Residential Pool Pumps and Motors

Response to California Energy Commission
2013 Pre-Rulemaking Appliance Efficiency
Invitation to Participate

Docket Number: 12-AAER-2F; Residential Pool Pumps and Motors

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Summary

The information below provides direct responses to the California Energy Commission's (CEC) Invitation to Participate (ITP) for the 2013 Appliance Efficiency Pre-Rulemaking, regarding Residential Pool Pumps and Motors, including reference to several primary sources, some of which are attached separately (see References for more details). This document includes all of the questions asked in the ITP, even for those with no response.

In summary, CEC has an excellent opportunity to capture energy efficiency opportunities for pool pumps and pool pump motors. Current standards in California for these products combined with voluntary incentive programs have helped shift the market to adopt dual speed and variable speed pumps and motors for residential applications over 1 Total Horsepower (THP). However, an opportunity exists to build upon these existing standards to improve the efficiency of single phase single speed, dual speed and variable speed pool pump motors under 5 THP whether sold for OEM or replacement purposes, and whether utilized in residential or small commercial applications for filtration or other purposes.

There are a few primary sources of data, reports and surveys for consideration:

1. **CEC Appliance Database**
   The CEC Appliance Database provides data about pool pumps and associated motors including manufacturer, model, motor efficiencies, construction type, nameplate horsepower and more. It also provides flow rates and Energy Factor at the three CEC pump curves; A, B & C.

2. **Association of Pool and Spa Professionals (APSP) Pool Pump/ Motor Efficiency Database**
   The APSP database provides pool pump motor and replacement motor data for equipment which complies with their APSP 15 standards. This database provides manufacturer, model, motor efficiencies, construction type, name plate horsepower and more. Much of this data is duplicative of the CEC pool pump database, except for the replacement motor data which is not currently included in the CEC Appliance Database.

3. **U.S. Swimming Pool and Hot Tub Market 2012 Report**
   This report, compiled by P.K. Data, provides national and state based data about the installed capacity and annual installs for in-ground pools, above ground pools, hot tubs, and commercial pools. (Note: Hot tub data does not differentiate between portable and in-ground hot tubs.)

4. **Residential Appliance Saturation Survey (RASS) 2009**
   The 2009 RASS survey provides valuable data about the statewide saturation, unit energy consumption, size, duty cycles and life cycles of pool pumps.

5. **Process Evaluation of 2006-2008 PG&E Mass Markets Program Portfolio and CFL, Swimming Pool Market Characterizations 2008**
   This report provides valuable information gathered from PG&E pool contractors, retailers and customers on a variety of issues including: pool pump run times, distribution of pump designs and size, how efficient pool pumps are marketed and more.

6. Additionally, we are submitting data related to the total dynamic head (TDH) of pool heaters as we believe there is an energy saving opportunity to reduce TDH and therefore reduce the power required by pool pumps to overcome the TDH. We encourage CEC to evaluate this data and consider energy-efficiency opportunities for pool heaters.

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1 Basic Information

1.1 Product Definition and Scope

We support replacing the current prescriptive pool pump motor design regulation with a performance-based one for new and replacement single phase pool pump motors under 5 total horsepower (THP). These would include filtration pumps, booster pumps and other pumps and motors designed for use in pools which are either residential or commercial pools using residential equipment.

1.2 Pool Sales Information

According to the Association of Pool and Spa Professional (APSP) U.S. Swimming Pool and Hot Tub Market 2012 report there are 1,309,056 in-ground and 539,428 aboveground pools with 55,000 and 154,780 new pools being installed per year, respectively (P.K. Data 2012).

1.3 Cost of different pool motors/ pumps

We conducted price research from different online retailers for new and replacement pumps and motors. Please see attachment IOU 2012a.

1.4 Product's Duty Cycle and Per Unit Energy Consumption

We estimated yearly unit energy consumption (UEC) values range between 1000 and 2600 kilowatt hours (kWh) for a single pool filtration pump, or 3300 kWh for an average residential pool with both a 1.5 nameplate hp dual-speed pump and 0.75 nameplate hp booster pump. This is consistent with RASS reported data of 3500 kWh for an average residential pool with a filtration and booster pump (KEMA 2010) and past CASE reports reporting a range of 1000 to 3900 kWh and averaging at 2600 kWh for a single pool pump (DEG & ES 2004).

Additionally, a Process Evaluation of 2006-2008 PG&E Mass Markets Program Portfolio and Swimming Pool Market Characterizations report (KEMA 2009) evaluated PG&E's pool showed a range of duty cycles for residential pool filtration pumps and booster pumps as shown in

and **Error! Reference source not found.** below.

Taking a weighted average from the tables below for single speed filtration pumps and booster pumps yields an annual duty cycle of 1,995 hours and 904 hours per year, respectively. For multi-speed filtrations pumps the weighted average annual duty cycle is 698 hours on high speed and 1,839 hours on low speed for a total of 2,537 hours. For commercial applications the duty cycle is assumed to be 8,760 hours as health codes require continuous filtration of commercial pools.

Table 1: Residential pool pump duty cycles in PG&E territory
Source: KEMA 2009

Length of Operating Period
for Residential Pool Pumps
As Estimated by PG&E Contractors/Retailers and Pool Owners

Pool pump operating periods	PG&E participating contractors/retailers (n=17,15,15)	PG&E general population contractors/retailers (n=26,18)	PG&E pool owners (n=268,20)
Average of typical single-speed pool pump operating periods (# hours)*	6.9	6.0	4.1
Average of typical multi-speed pool pump operating periods (# hours)*	9.3	6.6	3.4 at low speed 2.1 at high speed
Average % of time that multi-speed pool pumps operate at lowest speed**	83%	Question not asked	62%

Table 2: Residential pool cleaner duty cycles in PG&E territory
Source: KEMA 2009

Length of Operating Period
for Residential Automatic Pool Cleaning Systems
As Estimated by PG&E Contractors/Retailers

Automatic Pool Cleaning Systems	PG&E participating contractors/ retailers	PG&E general population contractors/ retailers
average daily operating hours		
presser side w/ booster pump (n=18, 25)	3.0	2.1
suction side (n=14, 26)	5.5	5.7
presser side w/o booster pump (n=10, 8)	5.3	5.3
in-floor (n=3, 6)	4.2	5.2

1.5 Design Life Cycle and Incremental Cost of Improvement

Generally, pool pumps are considered to have a life cycle of 10 years (DEER 2012). However, the RASS 2009 surveys show the age of discarded pool pumps could be a bit older, given the percentage of units that are older than 21+ years. See **Error! Reference source not found.** below.

Table 3: Age of discarded pool pumps from RASS 2009 Survey

Source: KEMA 2010

Report Year: 2009
Report View: Electric Utility
Survey Section: Misc Appliances
Survey Question: Age of discarded pool pump - M10
Report Detail: Weighted, Include No Response, Include Not-Applicable
Filtered By: None

The query returns 25,721 records, representing 11,523,719 Population.
*** Results represent a sample of fewer than 25 households.**

Survey Question: Age of discarded pool pump - M10

Electric Utility	1 - 10 YRS	11-20 YRS	21+ YRS	NO RESPONSE	NOT APPLICABLE	Total
PG&E	19,019	17,990*	1,656*	644*	4,594,772	4,634,081
	0.4%	0.4%*	0.0%*	0.0%*	99.2%	100%
SDG&E	1,360*	6,491*	6,478*		1,215,743	1,230,072
	0.1%*	0.5%*	0.5%*		98.8%	100%
SCE	19,739	12,418	7,878*	209*	4,331,373	4,371,617
	0.5%	0.3%	0.2%*	0.0%*	99.1%	100%
LADWP	10,873*	5,103*	1,516*	361*	1,270,097	1,287,950
	0.8%*	0.4%*	0.1%*	0.0%*	98.6%	100%
Total	50,991	42,002	17,527	1,213	11,411,986	11,523,719
	0.4%	0.4%	0.2%	0.0%	99.0%	100%

2 Product Information

2.1 Test Methods to Measure the Energy Consumption

2.1.1 Current Test Methods

IEEE 114-2001: IEEE Standard Test Procedure for Single-Phase Induction Motors

This test procedure determines the performance characteristics (motor efficiency) of single-phase induction motors, including non-excited synchronous motors and is intended for single speed motors. Title 20 references Standard 114-2001; IEEE has since published an updated version of the standard: IEEE 114-2010 (IEEE 2010).

HI 1.6-2000: Centrifugal Pump Test

This test procedure determines the pump efficiency for centrifugal pumps. Title 20 references Standard 1.6-2000; the Hydraulic Institute has since published an updated version of the standard: HI 1.6-2011 (HI 2011).

Title 20 Section 1604(g)(3): CEC Test Method for Residential Pool Pumps

This test procedure tests and reports pool pump speed, flow, power, and Energy Factor (EF, gal/Wh) for three system curves. It draws on IEEE 114 and HI 1.6 to determine motor efficiency and pump efficiency. The existing test procedure is similar, but not identical, to APSP 15 Section 4.1.2: Test Method for Pool Pumps. The APSP 15 test procedure has been recently updated to match the newest IEEE test procedure which made a minor correction from its last version (APSP 2011).

2.1.2 Proposed Test Methods

IEEE 114-2010: IEEE Standard Test Procedure for Single-Phase Induction Motors

We recommend CEC to consider updating Title 20 to reference the most recent version with appropriate modification to address variable speed motors with drives and controls (IEEE 2010).

HI 1.6-2011: Centrifugal Pump Test

Update Title 20 reference to most recent version (HI 2011).

Title 20 Section 1604(g)(3): CEC Test Method for Residential Pool Pumps

We recommend CEC to consider changing this test procedure to better align with APSP 15 (APSP 2011).

2.2 Sources of Test Data

The CEC, APSP and Energy Star all keep databases online of pump and motor efficiencies. To access the most recent database see below. The latest versions are also provided as attachments. (APSPb 2013) (APSPc 2013) (ENERGY STAR 2013) (CEC 2012)

Energy Star Pool Pumps:
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=PP

CEC Pool Pump/Motor Database: http://www.appliances.energy.ca.gov/AdvancedSearch.aspx

APSP Energy Efficient Pool Pumps and Replacement Motors: http://www.apsp.org/ResearchResources/content.cfm?ItemNumber=1034&navItemNumber=797

2.3 Energy Use Metrics

Pool pump and motor efficiency are typically measured by either the motor efficiency or the energy factor.

Energy Factor- Pumps are rated according to their energy factor (EF) which is in units of gallons per watt-hour (gal/Wh) and can be determined by dividing the gallons pumped by the watt hours used. (gpm*60/watt-hours/hour).

2.4 Product Development Trends

When PG&E first introduced its pool pump program in response to a CPUC request associated with the electric crisis of 2001, little attention was being paid in the pool industry to energy efficiency. While pool owners are sensitive to the cost of operating their pools, pool service contractors usually recommend, install, and set up the controls for pool pumps. Since contractors don't pay the utility bill, they're focus is on circulating plenty of water through the filter to make their pool maintenance job easier and assure that there will be no water quality problems.

Initially, the voluntary incentive program focused on high efficiency single speed (incorporating cap-start, cap-run, or permanent split capacitor designs), and two-speed products that were available in the market at that time. The two-speed pump offered 55 percent energy savings when run at low-speed, relative to single speed pumps.

By 2004, Ike Hornsby, a small pool contractor in Bakersfield, had coupled a StaRite Fountain Pump to an A.O. Smith 3 phase motor, and added a Square D Variable Speed Drive. This pump, branded IkeRick, was the first commercially available variable speed pump product. It received good acceptance from a few forward-thinking contractors. If fact, it became successful enough and presented sufficient competitive threat, that the StaRite pump head being utilized suddenly became in short supply, making it difficult for Ike to fulfill orders. Ike switched to purchasing the pump from Hayward, and for a short time Hayward offered the IkeRick product under its brand.

During this time, Rob Stiles, a young product manager at Pentair, had secretly been working on a very advanced variable speed pump. The attention on energy efficiency in California was sufficient for Rob to convince Pentair to complete development and bring this product into production. Pentair introduced the IntelliFlo pump, which soon became the innovation that all the other manufacturers would need to catch up with. Intelliflow sales soared, and even held steady during the economic downturn which occurred later in the decade. This pump was so sophisticated that "dumbed down" models eventually had to be introduced for less forward-thinking contractors.

Since that time, Hayward has introduced two generations of models, and Jandy (Zodiac), one. Several other smaller pump manufacturers have also introduced variable speed models. Regal Beloit and U.S. Motors (Nidec) have both introduced VS motors for OEM and replacement

applications. Current models on the market now mostly have integral controllers mounted on the pumps as part of the variable speed drives.

As new pumps have been introduced, pool product manufacturers have all modified products to offer better hydraulic performance by enlarging couplings and pipe fittings on pumps, filters, valves, etc.

As pumps have improved dramatically, little has been done with standard efficiency products, particularly single speed and two speed pump motors and gas fired pool heater hydraulic performance. While energy efficiency of these products can be improved through low-cost, readily available technology, the market has remained focused on least first cost.

2.5 Market Barriers to Energy Efficiency

See Section 2.11

2.6 How do consumers identify efficient products on the market?

See Section 2.11

2.7 How many small businesses are involved in the manufacture, sale, or installation of these products?

No response.

3 Residential Pool Pumps & Motors

3.1 Current annual sales 2008-2013 and estimated Compound Annual Growth Rate (in CA and nation)

See section 1.2.

3.2 What pool pumps models are currently in the market, please provide description/characteristics of the unit i.e. single speed, variable speed, and their efficiency.

Please see the Tables 4, 5 and 6 from Process Evaluation of 2006-2008 PG&E Mass Markets Program Portfolio and CFL, Swimming Pool Market Characterizations (KEMA 2009).

Table 4: Residential pool filtration pump type in PG&E territory
Source: KEMA 2009

Distribution of Residential Pool Filtration Pump Speed Options As Estimated by PG&E Contractors/Retailers and Pool Owners

Pool filtration pump characteristics	PG&E participating contractors/retailers (n=19)	PG&E general population contractors/retailers (n=27)	PG&E pool owners (n=300)
% of pools w/ working pool filtration pumps?*	99.7%	97.0%	98.3%
pool filtration pump types**			
% of single-speed	76%	76%	89%
% of two-speed	11%	10%	9%
% of variable-speed	12%	14%	3%
Total	100%	100%	100%

Table 5: Horsepower distribution for residential single speed pumps in PG&E territory
Source: KEMA 2009

Distribution of Horsepower Levels for Residential Single-Speed Pool Pumps As Estimated by PG&E Contractors/Retailers and Pool Owners

Horsepower of single-speed pool pumps*	PG&E participating contractors/retailers (n=18)	PG&E general population contractors/retailers (n=27)	PG&E pool owners (n=207)**
< 1 hp	25%	43%	21%
1-1.5 hp	59%	47%	48%
2-2.5 hp	18%	5%	26%
3 hp	1%	1%	6%
Total	103%	96%	100%

Table 6: Horsepower distribution for residential multi-speed pumps in PG&E territory
Source: KEMA 2009

Distribution of Horsepower Levels for Residential Multi-Speed Pool Pumps As Estimated by PG&E Contractors/Retailers and Pool Owners

Horsepower of multi-speed pool pumps*	PG&E participating contractors/retailers (n=16)	PG&E general population contractors/retailers (n=27)	PG&E pool owners (n=27)**
< 1 hp	3%	15%	13%
1-1.5 hp	61%	50%	63%
2-2.5 hp	3%	14%	0%
3 hp	28%	21%	25%
Total	94%	100%	100%

3.3 Do higher efficiency pumps require additional equipment to operate properly in new or existing pools? Such as timers or controllers etc?

CEC Code Compliant two and variable speed pumps need compatible controllers to enable the two and variable speed features to operate. The CEC currently has a regulation covering the requirements for compatible controllers, but it was written before variable speed products were widely available, so it needs to be revised to be more appropriate for products currently in the market. Most variable speed pumps and motors now on the market have integral controllers mounted as part of the variable speed drive on the motor.

3.4 What are the time and installation cost to replace an existing system and how does that vary with different efficiency and technology pool pump motors?

Replacement time and cost vary, but it is generally no more difficult, time-consuming, or expensive to replace an existing pump or motor with a standard or high efficiency Variable Speed model. Most Variable Speed pumps and motors now come with integral controllers. Where replacements do not come with integral controllers, such as with most two-speed pumps, additional time and expense is required to install an external compatible controller as a replacement for the old single speed controller. This can be roughly in the range of $300 to $500.

3.5 What test procedure should be used or modified to measure the efficiency of the pump/motor?

We support modifying IEEE 114-2010: IEEE Standard Test Procedure to better account for variable speed motors.

3.6 Are there any new features in pool motors/pumps that offer better efficiency from existing units?

There are many features in newly available pumps and motors that offer better efficiency performance than standard products. These include better design and components which are cost-effective using the CEC's methodology. Technologies generally include:

- Better hydraulic design for pump heads, filters, and related plumbing fixtures
- Variable speed controls and drives
- High Efficiency Permanent Magnet Electronically Commutated Motors, or equivalent designs
- Significant differences exist between the Total Dynamic Head loss of the best versus the worst performing natural gas pool heaters.

3.7 How many high efficiency units are in use in California, how much energy do they save?

No response.

3.8 Provide performance data related to pool motors/pumps i.e., total horse power, name plate horse power, service factor, flow rate, and head curves.

The CEC, APSP and Energy Star all keep databases online of pump and motor efficiencies. See Section 2.2.

3.9 Is there a difference between units sold to residential and commercial sectors?

We estimate that roughly 75 percent of commercial pools in California are residential in size and use identical equipment. The biggest difference comes in the operating hours as commercial pools

typically have continuous filtration requirements meaning that commercial filtration pumps operate 8,760 hours per year. Because of these requirements commercial pools typically use a single speed pump as there is no low speed filtration option.

3.10 Is there any survey done to gauge consumers' acceptance and performance of the new units? If so, what results?

No response.

3.11 How is pool pump motor energy efficiency marketed to residential and commercial sectors?

Please see **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.** below from Process Evaluation of 2006-2008 PG&E Mass Markets Program Portfolio and CFL, Swimming Pool Market Characterizations (KEMA 2009).

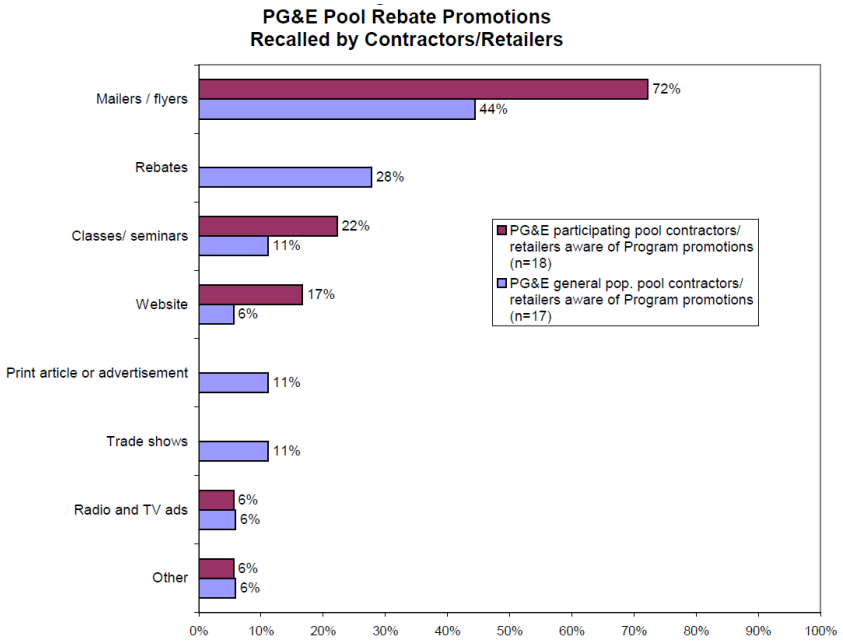

Figure 1: PG&E pool rebate promotions recalled by contractors/ retailers
Source: KEMA 2009

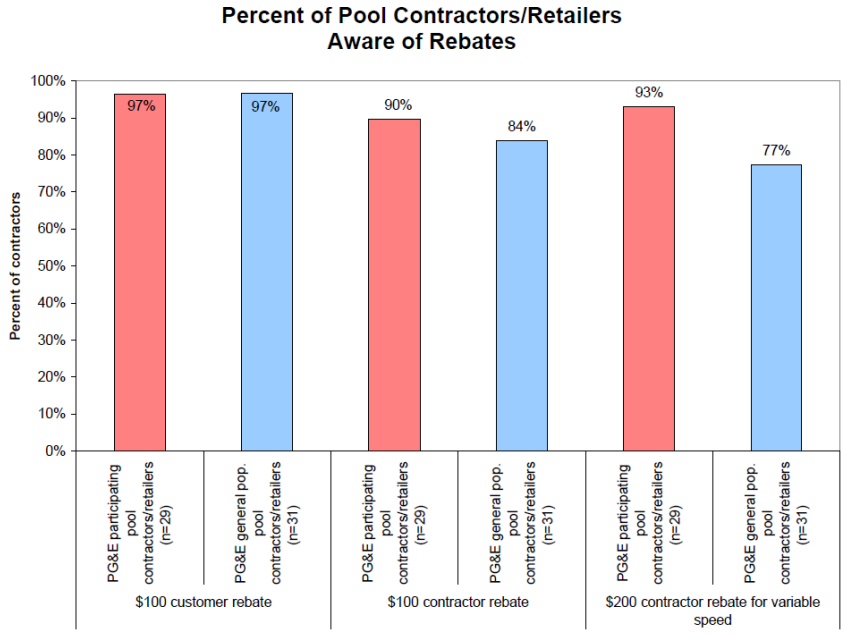

Figure 2: Awareness of PG&E pool related rebates by contractors/ retailers
Source: KEMA 2009

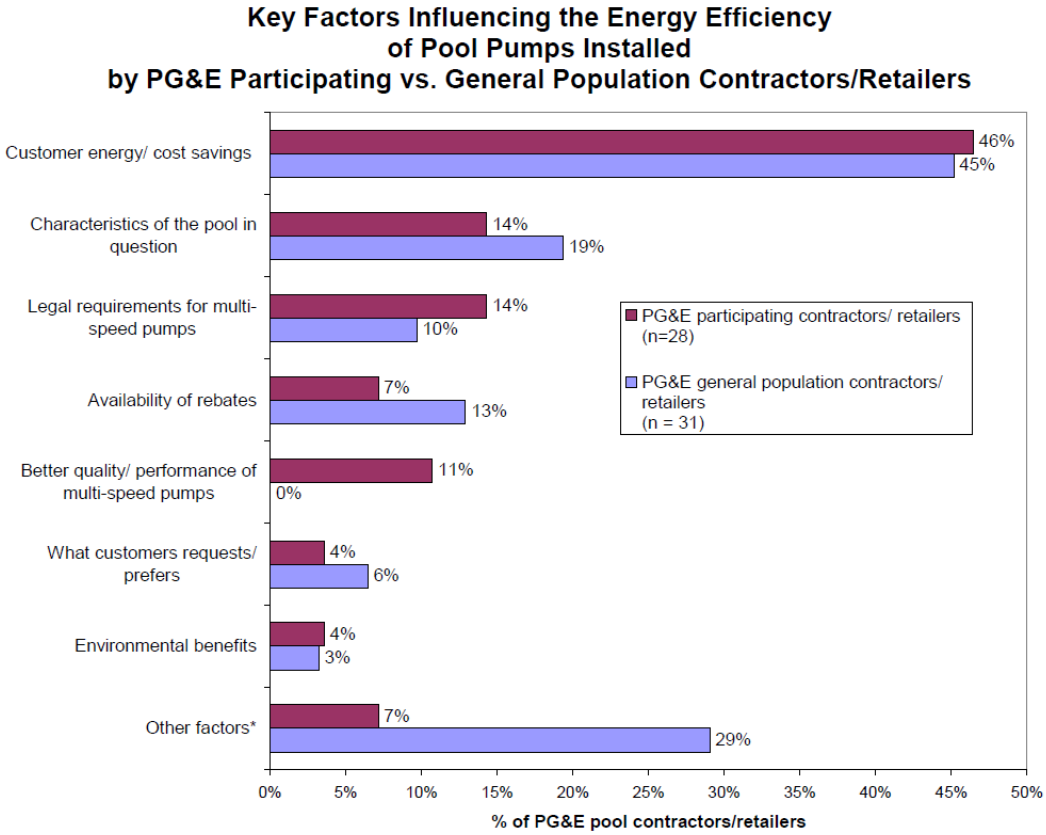

Figure 3: Key influencing factors for energy efficiency in PG&E territory
Source: KEMA 2009

4 Other Relevant Pool Data

4.1 What are the head losses of different Pool Heaters?

We surveyed many different manufacturers and also commissioned testing to obtain total dynamic head levels at various different flow rates for 20 different pool heaters. This data can be found in attachment IOU 2012b.

4.2 What technologies are available to reduce TDH for Pool Heaters?

Reduction of the total dynamic head on gas-fired pool heaters during non-operation may be achieved by adding a circuit to the system piping or integrating a relief circuit in the pool heater design. An add-on bypass circuit can, for one instance, be composed of an auxiliary set of electronically controlled valves added before and after the pool heater. The valves would redirect flow around the heater and be controlled based on heating calls. The controls would need an additional time delay after a heating call has been satisfied, to continue to flow water through the heat exchanger, removing any residual heat and prolonging the life of the unit. The unit may also require a daily purge cycle, to prevent corrosion and seal damage due to stagnant water. Another option is for compliant heaters to have an internal bypass circuit, in addition to the existing thermal and pressure regulators.

4.3 What are the costs associated with reducing TDH of Pool Heaters?

The incremental cost for heaters with internal bypass circuits are expected to be minimal as the heaters are designed with pressure and thermal regulated bypass circuits. The maximum incremental cost would be associated with installing an external bypass added to an existing heater. The proposed design change would take advantage of one electronically controlled valve, an additional set of PVC piping, Tee's and a check valve, totaling approximately $158 (lowes.com and poolsupplyworld.com).

4.4 How many Pool Heaters are installed in CA and how many are sold every year?

The APSP U.S. Swimming Pool and Hot Tub Market 2012 report shows a 4 percent reduction in new in-ground pool installations from 2010 to 2011. New in-ground pool installations in the last year were 10,802, and the installed base is approximately 1.3 million or 24 percent of the US market (P.K. Data 2012).While growth in the market is slow, California remains the largest market in both installed and new pool installations.

On a national level, sales of pool heaters have increased on average by 13,000 units each year since 2003 (DOE 2010). Sales figures specific to California are not known, but if they follow the market distribution of heaters, an annual shipment of approximately 92,000 units (24 percent) can be expected in 2012 (DOE 2010). The same figure could be around 73,164 units if calculating from the current stock of heaters and assuming the product average lifetime is 6 years (KEMA 2010).

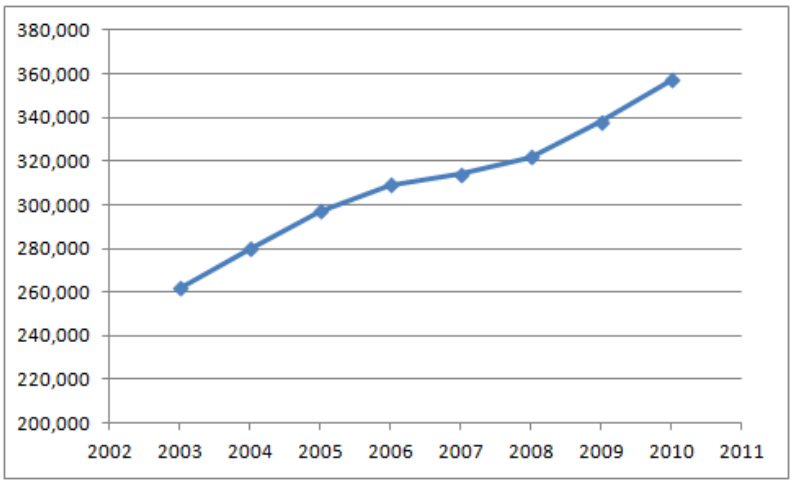

Figure 4: Nationwide Shipments of Gas Fired Pool Heaters
Source: DOE 2010

Table 7: California Stock and Sales
Source: KEMA 2010

Product Class	**Annual Sales** (units)	**Stock** (units)
Residential Pool Heaters	73,162	438,974 [A]

5 References

(References attached separately are highlighted in grey)

[APSPa] Association of Pool and Spa Professionals. 2011. *ANSI/APSP/ICC-15 2011: American National Standard for Residential Swimming Pool and Spa Energy Efficiency*. Approved August 11 2011. Alexandria, VA: Association of Pool and Spa Professionals.

[APSPb] Association of Pool and Spa Professionals.2013. Energy Efficient Pool Pump Database. http://www.apsp.org/ResearchResources/content.cfm?ItemNumber=1034&navItemNumber=797.

[APSPc] Association of Pool and Spa Professionals. 2013. Energy Efficient Pool Pump Motors Database. http://www.apsp.org/ResearchResources/content.cfm?ItemNumber=1034&navItemNumber=797.

[CEC] California Energy Commission Appliance Efficiency Database 2012, Residential Pool Pumps and Motors. http://www.appliances.energy.ca.gov/.

[DEER] Database for Energy Efficient Resources. 2012. http://www.energy.ca.gov/deer/.

[DEG & ES] Davis Energy Group and Energy Solutions. 2004a. *Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development. Analysis of Standards Options for Residential Pool Pumps, Motors, and Controls.* http://consensus.fsu.edu/FBC/Pool-Efficiency/CASE_Pool_Pump.pdf. Prepared for Pacific Gas and Electric Company.

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[IOU 2012a] Pool Pump/Motor Price Database compiled by IOUs 2012/2013.

[IOU 2012b] Pool Heater Total Dynamic Head and Flow Database compiled by IOUs 2012.

[KEMA] KEMA, Inc. 2009. *Process Evaluation of 2006-2008 PG&E Mass Markets Program Portfolio and CFL, Swimming Pool Market Characterizations: Final Report.* Madison, WI: KEMA, Inc. Prepared for Pacific Gas and Electric Company.

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[P.K. Data] P.K. Data, Inc. 2012. *U.S. Swimming Pool and Hot Tub Market 2012.* 2012. http://www.apsp.org/utility/showDocumentFile/?objectID=1058.