitness centers often have Olympic-sized lap pools. Only 31 sites were successfully surveyed because irregular staffing schedules made it difficult to gain access to the site. Survey data from assemblies were used were used to inform the development of this work paper but not used in savings calculations.
* **Flow Requirements:** Several sites have pumps that are undersized and therefore cannot meet the required 6 hours/turnover flow rate. In addition, many of the pools are too large to be served by a single pump ≤ 3 HP. Many pool operators surveyed did not know their local turnover requirements.

**Field Monitoring**

The field monitoring showed that persistency is a problem with variable speed pool pump installations. Two of the five sites yielded negative savings due to poor installation, commissioning, and/or customer interference with pump programming. However, the remaining three sites yielded an average savings of 0.55 kW. This study did not provide any training for the customer as part of the field monitoring on the proper use of the VSD equipped pool pump in conjunction with retrofitting their original single-speed pump. It is concluded that the customer training is critical to achieve the potential savings and this persistence issue will be addressed by SCE commercial DI Program through both program implementation and documentation requirements. See Section 1.1 for more details.

### 1.5.2 DOE Measure Guideline: Replacing Single-Speed Pool Pumps with Variable Speed Pumps for Energy Savings [466]

This report discusses the function, energy consumption, and energy savings potential for pool pumps. It was prepared for by the DOE by the Building Media and the Building America Retrofit Alliance, in 2012. This work paper uses the report as a general source of information about the benefits, potential, and costs of VS pool pumps when compared to single-speed pumps.

## 1.6 Data Quality and Future Data Needs

The savings in this work paper are based on Commercial Variable Speed Pool Pump Market Characterization Study, ET13SCE1170 [468]. The data can be augmented in the future with additional collected data.

# Section 2. Calculation Methodology

## 2.1 Energy Savings and Demand Reduction Estimation Methodology

The savings in this work paper were developed using Commercial Variable Speed Pool Pump Market Characterization Study data, ET13SCE1170 [468]. The following methodology was used to calculate the savings:

All calculations are in Attachment 2.

1. **Assemble initial data set**

As mentioned in Section 1.5.1, the Schools and Assembly data were removed from consideration as they are not part of this offer. This left 50 sites for lodging (50).

1. **Remove ineligible sites**

Twenty six of the 50 sites were removed from consideration for one or more of the following reasons:

* Existing pump is not a single speed unit and therefore ineligible for this measure.
* Existing pump is greater than 3 HP and therefore not within the scope of the measure.
* Pool requires a larger pump or multiple pumps**:**

The highest Curve C flow recorded in the CEC database, for any type of pool pump, is 102 gpm (except for 1 outlier at 170 gpm). Assuming a 6-hour turnover, this corresponds to a pool size of approximately 36,000 gallons. This implies that sites with a pool > 36,000 gallons, under Curve C conditions, need a pump greater than 3 HP or multiple pumps in parallel. In addition, filter type and pipe size will limit maximum flow rate (a 2” pipe can accommodate 70-80 gpm, while a 2.5” pipe can accommodate 110-120 gpm). All sites that were larger than 36,000 gallons were removed from consideration. There will be cases where the plumbing system has less head than specified by Curve C and allows flows > 102 gpm, but those cases are not considered in this analysis.

1. **Energy Savings and Demand Reduction for each sites**

As described in Section 2.2, energy savings and demand reduction were calculated for each sites using both survey data from ET study and engineering equations. See Section 2.2 and Attachment 2 for more detail.

1. **Average Energy Savings**

Once energy savings were calculated for each sites. Then a straight average of the 26 per-site energy savings values yielded for this measure:

* **ROB: 8,071.18 kWh**

1. **Average Demand Reduction**

Once demand reduction were calculated for each sites. Then a straight average of the 26 per-site demand reduction values yielded:

* **ROB: 0.68 kW**

1. **Climate Zone**

This measure is assumed to be unaffected by climate zone, so no further adjustments were made.

## 2.2 Energy Savings and Demand Reduction Estimation Methodology

This section demonstrates how energy savings and demand reduction for each sites were calculated using both survey data from the ET study and engineering equations. As described in Section 2.1, a straight average of the 26 per-site energy savings and demand reduction values yielded the savings for this measure.

|  |
| --- |
| **Example Site** |
| This site will be used in all following examples:  Building type: Motel  Pool hours: 7:00am‒7:00pm  Pump run hours: 24/7  Pump: Single-speed, 1.5 HP  Pool: 26,393 gallons  Electrical: 1-phase, 8.8 amps, 230 V, no power factor measured |

**2.2.1 Base Case Energy Usage**

The base case power consumption is calculated using voltage (V), current (I) and power factor (pf) measurements taken during the surveys. Due to issues with the meters, in most cases only voltage and current readings were obtained. Therefore, if power factor is not available, a value of 0.8 (from the Handbook of Pumps and Pumping [472], full load for 0.75‒7.5 kW; see Figure 2) is assumed.



Figure 2 Typical Power Factors by Motor Size

The annual energy usage (E) is calculated as shown:

Motel Example

The baseline, constant speed, pump meet the Title 24 turnover requirement by pumping excess water. This is done to ensure that the Title 24 minimum turnover requirement is met at all times, even when the pool filter is in need of cleaning, which causes the pumping head requirement to increase and the pumping flow to reduce.

**2.2.2 Measure Case Energy Usage**

The measure case power consumption is determined from a regression analysis of data from the California Energy Commission (CEC) Appliance Efficiency Database, for Residential Pool Pumps. In the proposed future code, there is no significant distinction between residential and commercial pool pumps (upcoming Title 20 standards will apply the same requirements to both when it is adopted.) [467], so the use of residential data is considered acceptable.

**CEC System Curves**

For each pool pump in the CEC database, flow rates and watt draws at each of the three CEC system curves (A, B, C) are provided. Each VS pump has several entries because they are tested at multiple speed (rpm) settings. See Figure 3 for a sample pump curve and the CEC curves and equations.



Figure 3 Sample Pump Performance Curve and CEC System Curves

Since pool plumbing head losses are site-specific, the CEC curves are used to represent three typical plumbing scenarios:

* Curve A corresponds to a system with high head losses. This is typical of a new pool with 2” PVC pipe [469, 470].
* Curve B corresponds to an older system with very high head losses. This is typical of a pool with 1½” copper pipe [469, 470].
* Curve C corresponds to a system with medium head losses. This is typical of a new pool with 2½” PVC pipe [469].

For the VS pool pump measure, Curve C is used because it is assumed to be the most representative of VS pump installations. The Los Angeles County Department of Public Health has issued guidelines for the installation of VS pumps, which state:

“For existing pools, installation will be allowed only when plumbing and equipment is sized to accommodate the maximum flow of the pump at 60 feet of head at the highest rpm.”

The guidelines also include specific requirements for a particular VS pump model:

“Installation of this pump will only be allowed when the plumbing size of the suction line is at least 3” and the plumbing size of the return line is at least 2 ½“. These are the pipe sizes needed to accommodate the maximum flowrate of this pump.”

While these guidelines may not be standard for other counties, and while many other variables such as filters and piping configuration will influence head losses, for this work paper it is assumed that during installation some system improvements will be performed so that the post-retrofit system curve resembles Curve C.

See Figure 4 below for a plot of the polynomial regression and please refer to attachment 2 for more detail:



Figure 4 CEC Curve C Flow vs Power for Variable Speed Pool Pumps

**Pool Open Hours**

The Title 24 6-hour turnover requirement for public pools is used to determine the minimum flow rate (Qopen) during pool open hours:

Motel Example

Pool skimmers require a minimum of 25 gpm to function adequately [466], so a minimum value of 25 gpm is used if flow is calculated to be below 25. This is also the minimum flow in the Energy Star Pool Pump Calculator. In addition, pool heaters may shut down if the flow is too low. It is noted that not all VS pool pump models will be able to lower flow rate to 25 gpm or below, so in those cases the energy savings may be reduced.

Using the regression results shown in Figure 4, the expected watt draw of a VS pump providing 73.31 gpm is:

Note that some counties may require a turnover rate greater than Title 24’s 6 hours/turnover, so the watt draw may be greater in those cases.

**Pool Closed Hours**

There are no regulations that specify minimum flow rates for public pools during closed hours, but it is recommended that the water be filtered two hours before and two hours after open hours [471]. Therefore pool pumps can be run at any speed during closed hours as long as the water passes health code water quality criteria (including pH, disinfectant concentration, and clarity/turbidity). Since residential pools have a suggested turnover rate of 24 hours/turnover [466], this work paper uses that turnover rate for commercial pools during closed hours.

Motel Example

Since skimmers require 25 gpm to function adequately, and since some VS pool pumps have a limit on how low speed can be reduced:

At 25 gpm, the expected watt draw of a VS pump is 0.077 kW.

However, as a conservative assumption, the minimum watt draw is set at 120 W, which is the lowest possible watt draw from the Pentair Commercial Pool Pump Savings Calculator [469].

**Annual Energy Usage**

The following assumptions are used in the annual energy usage calculations:

* Non-filtration tasks such as pool cleaning, backwashing filters, and water features may require a pool pump to run at high speed. The Title 24 6-hour turnover time for public pools requires that, in many cases, commercial VS pool pumps operate at high speed for filtration during open hours. Therefore, it is assumed that the open hours flow rate Qopen is sufficient to perform non-filtration tasks as well.
* Approximately 10% of a pool pump’s operation time is used for non-filtration tasks [466]. Therefore, the open hours are extended by applying a factor of 1.1:

The annual energy usage (E) is calculated as shown:

Motel Example

The measure case variable speed solution allows for fine tuning of the flow that is not possible with the baseline constant speed system. As such, during pool open hours (on-peak TOU), the proposed variable speed pump is assumed to obtain a small energy savings and on-peak demand reduction.

**2.2.3 Energy Savings and Demand Reduction**

**Energy Savings**

The annual energy savings for the Motel Example are:

Motel Example

However, the energy savings for this measure is the average across 26 sites as found in Attachment 2, and is found to be:

**Per-site Demand Reduction**

Most lodging sites are open year-round, but several only open during summer or winter. Nearly all sites operate their pools between 2pm and 5pm. The coincident diversity factors (CDFs) are calculated by averaging the number of open hours during 2‒5pm and dividing by 3:

Coincident Diversity Factors

|  |  |
| --- | --- |
| **Building Type** | **CDF** |
| Lodging (Hotel and Motel) | 0.98 |

Motel Example

However, the demand reduction for this measure is the average across 26 sites as found in Attachment 2, and is found to be:

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Lodging - Hotel | Residential Pool Pumps | Residential |
| Lodging - Motel | Residential Pool Pumps | Residential |

# Section 4. Costs

## 4.1 Base Case Cost

The base case equipment cost is from web searches and are captured in attachment 3. Based on 8 cost samples of 3 HP single speed pool pump, the average base case equipment cost is $879.28. The labor cost is $250.00. This cost was obtained from installed SCE customized program projects. The total base case cost of $1,129.28 includes base equipment and labor charges dealing with installation.

## 4.2 Measure Case Cost

## The measure case equipment cost is a combination of an installed SCE customized project and online retailers (See attachment 3). The measure equipment cost of $1,299.53 is based on 3HP variable speed pool pumps in a commercial setting. The labor cost of $250.00 is the same as the base case. The total measure cost of $1,549.53 includes measure equipment and labor charges dealing with installation.

In some cases, auxiliary equipment such as flow meters and valves need to be replaced. Permit fees are not included in the measure cost, as they are assumed the same in either case.

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| PM-12046 | ROB | $420.25 | $420.25 | N/A |

# Attachments

* + 1. SCE17WP008.1 A1 - Calculation Template.xlsm
    2. SCE17WP008.1 A2 - Survey Results and Calculations.xlsx
    3. SCE17WP008.1 A3 - VFD Prices\_com.xlsx

# References

1. References\_12122016\_100741.xlsx

[467]

[468]

[469]

[471]

[472]

[505]

[506]

[508]