CEE[SM] High Efficiency Residential Swimming Pool Initiative

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January 2013

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1 Acknowledgements

CEE would like to thank these specific individuals who shared their pool pump program and engineering expertise and provided a rigorous technical review of this Initiative.

John Trowbridge	Austin Energy
John Hodge	BC Hydro (Contract Employee)
Brigitte Lalonde	Hydro-Québec
Charles Ouellet	Hydro-Québec
Doug Eddie	NV Energy
Gary Fernstrom	Pacific Gas & Electric (Contract Employee)
Joanne Panchana	Pacific Gas & Electric
Rich Fortescue	Public Service Company of New Mexico
Paula Robertson	Sacramento Municipal Utility District
Nathan Morey	Salt River Project
Richard Pulliam	Southern California Edison

2 Executive Summary

Residential swimming pools represent a significant remaining energy savings opportunity in the residential sector. In residences with swimming pools, pool energy use can account for over half of the energy consumption in the home and can be a large contributor to summer peak demand in the residential sector.[1] Pool pumps almost always represent the largest single electrical end-use for a residential premise, typically using over three times the energy of a new refrigerator.[2]

It is important to note that the energy savings opportunity varies with geography and climate and is greatest in regions with the largest number of residential swimming pools. For example, in California – a geography with a particularly large installed base – the energy savings potential for switching to variable speed pool pumps is estimated to be around 3.2 million MWh/yr, while in New York, it is estimated at closer to 0.8 million MWh/yr and in Illinois 0.3 million MWh/yr. The tables below provide estimates of the savings opportunity for the top ten states in the US and six regions in Canada. We note that these energy savings estimates assume an aggressive case where the market shifts from 25 percent market share for variable speed pumps to 90 percent. Those states where data is only available for one pool type (either inground or above-ground) exhibit lower energy savings estimates than had complete data on pool installations been available. Nevertheless, the data suggests that a very significant opportunity exists around transforming the market for residential pool pumps through an approach that leverages binational consistency among participating efficiency programs.

[1] US Energy Information Administration. *Residential Energy Consumption Survey* 2005.
[2] Davis Energy Group, *Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development. Analysis of Standard Options for Residential Pool Pumps, Motors, and Controls*. May 12, 2004.

Table 2-2: Top Ten US States by Number of Pools - 2011[3]

State	Inground Pools	Above-Ground Pools	Total Number of Pools	Estimated Energy Use Single Speed (MWh/yr)	Estimated Energy Use Variable Speed (MWh/yr)	Estimated Energy Savings (MWh/yr)
Arizona	323,642	NA	323,642+	953,854	304,450	649,404
California	1,218,177	368,184	1,586,361	4,675,402	1,492,290	3,183,113
Florida	755,208	204,138	959,346	2,827,432	902,457	1,924,976
Georgia	NA	112,716	112,716+	332,202	106,032	226,170
Illinois	NA	151,425	151,425+	446,287	142,445	303,842
Michigan	NA	159,985	159,985+	471,516	150,498	321,018
New Jersey	119,361	NA	119,361+	351,787	112,283	239,504
New York	263,009	171,080	434,089	1,279,369	408,348	871,021
North Carolina	95,701	121,304	217,005	639,568	204,137	435,431
Ohio	120,201	172,311	292,512	862,106	275,166	586,940
Pennsylvania	140,805	157,000	297,805	877,706	280,145	597,561
Texas	473,531	276,634	750,165	2,210,924	705,680	1,505,244
Virgina	97,194	NA	97,194+	286,455	91,430	195,025

Table 2-2: Existing Pools in Canada - 2008 (Estimated) [4,5]

Region	Inground Pool	Above Ground Pool	Total Number of Pools	Estimated Energy Use Single Speed (MWh/yr)	Estimated Energy Use Variable Speed (MWh/yr)	Estimated Energy Savings (MWh/yr)
Atlantic	5,780	8,935	14,715	43,369	13,948	29,420
Quebec	92,990	190,000	282,990	834,042	268,246	565,796
Ontario	259,070	42,750	301,820	889,539	286,095	603,444
Prairies	7,860	2,680	10,540	31,064	9,991	21,073
Alberta	7,665	2,835	10,500	30,946	9,953	20,993
BC	30,635	6,170	36,805	108,474	34,887	73,586

[3] Association of Pool and Spa Professionals, U.S. Swimming Pool and Hot Tub Market 2011.

[4] Statistics are harvested from Statistics Canada and their building permit records for swimming pools with an overview of new pool permits for major urban areas. Pool & Spa Marketing magazine supplements this information with input from distributors, manufacturers, dealers and retailers from regional markets. Kenilworth Media Inc. shall not be liable for damages of any kind resulting from use or reliance on this information.

[5] Pool & Spa Marketing. April 2009. This report uses official data from the old National Spa & Pool Institute (NSPI) Market Statistics committee numbers (1993), and factors the Industry's growth and market trends for the years since the NSPI report was released. These estimates are conservative, but do indicate market size in the United States. Kenilworth Media Inc. shall not be liable for damages of any kind resulting from use or reliance on this information.

The primary goal of the *CEE* High *Efficiency Residential Swimming Pool Initiative* is to increase the likelihood of purchase and proper installation of high efficiency swimming pool equipment in order to deliver untapped energy savings available in both new and existing residential swimming pools across the United States and Canada. To achieve this goal, the Initiative focuses first on the largest energy savings opportunity within residential swimming pools, namely replacing comparatively inefficient single speed pool pumps with higher efficiency multi or variable speed pumps. Through the strategies outlined below, CEE seeks to transform the market such that a critical mass of high efficiency pool pumps is installed, installed properly and that these highly efficient pumps become readily identified as the preferred option by users, and supply and installation players at a national level. Although pumps are the principal focus of this Initiative at the outset, the Initiative positions CEE members is to further explore and support a number of other energy savings opportunities that exist within pool systems, including those associated with pool timers, pool cleaners / vacuums, pool heaters and pool covers.

The specific strategies of the CEE initiative are designed to overcome the most significant market barriers to the sale and installation of efficient pool equipment, commencing with multi and variable speed pool pumps in order to capture the associated energy savings. The major barriers identified are higher incremental price, lack of awareness of the benefits (among both consumers and contractors), and difficulties with explaining the benefits of high efficiency equipment to customers. Some other notable barriers include overcoming complexities surrounding the proper installation of high efficiency equipment that is necessary to ensure product performance and safety as well as maximize the energy savings. A core Initiative strategy is to stimulate consumer demand for multi and variable speed pumps, and provide consistent and credible materials to trade allies in order to support their efforts to sell and install these pumps. In turn, this, will encourage program administers to increase the number of rebates being offered, with the goal being to offset the higher incremental price of efficient pumps. Overall, establishing consistency across all these elements provides a clear signal to the market, and enables market players to more easily identify, promote, sell and install high efficiency products. The activities developed to support these strategies include establishing a definition of high performance (CEE Tier level specifications), sharing educational and marketing materials and approaches among energy efficiency programs, and supporting discussions around the development and delivery of consistent contractor training across the US and Canada.

CEE staff will promote the Initiative approach/strategy to programs in order to increase adoption by CEE members and hence to achieve critical mass in the relevant areas (identified above). Staff is also responsible for supporting the CEE Residential Appliance Committee in its efforts to develop and maintain high efficiency product specifications as well as provide CEE members with qualifying product lists. Staff will facilitate Committee calls, enable sharing of educational materials and provide a central location to house related resources for ready program access. CEE will develop an annual summary of relevant swimming pool program information to educate both members and industry stakeholders. CEE staff will enable an open dialogue with the swimming pool industry and pursue joint activities such as developing training guidance that assists pool contractors in achieving correct installation of variable speed pumps. Lastly, CEE staff will continue its exploration of other energy savings opportunities in residential swimming pools, such as pool heaters, which will require integration with gas efficiency program interests.

CEE members' role includes; 1) promotion of products that meet the CEE high efficiency specifications, 2) effectively messaging about the benefits to consumers, pool contractors, and retailers, which includes providing pool contractors and retailers with the tools necessary to bring

this message directly to consumers, and 3) working to ensure that, through contractor training and audit programs, high efficiency pool pumps are installed correctly such that they deliver and maximize potential energy savings.

By following this three-pronged approach, CEE members will work in coordinated fashion to enable a market where consumers and contractors in all geographic areas are better equipped to understand the benefits of high efficiency pool equipment such that they are motivated to purchase and install it. Likewise, pursuing these efforts is intended to improve contractor knowledge around how to install efficient equipment correctly so that both superior performance and maximum possible energy savings are delivered.

The Initiative begins by providing an in depth look at the residential swimming pool market (Section 2) including background on how pool systems work, market players, trends, and barriers, as well as an assessment of the different energy savings opportunities. This market overview and savings opportunity assessment directly informs the approach and strategies employed by the Initiative, which is covered in Section 3. Additional technical details and the *CEE Efficient Residential Pool Pump and Control Specifications* development process are covered in Appendix A and B, respectively.

Lastly, we highlight that any program administrator considering a swimming pool program, whether or not complying with the CEE initiative criteria, should maintain a focus on understanding and addressing the safety implications posed by high piping velocities and potential entrapment hazards. These considerations are further detailed in section 3.3.1 and 4.3.4 of the Initiative.

3 Residential Swimming Pool Market

3.1 Market Overview

There are over 11 million residential swimming pools in the United States and Canada. The Association of Pool and Spa Professionals (APSP) 2011 Industry Statistics indicate that there are 10,364,000 swimming pools in the US.[6] Based on a Natural Resources Canada (NRCan) 2003 Survey of Household Energy Use (SHEU), there were 1,088,630 households with swimming pools, representing roughly 18 percent of single detached homes in Canada.[7] The total number of swimming pools in Canada is now likely closer to 1,168,380, based on adding the number of pool construction permits issued between 2003 and 2010.[8]

Of these 11 million swimming pools, approximately 52 percent are in-ground and 48 percent are above ground. Over half of swimming pools in the US market are located in thirteen states. In order of magnitude they are; California, Florida, Texas, New York, Arizona, Pennsylvania, Ohio, North Carolina, Michigan, Illinois, New Jersey, Georgia and Virginia. The top three states, California, Florida and Texas, represent 46 percent of in-ground pools and 17 percent of above

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[6] Association of Pool and Spa Professionals. *U.S. Swimming Pool and Hot Tub Market 2011*. © 2011, P.K. Data, Inc. http://www.apsp.org/Public/Media/IndustryStatistics/index.cfm

[7] Natural Resources Canada, Office of Energy Efficiency. *Survey of Household Energy Use Table 5.17*. 2003. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/sheu03/publication_en_038_1.cfm?attr=0

[8] Jason Cramp, *Pool and Spa Marketing*. Volume 35, Number 3, Page 10"State of the Industry" April 2011 Statistics are harvested from Statistics Canada and their building permit records for swimming pools with an overview of new pool permits for major urban areas. Pool & Spa Marketing magazine supplements this information with input from distributors, manufacturers, dealers and retailers from regional markets. Kenilworth Media Inc. shall not be liable for damages of any kind resulting from use or reliance on this information. http://www.kenilworth.com/publications/psm/de/201104/index.html

ground pools. [9] In Canada, the eastern provinces dominate the market. Provinces of Ontario and Quebec represent 89 percent of the swimming pools in Canada, followed by British Columbia representing over five percent. For in-ground pools, Ontario represents the majority (64 percent) while for above ground pools, Quebec is the leader, representing 75 percent.[10]

Approximately 2.3 million residential swimming pools in the US and Canada have pool heaters. Based on preliminary 2009 data from the US Energy Information Agency, 2.1 million residential swimming pools in the US are equipped with heaters. Over half of these pool heaters rely on natural gas, just under one fourth use electricity, and the remaining heaters use propane, liquefied petroleum gas or other sources.[11] Based on the 2003 SHEU, Canada had 212,230 households with heated pools, representing approximately 20 percent of all Canadian homes with swimming pools.[12]

3.1.1 Swimming Pool Systems

The key aspects to maintaining residential swimming pools include; water circulation, water filtration (including the removal of debris), even dispersal of chemicals, and occasionally water heating. Residential swimming pools are complex systems and their energy use depends on a variety of factors such as pool size, type and configuration of equipment used, and characteristics of the operating environment.

A typical basic swimming pool design includes nine major components:

1. A basin
2. A pool pump / motor(s)
3. A filter
4. A chemical feeder
5. Drains
6. Returns
7. Plumbing connecting all of these elements
8. Pool sweep/vacuum (cleaning) system
9. Pool heater

The swimming pool pump / motor combination or more commonly referred to as the "pool pump" is the main mechanical component within a pool system. A pool pump is a mechanical assembly of the motor and impeller within a pump housing or "wet end." The pool pump is responsible for moving water, keeping it free of dirt, debris and bacteria by pushing it through the filtering and chemical treatment systems and then returning it back to the pool. Water is pushed from the main and skimmer drains, flows through the skimmer basket, which catches leaves and other large debris that might clog the pool pump, enters the pool pump, moves on to

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[9] Association of Pool and Spa Professionals. *U.S. Swimming Pool and Hot Tub Market 2011*. © 2011, P.K. Data, Inc. http://www.apsp.org/Public/Media/IndustryStatistics/index.cfm

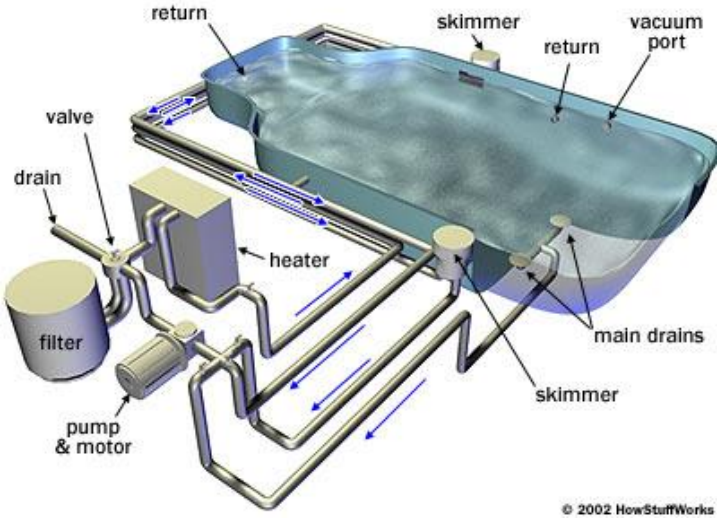
[10] Statistics are harvested from Statistics Canada and their building permit records for swimming pools with an overview of new pool permits for major urban areas. Pool & Spa Marketing magazine supplements this information with input from distributors, manufacturers, dealers and retailers from regional markets. Kenilworth Media Inc. shall not be liable for damages of any kind resulting from use or reliance on this information. http://www.kenilworth.com/publications/psm/de/200904/index.html

[11] US Energy Information Administration, *2009 Residential Energy Consumption Survey* (*Preliminary results)*, Table HC8.1, "Water Heating in US Homes, By Housing Unit Type, 2009" http://www.eia.gov/consumption/residential/data/2009/

[12] Natural Resources Canada, Office of Energy Efficiency. *Survey of Household Energy Use Table 5.17*. 2003. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/sheu03/publication_en_038_1.cfm?attr=0

the pool filter, passes through a chemical feeder, and then flows back out to the pool via the water inlets or returns.

Figure 3-1 – Image of a Pool System[13]



There are three main types of pool pumps that operate within a typical pool system:

- Single Speed: a pump equipped with an electric motor that operates at only one speed.
- Multi Speed: a pump equipped with an electric motor that can operate at multiple, discrete speeds (this includes, but is not limited to, two speed pumps).
- Variable Speed: a pump equipped with an electric motor that can operate at continuously variable speeds.

Residential pump motors generally range in size from one half to three total horsepower (hp) and deliver approximately 1.5 kilowatts (kW) per total horsepower. The total kW is dependent on the total horsepower, as shown in Table 3-1.Total horsepower is defined as the nameplate horsepower multiplied by the service factor rating of the pump.

Table 3-1: Total Horsepower and kW

Total Horsepower	kW
0.5	1.2
0.75	1.5
1	1.75
1.5	2.25
2	2.4
3	3.4

[13] Harris, Tom. "How Swimming Pools Work" 17 September 2002. HowStuffWorks.com. http://home.howstuffworks.com/swimming-pool.htm 19 November 2012. Permission to use image from Tracy Wilson, 19 November 2012.

There are several key terms that require definition in order to explain how a pool pump operates within a pool system. These are: pressure head, suction head, flow, total dynamic head, filtration flow rate, and turnover time.

"Pressure Head" (Dynamic Head) is a measure of the pressure at a given point in a water system, expressed in feet of head (ft), or the height of a column of water that would produce the referenced pressure.[14] Head is necessary to move fluid through pipes, drains, and inlets, to push water through filters and heaters, as well as project it through any fountains or jets. "Suction Head" (Static Head) is the vertical distance from the water surface to the pump's impeller.

"Flow" is the movement of the water, and is necessary to maintain a sufficient level to result in efficient filtering, heating, sanitation, skimming, and consistent water temperature within the pool system. The volume of water moved at a given time is called the "flow rate" as measured in gallons per minute (GPM). [15] The flow rate is primarily determined by the speed at which the pump is running, but also depends on the horsepower of the pump, the size and configuration of the pool's plumbing, the type and cleanliness of the filter, and the amount of debris in the pool. For example, plumbing having smaller diameter pipes or sharp angles, or the presence of dirty filters or significant debris, will impede a pump's ability to move water through the pool system and will therefore require the pump to operate at higher speeds in order to deliver the desired flow rate. In addition, permanently plumbed-in heaters can slow the flow of water, even if the heaters are not in use.

"Total Dynamic Head" (TDH) is the term used to describe the sum of resistance in an operating circulation system and is expressed in feet of head. The average TDH for a residential pool installation is 50 feet. [16]

The "Filtration Flow Rate" is the rate of flow required to turn over the pool water volume such that sufficient water clarity and sanitation is maintained. Depending on the pool operations required, optimal flow rates will vary and these are determined on a system by system basis. Every pool system will have an optimal filtration flow rate, with a higher flow rate being necessary to support any auxiliary pool loads such as running pool cleaners/vacuums, salt generators, pool heaters, spas or other water features.

"Turnover Time" (TOT) is defined as the amount of time it takes for the circulation system to move the entire pool volume through the filtration equipment. According to the Independent Pool & Spa Service Association, suggested turnover times for residential swimming pools are between 8 and 12 hours. [17] According to standards promulgated by the Association for Pool and Spa Professionals (APSP)-15 and California Energy Commission (CEC) Title 24, turning over the entire pool volume in under 6 hours is considered excessive and a waste of energy. Appropriate turnover times are also dictated by the operating environment, including ambient temperature, humidity, landscaping, and presence or absence of a pool cover. For example, swimming pools in warmer and more humid climates with no cover would likely require that the pool water be turned over more quickly.

[14] Lowry, Robert W. Independent Pool & Spa Service Association. Basic Training Manual: Part 2 – Equipment. 2008
[15] Lowry, Robert W. Independent Pool & Spa Service Association. Basic Training Manual: Part 2 – Equipment. 2008
[16] Lowry, Robert W. Independent Pool & Spa Service Association. Basic Training Manual: Part 2 – Equipment. 2008
[17] Lowry, Robert W. Independent Pool & Spa Service Association. Basic Training Manual: Part 2 – Equipment. 2008

The necessary flow rate can be calculated by dividing the pool volume by the desired turnover rate.

Flow rate (GPM) = Pool Volume (gallons) / Turnover Time (hours) / 60 (minutes/hour)

Filtration often benefits from lower flow rates and pool pumps that can operate at multiple speed settings are typically set to deliver flow rates ranging 20 to 25 GPM for filtration and 40 to 45 GPM for cleaning. In California, it is recommended that the flow rate should be selected to achieve a 12-14 hour turnover and to achieve a cleaning rate that is as slow as possible while allowing the cleaner to function properly. Flow rates required to support auxiliary functions usually range between 50 and 100 GPM.[18] Depending on the type of pool pump, the motor can run at different speeds to deliver the necessary flow rates.

A single speed pump needs to be sized appropriately so that it can overcome the total dynamic head of a system and still provide the flow rates required. If a pool system includes auxiliary loads, this means it may be operating at a higher speed than would be optimal for basic filtration. In addition, a pump should not be so large that it creates excessive suction or discharge piping velocities, relative to those recommended by APSP.

The size or horsepower rating of multi speed (or two speed) pumps is slightly less critical because they can operate at different speeds; however it is important that the low speed setting (typically 1725 rpm) can provide the necessary filtration flow rate for the pool system. The higher speed settings (typically 3450 rpm) are most often used for auxiliary loads, which require higher pressure to achieve the necessary flow rates than those required for basic filtration.

Variable speed pumps provide the most flexibility because they can be programmed to operate at all speeds and thus can produce optimal flow rates for every desired function. Typically, filtration speeds for these units range from 800-1000 revolutions per minute (RPM).

3.1.2 Swimming Pool Energy Use

In residences with swimming pools, energy use by the pool system can account for over half of the energy consumption in the home, and thus can be a large contributor to summer peak demand in the residential sector.[19] In homes with swimming pools, pool pumps are almost always the largest single electrical end-use, using over three times the energy of a new refrigerator. In addition, they constitute a diversified electrical demand[20] that, in practice, can be over 20 times that of a new refrigerator.[21]

The most energy intensive aspects of residential swimming pools are related to water circulation, filtration, and water heating. The primary equipment used to provide these amenities are swimming pool pumps and pool heaters. On average, swimming pool pumps consume 3,500

[18] Personal communication with representative from Pentair Water Pool & Spa, February 2012.

[19] US Energy Information Administration. *Residential Energy Consumption Survey* 2005.

[20] Diversified demand is the sum of the demand for the same time period by different products, It may also be referred to as simultaneous demand.

[21] Davis Energy Group, *Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development. Analysis of Standard Options for Residential Pool Pumps, Motors, and Controls*. May 12, 2004.

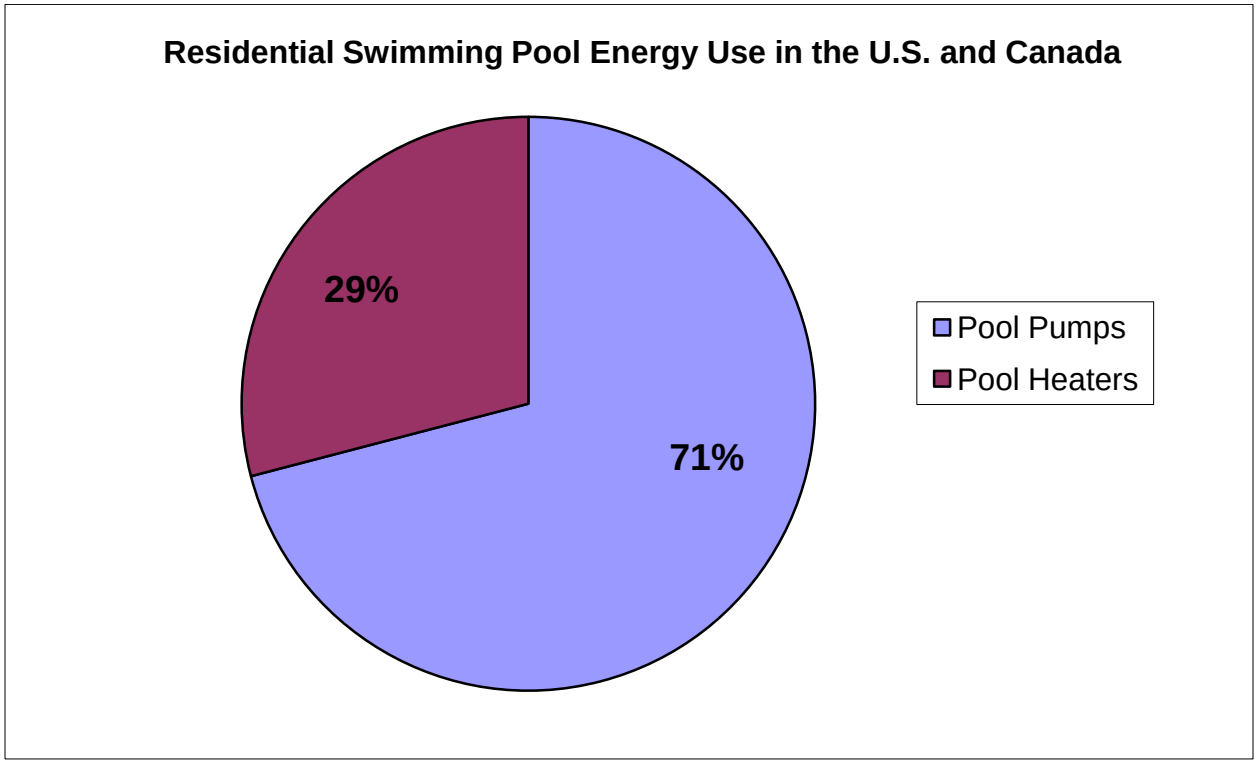
kWh per year.[22] According to the US Energy Information Agency, water heating in swimming pools heaters consumes on average 36.9 million British thermal units (MMBtu) per year.[23]

Based on figures presented in Section 3.1 Market Overview, pool pumps and heaters installed in the US and Canada account for approximately 41 billion kWh of electricity and 55 million MMBtu of gas annually. The total energy use of residential swimming pools is around 190 billion MMBtu per year, or 58 billion kilowatt hours (kWh) per year, with pool pumps representing roughly 70 percent of the total, and pool heaters the remaining 30 percent, as demonstrated in the chart below. These values assume a conversion factor of 1 kWh = 3,412.14 Btu.

[22] Based on a CEE calculation of average pool pump energy consumption across the US and Canada. More details can be found on pages 27 and 28.

[23] US Department of Energy, Energy Information Administration, *Table WH7. Average Consumption for Water Heating by Major Fuels Used*, 2005. http://www.eia.gov/consumption/residential/data/2005/#Water1

Figure 3-2: Annual Energy Use from Residential Swimming Pools



Other less energy consumptive features of swimming pools are automatic pool cleaners (or sweeps), spas and other water features. These secondary amenities are important to consider, however, because they impact the overall pool system and therefore the energy use of pool pumps and heaters as described in Section 2.1.1, Swimming Pool Systems.

3.1.2.1 Water Circulation and Filtration

3.1.2.1.1 Pool Pumps and Motors

As previously mentioned, pool pumps represent about 70 percent of energy used in swimming pools and they consume around 3,500 kWh per year, per installation.

The energy use of any individual pool pump is directly related to its size (i.e., its impeller rating), the speed at which it operates, and how long it runs. In swimming pool systems with significant total dynamic head and/or auxiliary loads, the pump system will require more power to deliver the necessary flow rates. After the appropriate speed and run time of a pool pump are determined by a pool installer or maintenance contractor, they are most often managed by a pool pump control device. Pool pump controls are defined as an integrated or external device providing automated speed control and programmable timing functionality.

3.1.2.1.2 Pool Cleaners

According to a Pacific Gas and Electric (PG&E) Study, the amount of energy used by pool cleaners (also called pool vacuums or pool sweeps) varies greatly depending on the technology. PG&E evaluated the incremental energy use of pool cleaners relative to a 2-speed, CEC required pump. The PG&E study measured the additional energy use resulting from either running the booster pump and/or the filtration pump at the higher speed required to operate the cleaner. They

compared this to the energy use from running the pump continuously at the lowest speed, and solely for filtration. PG&E found that for single speed pool pumps, cleaners result in relatively little additional energy use. However, for multi and variable speed systems, the method of powering a pool cleaning device represents a good opportunity to further reduce pump speed and increase energy savings. Based on this study, booster pump powered cleaners were found to consume 2,989 kWh/yr, while cleaners powered by the pool's filtration pump used 1,675 kWh/yr, and robotic cleaners used an estimated 197 kWh/yr.[24]

3.1.2.2 Pool Heaters

According to the US Energy Information Agency, water heating in residential swimming pool heaters consumes on average 36.9 MMBtu per year. This value combines the major fuels used: natural gas, electricity, propane and liquefied petroleum gas. On average, natural gas water heaters consume 38.8 MMBtu per year and electric water heaters 12 MMBtu per year or 3,517 kWh/yr.[25]

3.1.3 Market Structure

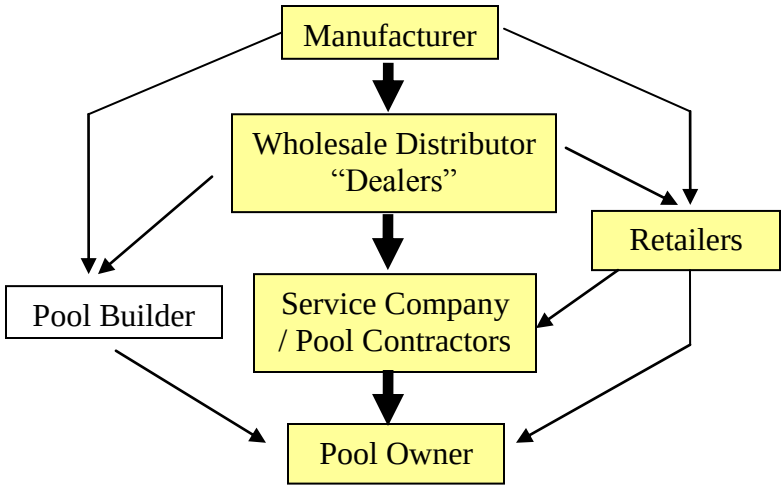
The market for residential swimming pool equipment is complex and, as illustrated by Figure 3-3 below, product can pass through a variety of different channels to reach the end consumer. The shaded channels represent the pathways for existing pool equipment and the white denotes the typical path for new construction. Pool equipment purchases occur primarily in connection with existing installations. For example, according to Pool and Spa Marketing, new pools represent less than one percent of the Canadian market.[26] CEE estimates that the channels, depicted below, represent over ninety percent of all sales and installation.

Figure 3-3 – Swimming Pool Equipment, Market Channels

[24] Pacific Gas and Electric Company, *Residential Pool Program Application Assessment Report #0918. Laboratory Testing of Residential Pool Cleaners*, San Ramon, CA March 2010.

[25] US Department of Energy, Energy Information Administration, *Table WH7. Average Consumption for Water Heating by Major Fuels Used*, 2005. http://www.eia.gov/consumption/residential/data/2005/#Water1

[26] Jason Cramp, *Pool and Spa Marketing*. Volume 35, Number 3, Page 10"State of the Industry" April 2011 Statistics are harvested from Statistics Canada and their building permit records for swimming pools with an overview of new pool permits for major urban areas. Pool & Spa Marketing magazine supplements this information with input from distributors, manufacturers, dealers and retailers from regional markets. Kenilworth Media Inc. shall not be liable for damages of any kind resulting from use or reliance on this information. http://www.kenilworth.com/publications/psm/de/201104/index.html



3.1.3.1 Manufacturers

In new construction applications as well as equipment replacements in existing pools, pool pumps are typically sold as complete units, or as pump and motor systems. This means that the pump system manufacturer has purchased the motor from a motor manufacturer and coupled the motor with its "wet end." Each manufacturer's wet end design is unique and as a result, the design of the motor for each such wet end also is unique. There are also instances where a motor is purchased separately to replace a malfunctioning motor in an existing pool pump, which according to Regal-Beloit EPC, Inc. (Century Electric) represents approximately 45% of replacement purchases. Regal-Beloit estimates that there are around 450,000 motors and 550,000 pump and motor systems replaced in in-ground pools annually. The corresponding number for above-ground pool replacements is likely 10 to15 percent of the in-ground pool number.

There are four major pool pump or pool pump system manufacturers in the US and Canada. Pentair Aquatic Systems (Sta-Rite) is the market share leader, followed by Hayward® (Goldline), Zodiac® (Jandy) and Waterway Plastics. The top three manufacturers listed also supply the majority of pool cleaners and pool heaters found in the market.

The top four pool pump motor manufacturers by market share in the US and Canada are Regal-Beloit EPC, Inc (formerly A.O. Smith), Nidec Motor Corporation (previously Emerson Motor Company), E.M.G. Elettromeccanica and Franklin Electric. A fifth motor manufacturer that has become successful on the residential side of the high efficiency pool motor business is "S.N.Tech", which markets IM Power multi-speed motors, formally branded as Marathon Electric Motor.

While pool pumps often have integrated controls, control packages may also be sold separately. The same three manufacturers (Pentair, Hayward, and Zodiac) market separate controls packages along with Regal-Beloit (formerly A.O. Smith), Allen Concepts, Allied Innovations, Innovative Pool Products, Intermatic, Nidec Motor Corporation (formerly Emerson Motor Company), Paragon, and Wailani Water Products. Purchases of a pool pump or replacement motors can be heavily influenced by manufacturers, as it is most often the pool pump manufacturer that provides education and training to pool contractors regarding the energy savings potential of competing products as well as furnishing instructions on how to correctly program and install

them. In addition, the manufacturers control the direct pricing and promotions that may be offered to wholesalers and retailers and this heavily impacts relative market share in sales.[27]

3.1.3.2 Distributors

Distributors or "dealers" are the primary sales channel for pool pump equipment and they may also provide limited technical support. Distributors are educated by the manufacturers, meaning they are most often the conduit for relaying product information to pool contractors and retailers. As a result distributors typically know the components well, but may lack operational knowledge regarding pool systems. Distributors often provide their facilities for manufacturers to host contractor trainings. In practice, distributors often promote different types of pool pumps by stocking them consistently and promoting them to pool contractors and retailers. [28]

3.1.3.3 Retailers

The remaining balance of pool equipment sales are conducted through retail channels. The majority of pool pump retailers are small, local stores but there is also one large national chain, Leslie's Swimming Pool Supplies. While retailers are primarily sellers of pool pump equipment, they will often have a service branch with employees that are typically licensed pool contractors who are primarily responsible for purchasing and installing pool equipment for a pool owner. [29]

3.1.3.4 Pool Contractors

Swimming pool contractors install and service pool pump equipment, which they may purchase directly from the distributor, or from a retail location. The vast majority of pool pump and pool heater installations involve a pool contractor. For this reason, contractors are highly influential in the selection and installation of pool equipment in both planned and emergency replacement situations. Moreover, pool contractors are typically responsible for programming the pool pump controls and often for delivering regular maintenance of the pool system as well. [30] However, it is important to remember that contractors aren't responsible for the energy bills associated with a pool system and therefore they may be more interested in lowest-first-cost competitive sales as well as in operation of the pump at higher speeds for longer times which could support an easier maintenance cycle. As a result, program design should specifically target pool contractors as discussed in section 4.3.4, which covers quality installation guidance and contractor training.

3.1.3.5 Pool Owners

Pool owners can purchase pool equipment directly from their contractor or through retailer locations. These purchasing decisions are typically driven by first costs, unless owners are made aware of the energy savings from high efficiency equipment. Since pool owners are responsible for their energy bills, they may well have greatest incentive to purchase, install, and correctly program high efficiency pool pumps. [31]

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[27] Communication with Gary Fernstrom, Pacific Gas & Electric, September 15, 2012.

[28] Personal communication with representative from Pentair Water Pool & Spa, February 2012.

[29] Personal communication with representative from Pentair Water Pool & Spa, February 2012.

[30] Personal communication with representative from Pentair Water Pool & Spa, February 2012.

[31] Personal communication with representative from Pentair Water Pool & Spa, February 2012.

3.2 Market Trends

3.2.1 Equipment Trends

Energy saving pool pumps are relatively recent entrants to the market. Variable speed pool pumps were first introduced by Ike Hornsby in Bakersfield, CA, who sold a custom made product under the brand name IkeRick. In late 2005, Pentair Aquatic Systems® developed product that was launched in 2006. Pentair was followed by the other two large manufacturers Hayward® and Zodiac®, who had full model availability starting in 2011.

According to an industry expert, approximately two-thirds of pool pump sales are single speed pumps and the remaining sales are represented primarily by variable speed pumps, with multi speed (or two speed) pumps representing only a very small portion of the total market.[32]

The life expectancy of pump / motor systems varies. Regal-Beloit has provided some life expectancy ranges based on averages. In an environment where they are in use year-round, a wet end can be expected to last 10 to 15 years. Motor life expectancy in these same environments is approximately 5 to 7 years. As a result, a wet end could see 2 to 3 replacements of a mated motor during its service life.[33]

The most common reason for motor failure is the loss of a tight water seal between the motor and the wet end. This may lead to end-of -life in various ways, but the most common is motor bearing malfunction due to the entry of water into the bearing. This condition creates a demand for motor replacements in the aftermarket which are typically sold side-by-side with integrated pump and motor systems. Due to the lower cost of a motor replacement versus a complete pump and motor system, this partial replacement option is very popular in the marketplace. Based on current information available from the largest national retailer in the US, *Leslie's Swimming Pool Supplies*, the incremental purchase price of a variable speed pump over a single speed pump ranges from $550 to almost $900 for in-ground units, and about $1,100 for above ground units (See Table 2-1 below). In instances where two-speed pumps are required by statute, the incremental price for moving to a variable speed pump can be lower since purchasing a lower cost single speed pump is not permitted. These values do not reflect incremental costs for installation.

Table 3-2: Average Incremental Price for Variable Speed Pumps[34]

Pump Type	Average Price	Incremental Price for Variable Speed Pump
Inground		
3/4 HP Single Speed	$509.99	$890.00
1 HP Single Speed	$553.99	$846.00
1.5 HP Single Speed	$627.99	$772.00

[32] Personal communication with representative from Pentair Water Pool & Spa, February 2012.
[33] Personal communication with representative from Regal Beloit, August 2012.

[34] Leslie's Swimming Pool Supplies, March 2012. http://www.lesliespool.com/Home/Pumps-and-Motors/Pool-Pumps.html

2 HP Single Speed	$747.49	$652.50
3 HP Single Speed	$843.32	$556.67
Variable Speed	$1,399.99	
Above ground		
3/4 HP Single Speed	$279.99	$1,120.00
1 HP Single Speed	$269.99	$1,130.00
1.5 HP Single Speed	$289.99	$1,110.00

Numerous conversations with industry actors suggest that the majority of pool contractors install single speed pumps because they are unaware of the energy savings potential offered by more advanced equipment or they don't know how to install them. In a few states however, single speed pumps are no longer an option. Arizona, Connecticut, Florida, New York, and Washington have all adopted residential swimming pool pump standards based on standards California began implementing in 2006. In brief, these standards require all pool pumps greater than 1 total horsepower (HP) to have at least two speeds, and to be fitted with a control device that defaults the system to a low speed setting.

As we have noted, the swimming pool market is competitive and purchasing decisions are frequently driven by first costs. Based on CEE member experience, first cost, as opposed to life cycle cost, is the dominant factor in purchasing decisions of this equipment, leading to the market being dominated by sales of lower cost, lower efficiency units.

3.2.2 Installation Trends

Many pool contractors and pool owners specify pool pumps that are oversized for the application, and may also program these units with run times that are longer than necessary to assure water clarity and sanitation.[35] This typically occurs because it requires lower effort on the part of the pool contractor while building in a "performance buffer" designed to ensure that customer expectations in terms of water quality are satisfied. In assessing opportunities for "right sizing" both pumps and duty cycles in residential applications, the key factor to consider is whether the pump size and run time are capable of providing one turnover per day, while also delivering the necessary flow rates required for the various pool loads for the number of hours needed. According to industry, one turnover per day is considered sufficient for lightly used residential pools, in other words more turnovers may be required during periods of heavier use, such as during a pool party where occupant numbers may increase substantially.[36]

With respect to replacement of existing motors, replacement can be achieved in two different ways. In the first scenario, the same total horsepower is selected but the motor chosen is a "stock" motor most frequently purchased through a pool parts distributor. Various motor manufacturers supply "stock" motors that achieve the same rated output as the motor originally specified in the pump and motor system. The second scenario is when a pool contractor changes the diffuser inside the wet end and/or the impeller along with changing out the motor. This scenario typically occurs so that the contractor can alter flow rates in an installed pump and

[35] Personal communication with representative from Pools by Ben. February 2010.

[36] National Swimming Pool Foundation, Hanley Wood, and Foundation for Pool & Spa Industry Education, "Aquatic Service Tech Series Volume 1: Certified Aquatic Energy Auditor" page 17, 2011.

motor system while still meeting the filtration requirement to maintain sanitary conditions within the pool.

Most variable speed motor replacements have on-board timers which allow for controllability and customization to maximize energy savings. This allows the pump motor system to change speeds based on the time of day (such as to address demand reduction opportunities) as well as to maximize total energy savings.

3.3 Energy Savings Opportunities

3.3.1 Pool Pumps

As described above, residential pool pumps may be oversized for the pool system, thus providing more than one turnover per day and wasting energy.

Variable speed pumps address this wasted energy because they can be operated at a variety of different speeds and typically have integrated controls. When programmed appropriately, they can deliver significant energy savings for all pool loads and without degrading performance relative to water quality. The Foundation of Pool and Spa Industry Education (FPSIE) has worked to develop training materials to help educate the swimming pool industry about proper installation and energy savings from variable speed pumps.[37] In addition, the Association of Pool and Spa Professionals (APSP) has developed standards for energy efficiency for residential in-ground swimming pools and spas. Consistent with the science, the APSP standard encourages lower flow rates and longer filtration times to achieve maximum energy efficiency.[38]

The APSP standard also requires that the pool filtration flow rate not exceed 36 gpm, or the rate needed to turn over a pool's water volume in six hours, whichever is greater. In practice, this means that for pools of less than 13,000 gallons, the pump must be sized to produce a flow rate of no less than 36 gpm, and for pools of greater than 13,000 gallons, the pump must be sized using the following equation: Max Filtration Flow Rate (gpm) = Pool Volume (gal.) / 360.

Equipment improvements can include either purchasing a pump system with a higher efficiency motor, or a pump equipped with multi or variable speed capability. The savings potential of these options as measured in a reference installation, as compared with a standard efficiency, single speed pump, is presented in Table 3-3 below. Of the three options, variable speed pool pumps provide the largest energy savings opportunity. The energy savings that come from replacing a single speed pump with either a multi speed or variable speed pump are based on an engineering principle known as the "Pump Affinity Law." Similar energy savings can also be gained with a motor only replacement (i.e., replacing a single speed motor with either multispeed or variable speed), which account for approximately forty five percent of existing pump retrofits.[39] In these instances, it is important that the service professional properly match the replacement motor to pump head capacity.

Table 3-3: Potential Motor and Pump Energy Savings

[37] National Swimming Pool Foundation, Hanley Wood, and Foundation for Pool & Spa Industry Education, "Aquatic Service Tech Series Volume 1: Certified Aquatic Energy Auditor" page 17, 2011.
[38] APSP-15 Standard for Energy Efficiency for Residential Inground Swimming Pools, and Spas http://consensus.fsu.edu/fbc/pool-efficiency/APSP-15%20Pool%20Energy%20language%20%281-11-10%29%20%20for%20Florida.pdf

[39] Personal communication with representative from Regal Beloit, February 2012.

Equipment	Per Unit Energy Use (kWh/yr)	Per Unit Energy Savings (kWh/yr)	Percent Energy Savings
Standard Efficiency Single Speed Pump	3,719		
High Efficiency Single Speed Pump	3,300	419	10%
Multi Speed Pump	1,682	2,037	55%
Variable Speed Pump	632	3,086	83%

With respect to these savings, we note that in California, as well as the other states that have adopted similar standards, sales of standard efficiency motor designs are prohibited, meaning that the savings opportunity associated with upgrading to a higher efficiency motor no longer exists.

In addition to delivering energy savings, it is critical that pool pumps are installed and programmed correctly so as to avoid high piping velocities and potential entrapment hazards. Some variable speed pumps may be capable of producing a maximum flow rate that is higher than the preexisting single-speed pump. Excessive flow rates can present bodily hazards such as suction entrapment. For this reason, pool contractors must pay particular attention to programming the pump to deliver appropriate flow rates. According to Section 4.4 of ANSI/APSP Standard 7, water velocities are to be limited to 6 feet per second based on the "Maximum System Flow Rate." User manuals provided by manufacturers indicate that these pumps should only be installed by a pool professional and contain warnings about entrapment hazards associated with excessive flow rates. In addition, it is incumbent on the pool contractors to lock the pump settings so that they can't be inadvertently overridden.

3.3.2 Pool Timers

Pool timers can provide energy savings by reducing the run time of pool pumps fitted with single speed motors and no other controls. However, these savings depend entirely on the run time before and after the installation of a timer control. For example, if a pool system was pumping 24 hours a day with no timer, but was then reduced to 6 hours run time, such a change would yield 75% savings.

3.3.3 Pool Cleaners

Studies by Pacific Gas & Electric Company conducted in 2009 and 2010 indicate that robotic pool cleaners [40] can save significant energy over suction and pressure-side cleaners, which may draw power either from the pool pump or from a separate booster pump. While these savings are interactive with the pool filtration pump savings, it is important to note that they can only be achieved if the robotic cleaner is used in conjunction with a multi-speed or downsized single-speed filtration pump. Simply replacing a suction or pressure-side cleaner with a robotic cleaner

[40] A robotic pool cleaner is defined as a self contained pool cleaner, which operates on its own power and not that supplied by a suction or return line in a swimming pool. It is not attached to a pool's circulation system in any way.

will not result in energy savings, as most single-speed pool pumps are sized to handle filtration and cleaning duties and will use nearly the same amount of energy regardless of what type of cleaner is deployed. However, replacing a booster pump powered cleaner with a robotic cleaner can deliver significant savings, even with single speed filtration systems, as the cleaner booster pump is no longer needed when a robotic cleaner is used as demonstrated below.

Table 3-4: Robotic Cleaner Energy Savings[41]

Equipment	Per Unit Energy Use (kWh/yr)	Per Unit Energy Savings (kWh/yr)	Percent Energy Savings
Booster pump powered cleaner	2,989		
Cleaner powered by a pool filter pump	1,675	1,314	44%
Robotic Cleaner	197	2,792	93%

3.3.4 Pool Heaters

In pools that are heated for at least some portion of year, there are energy savings available from converting to more efficient heating equipment. There are several different technologies that offer heating efficiency improvements, including high-efficiency natural gas heaters, heat pumps, and solar thermal systems. The most appropriate technology to achieve thermal savings will vary depending on climate and pool usage patterns, and thus is worthy of careful consideration. For example, solar thermal systems and heat pumps are good at keeping a pool within a set temperature range for a long period of time, but are also very sensitive to climate variability, whereas high efficiency natural gas heaters are best suited for pools that require occasional rapid heating. There is also an opportunity to reduce the resistance to the flow of water through pool heaters when they are not firing by means of an automatic bypass, which should lead to electric energy savings.

There are federal minimum efficiency standards in place for gas-fired pool heaters[42]. As of January 1, 1990, gas-fired pool heaters are required to have a thermal efficiency of 78 percent. As of April 16, 2013 all new products sold will be required to have a thermal efficiency of 82 percent. The energy savings from this change is around 1.6 MMBtu/yr per unit. A pool heater with 78.2 percent efficiency consumes about 34.1 MMBtu/yr, whereas a pool heater with 82 percent efficiency consumes 32.5 MMBtu/yr. The most efficient pool heaters in the market have a thermal efficiency of 95 percent and consume about 27.8 MMBtu/yr, providing energy savings of 6.3 MMBtu/yr per unit, or 18 percent savings beyond the current federal standard.

[41] Pacific Gas and Electric Company, *Residential Pool Program Application Assessment Report #0918. Laboratory Testing of Residential Pool Cleaners*, San Ramon, CA Revised 8-12-10. March 2010. Contact: info@fpsie.org for a copy of the report.

[42] http://www1.eere.energy.gov/buildings/appliance_standards/residential/pool_heaters.html

3.3.5 Pool Covers

Pool covers provide energy savings by stemming evaporative losses and reducing the volume of debris that collects in the pool. According to the US Department of Energy, each pound of 80ºF water that evaporates takes 1,048 Btu of heat out of the pool. The evaporation rate varies depending on the pool's temperature, ambient air temperature and humidity, and the wind speed at the pool surface. The higher the pool temperature and wind speed and the lower the humidity, the greater the evaporation rate. Covering a pool when it is not in use is the single most effective means of reducing pool heating costs and can achieve 50 to 70 percent savings.[43]

3.4 Market Barriers

3.4.1 Equipment Barriers

Swimming pool pump manufacturers offer and promote a variety of high efficiency pool pumps (more commonly known as multi speed and variable speed pumps), however the market share of these products remains relatively low. The major barriers to purchase and installation of multi and variable speed pumps are high incremental price, lack of awareness of the benefits (among both pool owners and contractors), and the challenge for pool contractors to adequately explain the benefits of high efficiency equipment to customers in the face of higher equipment costs.

Similarly, the main market barriers for robotic cleaners and pool covers are high incremental price and lack of education regarding the associated energy savings. For standard bubble covers, another barrier to adoption is the effort that is required by the pool owner to deploy the cover when the pool is not in use. With automated/motorized covers, the issue of additional effort is overcome, but incremental price increases considerably.

The major market barriers for upgrading to a more efficient pool heater technology are incremental price and product availability. Another barrier may be limited savings potential due to relatively low hours of use and modest incremental opportunity for efficiency improvement.

3.4.2 Installation Barriers

A common practice among pool contractors is to install single speed pool pumps that are oversized for the pool system. [44] This approach takes the least amount of effort from a pool contractor because an oversized pump not only provides a high enough flow rate to run all the pool loads, but also alleviates the need to evaluate the pool system for minimum performance. Since single speed pumps only run at one speed, no programming is involved, with the possible exception of a pool timer. The equipment cost for this configuration is lower and the pool owner may not realize how much additional energy and money can be wasted by this configuration during day to day operation.

Installing and properly configuring multi and variable speed pumps requires additional knowledge of the contractor. While manufacturer technical support focuses on how to sell and install energy efficient pumps, they typically don’t address how to adjust a pool system and program the pumps for the highest efficiency while maintaining water quality. Contractors therefore need to have the capability to determine the appropriate speed settings to deliver the

[43] US Department of Energy, Energy Savers Website – Your Home. http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13140

[44] Personal communication with representative from Pools by Ben. February 2010.

optimal flow rates for the different operations in a pool system and adjust the pool system so it operates optimally at reduced flow. Pumps need to run at higher speed settings to support auxiliary pool loads, while a lower speed setting is required for standard filtration.[45] The speeds selected depend on the flow rate that is achieved given the total dynamic head of the pool system. It is the contractor's responsibility to ensure that the pump doesn't operate at speeds that are too high for the pool system, thus creating hazardous conditions. Once the speed settings are programmed, the contractor determines how frequently and for how long the system should run at each speed in order to deliver optimal overall performance. The controls and programming of variable speed pool pumps vary by manufacturer, meaning that contractors need to be knowledgeable about installing the different versions. Since successfully installing and programming multi and variable speed pumps requires additional training, many pool contractors may not have the time or may be either unwilling or intimidated by the prospect of learning about these technologies.

4 Swimming Pool Programs

4.1 Initiative Goal

The primary goal of the *CEE High Efficiency Residential Swimming Pool Initiative* is to increase the purchase and proper installation of high efficiency swimming pool equipment and to deliver energy savings in residential swimming pools across the United States and Canada.

4.2 Initiative Approach

The approach of this Initiative is to focus on the largest single energy savings opportunity within residential swimming pools and work to overcome the most significant market barriers that are addressable at a binational level. CEE has identified residential swimming pool pumps as the product area that will yield the greatest energy savings and that will benefit the most from a coordinated binational strategy. This approach to pool efficiency was developed by the CEE Appliance Committee (the Committee) starting in 2008.

Faced with maturing, successful high efficiency appliance programs, increasing market share of traditional ENERGY STAR® appliances, as well as growing energy savings targets, in 2008 the Committee began a search for additional energy savings opportunities. Given the significant energy consumption of residential pool pumps, swimming pools were identified as high priority. Utility sponsored residential pool pump efficiency programs were first launched in the state of California in 2001, and since then have expanded to other states with a prevalence of swimming pools such as Arizona, Nevada, and Texas. In addition to areas with existing programs, program administrators in locations with shorter swimming pool seasons such as New York, Massachusetts, Quebec and Ontario became interested in developing programs. Based on a combined show of support from CEE members across the US and Canada, the Committee decided to actively pursue efficiency opportunities associated with residential swimming pools.

It was subsequently determined that while swimming pool pump manufacturers offer and promote a variety of high efficiency pool pumps (i.e., multi speed and variable speed pumps), the market share of these products remains relatively low. The major barriers identified to greater penetration of multi and variable speed pool pumps were higher incremental price, lack of

[45] Personal communication with representative from Pools by Ben. February 2010.

awareness of the benefits (among both consumers and contractors), and difficulties with explaining the benefits of high efficiency equipment to customers. As a result, administrators of ratepayer funded energy efficiency programs have chosen to promote these products through voluntary programs across the United States and Canada.[46]

The Committee recognized the significant opportunity to impact the market through binational consistency and worked to develop a *CEE High Efficiency Residential Swimming Pool Initiative*. Widespread adoption of this Initiative by program administrators will provide a consistent platform for promotion of efficient equipment that is intended to increase the number of rebates being offered to offset high incremental price, stimulate consumer demand for multi and variable speed pumps, and provide consistent and credible materials to trade allies. This will ultimately support decisions by pool owners and contractors to purchase and install more efficient equipment and, over time, lead to increased market penetration of multi and variable pool pumps in residential swimming pools and energy savings.

4.3 Initiative Strategies

CEE has developed specific strategies that take advantage of and support the need for a larger, binational approach. The following three strategies need to be pursued together by efficiency programs in order to ensure successful market transformation:

1) Develop one set of performance specifications for high efficiency pool equipment, and that are adopted by efficiency programs and promoted in their local service territories through rebates and/or education.
2) Share educational and marketing materials and communication approaches among programs so that key messages to consumers, contractors and retailers are delivered more effectively, and such that both consumer and contractor understanding of the energy savings benefits, and therefore demand of high efficiency equipment, is enhanced.
3) Support quality contractor training guidance and related programs to increase contractor understanding and proper installation practices relative to high efficiency equipment across the US and Canada.

Combined, these efforts will promote the purchase and installation of high efficiency equipment and increase the likelihood that the product is installed optimally such that maximum performance and energy savings are achieved. Promoting consistency across all these elements provides a clear signal to the market, and enables all market players to more easily identify, promote, sell and install high efficiency products.

Through the work of the Initiative, pool contractors will be able to reference one list that identifies all variable speed pumps, they will be supplied with industry vetted materials to help sell variable speed pool pumps to their customers, and they will receive industry approved training on the installation and programming of variable speed pool pumps in order to deliver maximum energy savings to their customers. Without these resources being provided on a consistent basis across the US and Canada, individual pool contractors are more likely to continue their current practice of installing single speed pool pumps that run at higher speeds

[46] Program may incorporate midstream and upstream programs targeting distributors and other trade allies.

than required by the pool system. By positioning the Initiative to target pool contractors in multiple service territories at the same time, CEE members will yield greater energy savings and market impacts than could be achieved through separate efforts conducted by individual programs.

The strategies provided below identify what CEE is committed to pursuing in the near term, though there is interest in exploring additional energy savings opportunities in the future. More information on these opportunities can be found in Appendix Section A.2.

1. Develop and maintain relevant energy equipment performance specifications and tiers that represent high efficiency residential pool pump products throughout the United States and Canada.
2. Promote uptake of this Initiative in the market by supporting performance tiers and specifications that will attract program administrator use in local and regional markets and investment/promotion by industry partners including manufacturers and trade associations such as the Association of Pool and Spa Professionals, the Independent Pool and Spa Service Association, the Foundation for Pool and Spa Industry Education, the National Swimming Pool Foundation, and the Master Pools Guild.
3. Identify means to increase the use of and relevance of CEE specifications by maintaining a forum of CEE members, manufacturers, and industry associations to share program design approaches, marketing, educational, and training materials and other experiences, including consideration of expanding the scope of coverage to new product areas or approaches, and by documenting program successes.
4. Build and strengthen an effective ENERGY STAR® program, if launched, for use by energy efficiency program administrators to publicly promote high efficiency equipment.

4.3.1 Equipment Specifications

Pool pump equipment lends itself to mass-market prescriptive energy efficiency programs that are based on significant performance specifications developed by determining the consensus needs of program administrators, and vetted through a carefully considered stakeholder process. Efficiency programs promoting high efficiency pool pumps are often designed to address the first cost purchasing barrier by offering financial incentives to pool owners and/or pool contractors to help mitigate the higher incremental price associated with high efficiency equipment relative to standard products. This Initiative includes a *CEE℠ High Efficiency Residential Pool Pump Specification* to support these programs.

This specification is intended to represent a market relevant definition of energy efficient equipment performance, and establish performance levels that will attract program incentives and/or other program support as described in the Initiative Participation Requirements. CEE members may voluntarily adopt this specification as the basis for program incentives and activities that will encourage the purchase and installation of energy efficient equipment in local or regional markets. Widespread participation by CEE members will lead to broader promotion of the specification, greater impacts in the market, and overall greater energy savings compared to those that would be achieved through local or regional programs alone.

The specifications are developed by CEE and are intended to provide a common foundation for Initiative participants to design local or regional programs to enhance consumer awareness and increase demand for energy efficient pool pumps. Throughout the specification development and revision process, CEE relies on industry input to ensure that specifications are robust and

reasonable. Once these specifications are finalized, they serve to motivate manufacturers, distributors, retailers, and contractors to develop and market products that qualify for the designated efficiency levels.

As with other appliance categories, CEE tier levels serve as a basis for energy efficiency programs to promote high efficiency products. Differentiated efficiency levels also provide many ancillary benefits and opportunities, such as:

- Giving efficiency programs the ability to demonstrate third party technical credibility within their local service territories;
- Providing consumers a basis to identify relative product performance;
- Setting clear, bi-national targets for manufacturers when they design and engineer higher-efficient products;
- Supporting accelerating market transformation in the adoption of the higher efficiency equipment and practices
- Allowing efficiency programs and partners to benefit from affiliation with higher performance and,
- Helping manufacturers benefit from objective third party credibility in the promotion of their most efficient products.

As a supplement to these specifications, CEE will look to maintain a list of products that meet the different tier level requirements within the specification. This qualifying products list will enable key market players (distributors, retailers, pool contractors, and pool owners) to identify pool pumps that meet an established definition of high efficiency, and which are being supported by efficiency program administrations across the US and Canada. In addition, the product list will make it easier for CEE members to administer their programs by identifying which products will yield desired energy savings.

In addition to CEE specifications, CEE also monitors ENERGY STAR's program activities and convenes efficiency programs to discuss the opportunities and implications of ENERGY STAR. CEE is aware that ENERGY STAR is working to develop a pool pump specification and as appropriate, CEE will seek to promote consistency through provision of consensus responses and submission of comments on behalf of participating efficiency programs.

4.3.2 Program Educational and Marketing Materials

CEE is well aware of the need to address the lack of awareness regarding the benefits of multi speed and variable speed pool pumps. By sharing marketing and training materials, CEE supports members' efforts to educate consumers, pool contractors, and retailers about the benefits of multi speed and variable speed pool pumps. These materials ultimately have two purposes: 1) to educate the consumer, contractor, and retailer about the benefits of multi speed and variable speed pool pumps with materials from a credible third party source, and 2) to provide tools for pool contractors and retailers to facilitate consumer education, and hence sales of these products to consumers.

There are several target audiences for education regarding the benefits of multi and variable speed pool pumps: retailers, pool contractors, home improvement contractors, home energy

auditors, and pool owners. Based on local market conditions and individual resources, programs can strategically consider the best audiences to target in order to achieve their specific savings goals. As part of this Initiative, CEE provides a forum for sharing education and marketing materials developed for each of these target audiences. Programs have the opportunity to learn from fellow program administrators which messages and avenues have been the most successful and may then use these lessons learned to develop or enhance their own messaging, materials and trainings. CEE also engages industry stakeholders to help programs develop these core messages, identify the best avenues for outreach, and develop tools that will exhibit credibility within the industry.

Industry has specifically pointed to a lack of market understanding regarding both the long-term benefits and pool-specific cost savings. As a result, CEE plans to specifically support efficiency program efforts to illustrate cost savings by item (i.e., variable speed pump, pool cover, etc.) for a standard pool in different parts of the country. In addition, these efforts will make the pool industry more likely to accept and appreciate the value of high efficiency equipment and practices, and hence to use that information to sell the concept to individual consumers. Lastly, CEE intends to encourage materials that present the savings numbers in both dollars and energy reductions, in order to increase consumer enthusiasm and buy-in.

In addition to coordinating the exchange of educational and promotional materials and strategies among efficiency programs and industry, CEE provides a forum to develop those aspects that would benefit from binational consistency.

4.3.3 Program Summary

CEE plans to compile information regarding existing program approaches in the form of a Residential Appliance Program Summary. This program summary will highlight different market intervention strategies (e.g., consumer focused, installer focused, or combination), as well as examples of how programs are working through different market channels (e.g., manufacturers, distributors, and retailers) and partnerships to deliver messaging and training. This summary will primarily serve to help members refine their programs' effectiveness in promoting the adoption of energy saving practices related to swimming pools. It will enable the sharing of ideas and experiences among members, which will allow efficiency programs to learn from each other. The summary will also serve to inform industry and other stakeholders on efficiency program priorities and approaches toward building a greater overall impact in the market.

4.3.4 Contractor Training Materials and Programs

Proper installation of high efficiency pool pumps is critical in delivering energy savings to the consumer. If a variable speed pump is programmed to operate at a setting that is higher than necessary for the system, than the full energy savings will not be achieved. Indeed, lost energy savings with improper installation could range from 1 to 100% of the total available savings. However, we believe the scenario where a pool contractor installs a variable speed pump, but programs it to run only at the highest speed setting is unlikely. This is because pool contractors generally possess sufficient education regarding safety concerns and hence are aware that operating a pump at speeds that are too high for the pool system could create hazardous conditions.

Even if pool contractors have experience with installing and programming pool pumps so as to avoid overly high piping velocities and potential entrapment hazards, they may be less familiar with the fact that some variable speed pumps are capable of producing a maximum flow rate that

is higher than a preexisting single-speed pump. For this reason, pool contractors must pay particular attention to programming the pump to deliver appropriate flow rates. Lastly, it is incumbent on the pool contractors to lock the pump settings so that they can't be inadvertently overridden.

We recognize that some fraction of pool contractors will lack complete knowledge on how to install and properly configure multi and variable speed pumps. Accordingly, they will need additional guidance and education on how to adjust the pool system and to program these pumps for the highest efficiency while maintaining water quality. There is thought to be a need for contractors to improve their capability to determine the appropriate speed settings to deliver the optimal flow rates and to adjust the pool system such that it operates optimally at reduced flow. This includes the ability to determine and select the appropriate operating speed(s) based on the flow rates achieved, and given the total dynamic head of the pool system. Once the speed settings are appropriately programmed, the contractor needs to be able to determine how frequently and for how long the system should run at each speed in order to deliver optimal overall performance for the individual pool owner. Lastly, we note that the controls and programming of variable speed pool pumps vary by manufacturer, and that contractors therefore need to be knowledgeable about installing a variety of makes and models found in the market.

As a result, CEE has identified an opportunity to work with industry on enhanced contractor training materials and programs. The purpose of this effort will be to facilitate the education of pool contractors with respect to how to correctly specify and install multi and variable speed pool pumps, and to program associated control devices appropriately to deliver maximum energy savings while maintaining superior water quality and sanitation. This effort would also address potential safety concerns regarding high efficiency pool pumps.CEE perceives a need for enhanced contractor training materials and programs that educates the industry on best practices for installing multi and variable speed swimming pool pumps and programming controls. These materials could highlight topics related to energy use, such as pump sizing and run times. CEE may also be interested in supporting the development of a standard set of training materials in cooperation with industry to take advantage of its expertise and experience. Because these tools can be vetted by both programs and industry experts, they would provide an additional level of credibility and accuracy, and would enable programs to better educate pool contractors and customers about the benefits of high efficiency equipment.

One effort currently underway is being conducted by PG&E and FPSIE. These entities have begun work to develop an energy efficient installation training course, which presumes that manufacturers have engaged service professionals with messaging on how to install and program pumps. These efforts will be focused not just on training the pool contractor how to set the variable speed pump controls to work best within a given pool installation, but also to adjust the pool system to work optimally at the lowest practical flow rate.

In addition to training materials and programs, CEE is also interested in exploring support for the development of a pool audit tool that would allow contractors to properly, accurately, and credibly quantify potential savings in a customer's pool installation. Tools of this type would be expected to help contractors better sell the benefits of multi-speed pumps. We note that there may be some similarities with PG&E's current efforts to develop a pool savings modeling tool that can be used in conjunction with Energy Upgrade California to model potential savings relative to a measured baseline.

4.4 Initiative Participation

Initiative Participation is an opportunity for individual efficiency organizations to amplify the impact of their local efficiency program. By giving voice to participation in this Initiative (see requirements below), individual organizations are counted as part of a collective, harmonized effort to advance efficiency. Through program summaries and other corporate communications, CEE champions the collective Initiative participation with original equipment manufacturers and supply chain actors, thereby encouraging their ongoing investment in the supply of energy efficient products to local markets across North America. While one program may represent a small fraction of the binational market, the collective participant voice as channeled through CEE sends a powerful signal to the national supply chain that energy efficient products are valued and supported across North America.

As with all initiatives of CEE, participation in the *CEE Efficient Residential Swimming Pool Initiative* is voluntary. To be considered an Initiative participant, the following are the minimum requirements:

1. Promote high efficiency pool pump equipment meeting *CEE High Efficiency Residential Swimming Pool Pump Specification*
2. Effectively message about the benefits of high efficiency equipment to consumers, pool contractors, and retailers, as well as provide pool contractors and retailers with the necessary tools so that they can bring this message directly to consumers
3. Through the promotion of contractor training and audit programs, ensure that high efficiency pool pumps are installed correctly such that they deliver and maximize potential energy savings

AND:

4. Communicate to CEE that you voluntarily elect to participate in the Initiative. CEE typically publishes publicly available program information furnished by Initiative Participants in an annual program summary and in other communications to key market players about Initiative impacts that serve to advance the goals of the Initiative.

This Initiative is offered for use to any CEE member who agrees to the terms of use.

Appendix A Technical Descriptions

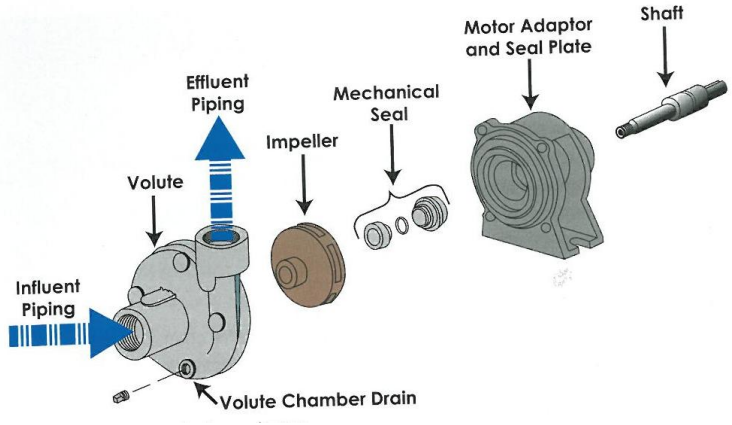
4.5 Pool Pumps and Motors

This Initiative is focused on swimming pool pumps responsible for maintaining the water filtration and circulation in residential swimming pools. Pool pumps intended to provide auxiliary functions (e.g., pool cleaner boosters and water feature pumps) or spa filtration are not included within the scope of this Initiative.

Pool pumps can be referred to by many names including – water pump, filtration pump, circulation pump, and centrifugal pump. Pool pumps are defined as a pump-motor combination used to circulate and filter pool water in order to maintain clarity and sanitation, and includes the centrifugal pump and the pump motor. Pump heads with motors are commonly referred to as "pumps," while pumps without motors are called "wet ends."

Every wet end has the same basic components shown in Figure A-1: a volute or pump housing, motor shaft (an extension of the pump motor), mechanical shaft seals, motor adaptor and seal plate, and impeller.

Figure A-1: Components of a Wet End[47] [Permission?]



4.5.1 Efficiency Metrics

The American National Standards Institute (ANSI) has a test method (ANSI/HI 1.6-2000) for residential pool pumps and replacement motors to measure the energy efficiency of pump and motor combinations.

Association for Pool and Spa Professionals (APSP) has also been working with the ANSI to develop energy efficiency standards for the industry, the first of which, ANSI/APSP/ICC-14 2011 Standard for Portable Electric Spa Energy Efficiency, was approved in early 2011. A second is ANSI/APSP/ICC-15, which is a total systems approach to pool energy efficiency,

[47] National Swimming Pool Foundation, Foundation for Pool and Spa Industry Education, and Hanley Wood. *Volume 1: Certified Aquatic Energy Auditor* ™. Page 12. 2011

provides energy efficiency performance specifications for swimming pool filtration systems. The purpose of this standard is to provide consistency for those states or provinces interested in adopting minimum efficiency requirements. This emerging standard will also enable those pool pump manufacturers who are building energy efficient pool pumps to publicly report pump performance data on the APSP website.

Although pool pumps are sold as an integrated unit including both pump and motor, motors are manufactured separately and their efficiency ratings are readily available directly from the original equipment manufacturer (OEM). The efficiency of a pool pump is most commonly measured by an energy factor (EF) metric. The energy factor measures the flow (volume of water pumped) in gallons for every watt hour of electrical energy consumed by the pump motor (gal/Wh).

Energy Factor = Flow (gallons/minute) * 60 / Power (watts)

The energy factor of a pool pump will vary based on the speed at which it runs as well as the pool system. Total dynamic head (TDH) is a measure of the resistance to flow, which is typically generated by friction within the pool water handling system or "plumbing loop" (i.e., pipes, fittings, filter, valves, as well as heaters and/or solar thermal equipment, if any). Building from a PG&E market characterization effort, the California Energy Commission developed three different plumbing curves to represent typical pool systems. Based on feedback received from swimming pool industry representatives, Curve A is the most representative of typical pools in the US and Canada.

Curve A: Head = $0.0167 \times \text{Flow}^2$

The EF value of a pool pump is determined by the gallons per minute filtered at a given operating speed. A single speed pump has only one operating point and one EF value, whereas a variable speed pump has many. The optimal filtering speed is the slowest speed possible to maintain water quality, and typically is not below that required for skimming.

4.5.2 Energy Savings Opportunity

The largest and most immediately available savings opportunity is presented by multi speed and variable speed pool pumps. The energy savings that come from replacing single speed pump with either a multi speed or variable speed pump are based on an engineering concept known as the "Pump Affinity Law".

The "Pump Affinity Law" states that the change in power drawn is proportional to the cube of the change in speed, where change in flow is proportional to the change in speed, and change in head is proportional to the square of the change in speed. With pool pump systems, reducing the motor's speed (rotations per minute or RPM) creates less resistance (total dynamic head or TDH) within the pool system, thus making the system more efficient and exponentially decreasing the amount of power required. As illustrated in Table A-2, if the pump operates at half of its original speed, resistance in the system will decrease to a quarter of the original TDH. As a result, the amount of power required to move the water with only a quarter of the resistance decreases to an eighth of the original amount. However, in order to maintain the same turnover rate being provided by the pump at its original speed, the pump needs to operate for twice as long.

Table A-2: Pump Affinity Law

Speed (RPM)	Reduction in Speed	Flow (GPM)	Resistance (TDH)	Power Demand	Run Time	Total Energy Consumption	Energy Savings
3,450	**0**	**1**	**1**	**1**	**X1**	**1**	**0%**
1,725	1/2	1/2	$(1/2)^2 = 1/4$	$(1/2)^3 = 1/8$	x2	1/4	75%
1,150	2/3	1/3	$(1/3)^2 = 1/9$	$(1/3)^3 = 1/27$	x3	1/9	89%

Note: Due to changes in motor efficiency that may accompany changes in speed, energy savings from speed reductions may be slightly reduced as compared to those predicted by the pump affinity law, but are still very substantial.

4.5.3 Existing Standards

As previously described, ANSI/APSP/ICC-15 is a total systems approach to pool energy efficiency and provides energy efficiency performance specifications for swimming pool filtration systems. The purpose of this standard is to provide a consistent reference point for those states or provinces interested in adopting minimum efficiency requirements.

Arizona, Connecticut, Florida, New York, and Washington have all adopted residential swimming pool pump standards, which are based on standards California began implementing in 2006. In general, these standards require all pool pumps greater than 1 total horsepower (HP) to have at least two speeds, and be fitted with a control device that defaults to the low speed setting. These standards were carefully considered in the course of developing the CEE specification for pool pumps.

4.5.4 Energy Savings

As noted above, energy savings from speed reductions tend to be slightly less than what is predicted by the pump affinity law, but are still very substantial. The annual energy savings for both warm and cool climates can be found in Table A-3. These energy savings are calculated based on the following equation:

Energy Use per Day = (Pool Capacity x Number of Turnovers) / Energy Factor.

Note: Where *Energy Factor* is derived from the CEC Curve A system.

The assumptions used to determine these savings have been vetted by the swimming pool industry as representative of typical operating conditions in the US and Canada. It is understood that actual conditions will vary further by region and individual pool system.

For purposes of standardizing its analysis, CEE assumes an average pool size of 22,000 gallons and that one turnover per day provides sufficient water quality and clarity. In cooler climates where pools are generally only operating for 4 months out of the year and pumps often run continuously, we assume a turnover rate of 2 times per day. For multi speed pumps, CEE assumes that the pump runs for an average of 10 hours per day – two hours on high speed and eight hours on low speed. Low speed operation is generally adequate for filtering, but high speed may be needed for other tasks, such as operating pool cleaners or reforming Diatomaceous Earth (DE) filters after backwashing.

The average energy factor values from the California Energy Commission database for all pumps at high speed are 2.0, multi speed pumps at low speed are 5.0, and variable speed pumps at lower speed are 12.0. In warm climates, CEE assumes that pumps are operating 365 days per year, and in cool climates, 122 days per year (4 months). The states and provinces included in the various climate regions are provided in Table A-4. The energy savings were calculated assuming EIA's average 2011 electricity rate of $0.1176/kWh. Initiative participants should calculate their energy savings independently based on the operating days and retail electricity rates in their service territory.

Given the expected incremental price and projected savings from Table A-3, in warm climates, the average payback period for multi speed pumps is less than 6 months, and is a little over a year and a half for variable speed pumps. For cooler climates, it is closer to 6 months for multi speed and 2.5 years for variable speed pumps.

Table A-3: Estimated Energy Savings

Equipment	Per Unit Energy Use (kWh/yr)	Per Unit Energy Savings (kWh/yr)	Per Unit Energy Savings (Dollars)[48]	Average Incremental Price	Pay back period
Warm Climate					
Single Speed Pump	4,714				
Multi Speed Pump	2,521	2,193	$241	$100	2 months
Variable Speed Pump	948	3,766	$414	$846	2 years
Cool Climate					
Single Speed Pump	2,723				
Multi Speed Pump	843	1,880	$206	$100	6 months
Variable Speed Pump	317	2,406	$264	$846	3 years and 2 months

Table A-4: Climate Regions

Region	Climate	States and Provinces in Each Region

[48] Assuming an average residential electricity rate of 0.1176 cents/kWh from the Energy Information Administration November 2011. http://www.eia.gov/electricity/monthly/excel/epmxlfile5_3.xls.

Southeast	Warm	Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee and Virginia.
Southwest	Warm	Arizona, California, Nevada, and Utah.
South Central	Warm	Arkansas, Colorado, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas.
Northeast	Cool	Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont.
East Central	Cool	Kentucky, Michigan, Ohio, and West Virginia.
West Central	Cool	Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin and Wyoming.
Northwest	Cool	Idaho, Montana, Oregon and Washington.
Canada	Cool	All provinces.

4.5.5 Demand Savings

CEE is particularly interested in the applicability of connected functionality in regards to residential pool pumps. A 2008 Southern California Edison pool pump demand response potential study determined that savings potential ranges from 70 to 170 MW per hour between the hours of noon and 6 pm. We note the potential for these savings to decline over the next 10 years as the state pool pump regulations influence the prevalence of variable speed pool pumps. Regardless, it is envisioned that once connected functionality is fully specified, CEE will consider adding it to this Initiative.

4.6 Other Pool Equipment and Products

CEE has identified several other promising opportunities to support energy savings in residential swimming pools. These include additional activities such as exploring the role of connected functionality requirements and partnering with industry to support the development of quality installation guidance, as well as further assessing other product areas for specification development, including pool motors, pool timers, robotic cleaners, pool covers, and pool heaters. As such, the following provides an overview of future opportunities for the edification of initiative participants, and to introduce areas for future expansion of program-based savings.

4.6.1 Pool Timers

Using multi and variable speed pool pumps with controls provides the most promising energy savings, but another solution for reducing the energy used for water filtration and circulation are pool timers. Pool timers may provide an attractive option for customers who aren't willing to absorb the incremental price of a multi or variable speed pump, or aren't ready to replace their

current pool pump. According to the US Department of Energy, pool timers can achieve up to 60% savings[49].

There also appears to be a considerable opportunity for increasing the market penetration of pool timers. In Canada, 392,270 swimming pools have a programmable timer on the filter pump, which represents only 36 percent of pools[50]. As a result, CEE may consider adding a pool timer specification to this Initiative in the future.

4.6.2 Pool Cleaners

An energy savings opportunity exists with robotic cleaners as compared with cleaners that are powered by either a filter or booster pump (see Figure A-5, below). For those systems that are already deploying hydraulic cleaners in an effort to reduce the run time and load on the pool pump, the energy required for robotic cleaners is reduced. The main market barrier for robotic cleaners tends to be higher first cost and lack of education regarding the associated energy savings. Several CEE members are currently promoting the use of robotic cleaners, which makes this is a product category that CEE may cover in the future.

Studies by Pacific Gas & Electric Company conducted in 2009 and 2010 indicate that robotic pool cleaners can save significant energy over suction and pressure-side cleaners which derive their power either from the pool pump or from a separate booster pump. While these savings are interactive with the pool filtration pump savings, it is important to note that they can only be achieved if the robotic cleaner is used in conjunction with a multi-speed or downsized single-speed filtration pump. Simply replacing a suction or pressure-side cleaner with a robotic cleaner will not result in energy savings, as most single-speed pool pumps are sized to handle filtration and cleaning duties and will use nearly the same amount of energy regardless of what type of cleaner is retrofitted. In the case of booster pump powered cleaners, significant savings can be achieved even with single speed filtration pumps, as the cleaner booster pump is no longer needed when robotic cleaners are used.

Table A-5: Robotic Cleaner Energy Savings[51]

Equipment	Per Unit Energy Use (kWh/yr)	Per Unit Energy Savings (kWh/yr)	Percent Energy Savings
Booster-pump-powered cleaner	2,989		
Cleaner powered by a pool filter pump	1,675	1,314	44%
Robotic Cleaner	197	2,792	93%

[49] US Department of Energy, Energy Savers Website – Your Home. http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13290

[50] Natural Resources Canada Office of Energy Efficiency, *Canada Survey of Household Energy Use*. 2003.

[51] Pacific Gas and Electric Company, *Residential Pool Program Application Assessment Report #0918. Laboratory Testing of Residential Pool Cleaners*, San Ramon, CA March 2010.

4.6.3 Pool Heaters

For pools that are heated for at least some portion of year, there are additional energy savings available from converting to more efficient heating equipment. DOE's 2009 Residential Energy Consumption Survey (RECS) indicates that of the 8 million US households estimated to have pools (in-ground and above-ground) with filtration equipment, 2.1 million have pool heaters. Of these households, 1.1 million use natural gas, 0.5 million use electricity, and 0.2 million use propane or liquefied petroleum gas (LPG). Based on the data provided in the SHEU, fewer than 20% of Canadian swimming pools have pool heaters, for a total of 212,230.

According to the DOE 2009 Technical Support Document for pool heaters, natural gas heaters consume an average 38 million Btu/yr. EIA data from 2001 indicates that electric heaters consume an average 2,300 kWh/yr.

The 2009 Survey also indicates that 6.4 million US households have hot tub or spa heaters. Of these households, 4.5 million have electric heaters and 1.5 million have natural gas heaters. The 2005 EIA data indicates that on average, electric swimming pool heaters consume 3,512 kWh/yr. Natural gas heaters on average consume 35.9 million Btu/yr.

There are federal minimum efficiency standards in place for gas-fired pool heaters. As of January 1, 1990, gas-fired pool heaters are required to have a thermal efficiency of 78 percent. As of April 16, 2013 all new products sold will be required to have a thermal efficiency 82 percent. The energy savings from this change is around 1.6 MMBtu/yr per unit. A pool heater with 78.2 percent efficiency consumes about 34.1 MMBtu/yr, whereas a pool heater with 82 percent efficiency consumes 32.5 MMBtu/yr. The most efficient pool heaters in the market have a thermal efficiency of 95 percent and consume about 27.8 MMBtu/yr, providing energy savings of 6.3 MMBtu/yr per unit over the current federal standard or 18 percent savings.

There are several different technologies that offer heating efficiency improvements, including high-efficiency natural gas heaters, heat pumps, and solar thermal systems. It is likely that the related energy savings could be captured through a high efficiency pool heater specification and/or quality installation guide. However, because the best technology will vary depending on climate and pool usage patterns, the correct approach needs to be carefully considered. For example, solar thermal systems and heat pumps are good at keeping a pool within a set temperature range for a long period of time but are also very sensitive to climate variability, whereas high efficiency natural gas heaters are best suited for pools that require occasional rapid heating.

There is a significant and cost-effective opportunity to bypass pool heaters when they are not firing, resulting in electric filtration pumping energy savings. The major market barriers for upgrading to a more efficient pool heater technologies are incremental price and product availability. Another barrier may be limited savings potential due to relatively low overall energy use and modest incremental opportunity for efficiency improvement. CEE likely will evaluate the appropriateness of including pool heater specification(s) in a future version of this Initiative.

4.6.4 Pool Covers

Pool covers provide energy savings by stemming evaporative losses and reducing the volume of debris that collects in the pool. According to the Natural Resources Defense Council, around 120,000 pool covers are sold annually in the US. This number is expected to rise in the near

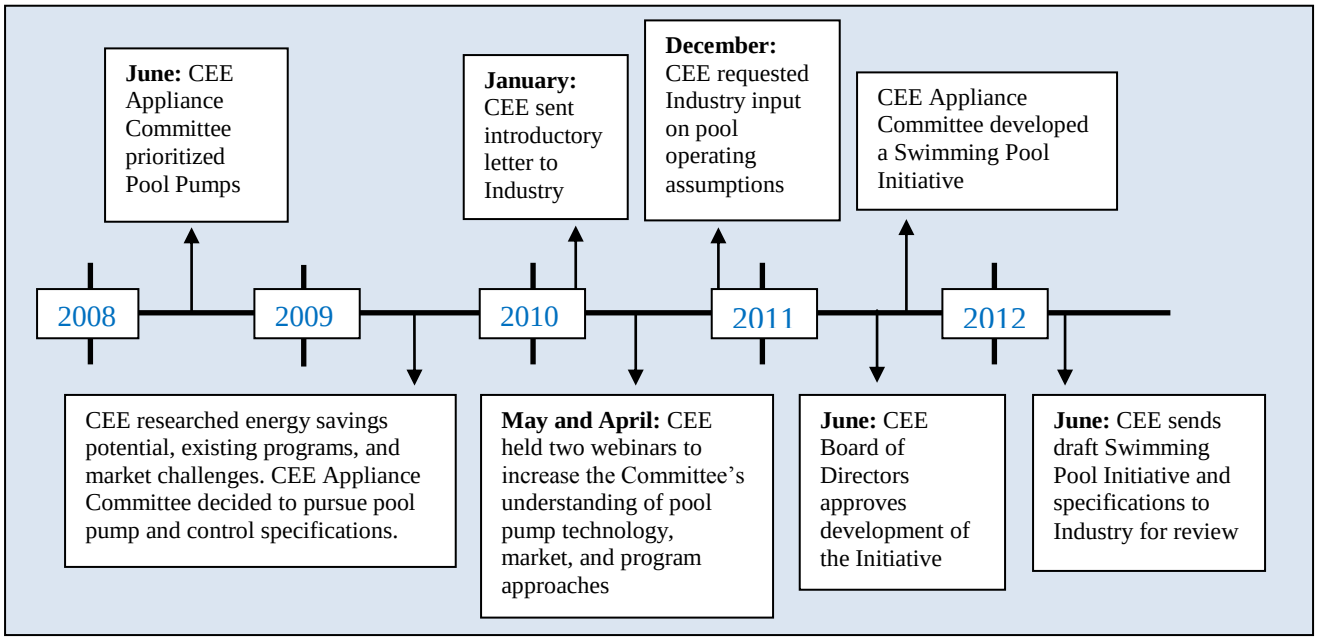
future as state mandates and local ordinances begin to require pool covers for both energy and safety.

Similar to robotic cleaners, the main market barrier for pool covers tends to be first cost and lack of education regarding the associated energy savings. For standard bubble covers, another barrier is the effort that is required to deploy the cover when the pool is not in use. For an automatic cover, the issue of additional effort is eliminated, but incremental price increases considerably.

CEE sees potential value in assessing whether the energy savings and program evaluation challenges associated with pool covers would warrant their inclusion in a future version of this Initiative.

Appendix B CEE Specification Development Process

Figure B-1: Specification development process/history



The current specification is detailed below in Table B-1 and is structured to be technology neutral. Tier 1 was set at a level sufficient to capture multi speed pool pumps, while only variable speed pumps can meet the Tier 2 requirements. Energy factors are calculated based on pool system Curve A, which was established by PG&E and then adopted by the California Energy Commission after review and input from industry.

CEE specifies the RPM values that are defined as low and high speed, as well as a likely operating setting.

Table B-1: CEE Efficient Residential Pool Pump Specification

	Energy Factor [A]		
	Lower Speed [B]	Low Speed [C]	High Speed [D]
CEE Tier 1		≥ 3.8	≥ 1.6
CEE Tier 2	≥ 8.0	≥ 5.5	≥ 1.7

[A] In order to demonstrate compliance with the CEE specification, energy factors shall be derived using system **Curve A**. Curve A is one of the three system curves developed by the California Energy Commission.[52]

Curve A: $H = 0.0167 \times Q^2$
Curve B: $H = 0.050 \times Q^2$
Curve C: $H = 0.0082 \times Q^2$
Where H is the total system head in feet of water and Q is the flow rate in GPM

The energy factor (EF) is calculated as:
$EF = (Q \times 60) / P$

[52] "CALIFORNIA CODE OF REGULATIONS Title 20. Public Utilities and Energy," (California Energy Commission, November 1, 2016), 232, energy.ca.gov/2016publications/CEC-140-2016-001/CEC-140-2016-001-REV3.pdf

Where Q is the flow rate in gallons per minute (GPM) and P is the power in watts

[B] Where "lower speed" is the optimal or most efficient speed for the pool pump, likely ranging from 600 to 1200 RPMs

[C] Where "low speed" is either the minimum speed for two speed pumps or half the maximum speed for variable speed pumps, typically 1725 RPM

[D] Where "high speed" is the maximum operating speed of the pump, usually 3450 RPM

Table B-2: Annual Per Unit Energy Savings

CEE Tier	Warm Climate Energy Savings (kWh/yr)	Cool Climate Energy Savings (kWh/yr)
Tier 1	2,193	1,880
Tier 2	3,766	2,406

CEE maintains a list of standalone pool pumps and pumps with integrated controls that meet both the Energy Factor and control requirements (included in the next section). This Qualified Product List supports efficiency programs in their efforts to identify and promote energy saving pool pumps to the contractors and consumers eligible to participate in their programs.

Because the ability of equipment to operate at low speed is an essential precursor to savings, efficiency programs can't deliver energy savings unless the pool pump can be (and is) programmed to run at low speed settings. The majority of variable speed pumps include controls, but many multi speed pumps require that controls be purchased separately. Accordingly, CEE has developed pool pump control specifications for both situations. CEE understands that pool contractors and home owners will need to program their pumps differently based on their specific needs. Therefore the requirements have been developed to correspond with the default settings of these controls.

Table B-3: CEE Efficient Residential Pool Pump Control Specification

Tier 1	Tier 2
The ability to operate a pool pump at two speeds based on user presets.	The ability to operate a pool pump at more than two speeds based on user presets.
A default filtration speed that (when no auxiliary pool loads are operating) is no more than one-half of the motor's maximum rotation speed.	
A default setting that returns the pool pump to the lowest user preset speed within one cycle or twenty-four (24) hours.	

CEE also maintains a list of stand-alone pool pump controls that meet this specification.