A Cannonball of Opportunity: The Hidden Savings Potential from Large Public Swimming Pools

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ABSTRACT

Unlike backyard and small public swimming pools (motel, apartment), large public swimming pools (school, college, community and waterpark) have largely been ignored by energy efficiency potential studies, building codes, state and federal appliance standards and rebate programs. Even the ENERGY STAR® Portfolio Manager program only addresses large public pools to exclude their energy use because it skews the related building's energy benchmark. This niche market of less than 100,000 public pools nationwide are estimated to account for nearly 2 GWs of demand and 15,000 gigawatt-hours (GWhs) annually from pumping energy use, alone. With a savings potential of 4,500 GWHs annually from water pumping process efficiency, this market deserves more attention.

Large pool filtration plants are industrial processes that employ similar technology to municipal water treatment plants but lack the process control technology needed to optimize operation. Current health and safety codes restrict the energy savings potential and regulatory trends threaten to increase energy use in this sector.

This paper describes how large pool systems work, current practices, and why many retrofits of variable speed technology either fail on large pool systems or achieve limited savings. To overcome key barriers, new initiatives are needed from energy efficiency policymakers including: recognition of large public pools as a unique commercial subsector; aggregation of energy use and savings potential; coordination between state energy and health agencies to improve codes; development of standards and best practices; and design of cross-sector information and incentive programs targeting the range of commercial sector customers who operate pools.

Introduction

"Public" or "commercial" pools are defined in state health codes as any publicly or privately-owned pool or spa open to public use.[1] Public pools range in size from residential-size motel pools to Olympic-size pools and waterparks. They are regulated primarily by state health and safety codes enforced by local health inspectors. The codes are prescriptive, and the general requirements are similar for all pools regardless of size.

Of nearly 5.4 million in-ground residential and public pools in the United States, approximately 300,000 pools are classified as public pools (Pkdata 2014). Approximately 207,000 of the public pools are smaller residential-size pools typically located in motels, hotels and multi-family housing.

[1] In this paper, the terms "public" and "commercial" have the same meaning. The term "public" is used in codes to define all pools open to public use regardless of size. The pool industry uses the term "commercial" to distinguish the market from private residential pools.

The remaining 93,000 pools are large public pools typically located at community centers, fitness centers, schools, colleges, resorts, and waterparks.[2] They are distinguished by the size and complexity of their treatment systems and have more in common with municipal water treatment plants than residential-size pools. Unlike municipal treatment plants, large pool plants recirculate water continuously, often require heating and must contend with organic matter, oils, and other contaminants introduced by bathers.

While large public pools make up less than 2% of the total number of in-ground residential and public pools, they are estimated to account for nearly 50% of the energy use for water pumping, almost 15,000 GWHs annually as shown in Figure 1.[3] In other words, less than 100,000 public pools use more electricity than all 5.1 million in-ground residential pools, *more electricity than used by the state of Montana* (EIA 2016).

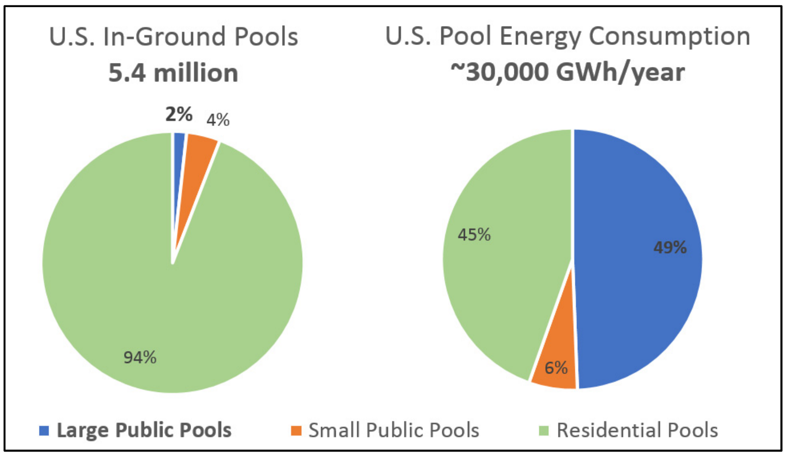

Figure 1. Estimate of U.S. in-ground pool energy consumption for water pumping compared to total pool market. *Source:* PK Data 2014

Large pool water treatment systems are custom-designed for the specific needs of each facility. While the water treatment objectives are the same for all public pools, the system design and equipment used can vary greatly. Unlike residential pools, public pool plants typically operate year-round, 24/7, whether the pool is open or closed to maintain disinfectant levels and water quality. Large pool filtration pumps range from 7.5 to 60 HP and are sized to meet worst-case conditions. Since large pumps are nearly all of single-speed design, they operate at "worst-case" at all times.

Variable speed technology applied to large pool pumps can yield significant energy savings but is not widely used due to restrictive health codes, and lack of standards, best practices, control technology, and training specific to the public pool industry. Public pool pump energy use could be reduced an average of 30%, or 4,500 GWhs nationally, with retrofit of appropriate process controls. Much higher savings may be possible with state level adoption of a performance-based standards for water clarity.

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[2] Aquatic facilities may have multiple pools designed for different purposes such as competition, recreation, diving, therapy or wading. They also may have spas and play features. Each is required to have separate filtration and treatment systems.

[3] Large public pool energy use and savings estimates used in this paper are based on unpublished data and analysis provided by HMW International, Inc. Pool industry demographics are based on publicly-available data from Pkdata, cited under References.

About half of all public pools are concentrated in eight states.[4] California, Florida and Texas account for roughly 30% of the market (Pkdata 2014). Programs or codes to capture large pool energy savings launched in any of these states would yield a high return and provide models for other states with less market share.

A Short History of the Public Pool Market

While public pools date back to antiquity, the modern public pool traces its history to the early 1900s when sand filtration and chlorination were first developed for domestic water treatment. This made possible maintaining safe bathing conditions without the need to drain and refill the pool. The same basic filtration and disinfection processes are still used today, in everything from backyard pools and spas, to large competition and recreational pools.

Originally, the water treatment equipment used for large public pools was essentially the same as for municipal water treatment systems. Equipment manufacturers created commercial pool divisions to market to this sector while their primary business remained the much larger market for water and wastewater treatment.

The public pool market quickly became overshadowed by the residential pool market that grew sharply after World War II with the advent of new lower cost construction techniques and the surge of middle-class suburban development. The rise of the residential market fostered a new pool equipment industry that designed smaller filters, pumps, and other equipment for a more price-conscious consumer mass-market.

The identification of residential pool pump and heater energy consumption in end-use studies and the homogeneity in residential pool design made it possible for regulators to target efficiency initiatives for this market. In the early 2000s, Pacific Gas & Electric Company led California in exploring residential pool pump energy efficiency. This resulted in the development of energy saving 2-speed pumps and variable speed pumps up to 4 horsepower (HP) for residential-size pools and a national pool pump efficiency standard set to take effect in 2021 (Fernstrom et al. 2016).[5]

Today, large public pool treatment systems still have more in common with municipal water treatment plants than residential-size pools. Despite their energy use and savings potential, they receive little attention for energy upgrades. For example, one of the largest federal investments of energy efficiency funding in the last decade, the American Recovery and Re-Investment Act (Stimulus bill), excluded any funding for public pools (ARRA 2009).[6]

How Large-Pool Water Treatment Systems Work

Since conversion of a single-speed pump to variable speed is the primary driver for energy savings, it is useful to understand how large pool plants work and how variable flow impacts equipment and operation. The kinds of equipment and processes that may be used in a

[4] The eight states which make up roughly half of the U.S. large public pool market are California (15%), Florida (9%), Texas (7%), New York (5%), Arizona (4%), Pennsylvania (3%), Illinois (3%), and Georgia (3%).
[5] Small public pools, such as hotels and motel pools reap the benefit of this work too since their pumps generally run 24 hours per day rather than the recommended average 6-10 hours for residential filtration pumps.
[6] Sec. 1604 of the American Recovery and Re-investment act: “Prohibits the use of funds appropriated or otherwise made available in this Act for casino or other gambling establishments, aquariums, zoos, golf courses, or swimming pools.” No distinction was made between public pools serving publicly-owned non-discriminatory facilities and privately-owned pools.

pool water treatment plant are illustrated in Figure 2. The following discussion outlines a typical pool plant and how lowering the flow rate to save energy can impact its equipment and processes.

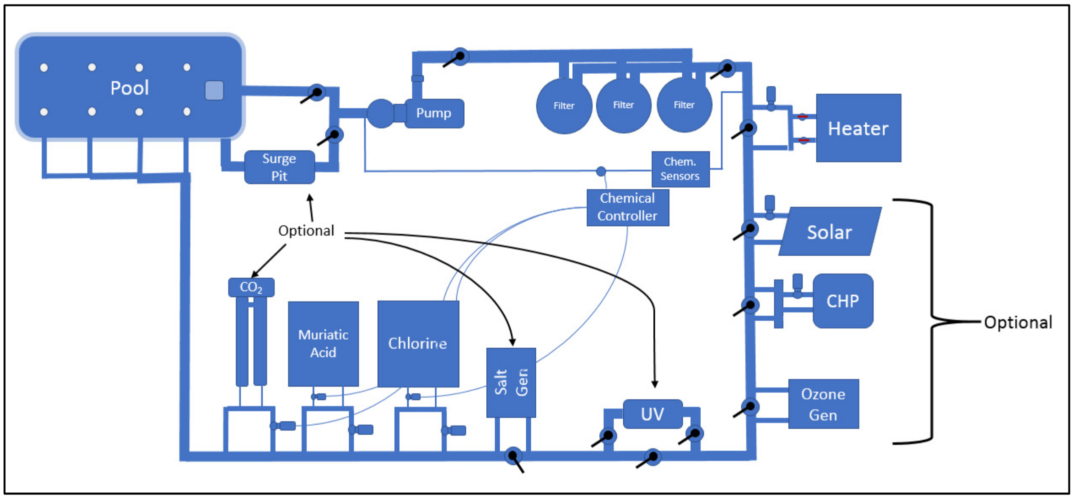

Figure 2. Basic large public pool plumbing schematic.

Flow connects all processes in a pool system. Therefore, *changing the flow rate impacts all processes in a pool system.* The pool's hydraulic system is designed and commissioned for full-speed operation of the filtration pump. Lowering the pump speed can yield unpredictable results, caused by many factors, including the design, equipment, pipes and fittings, valve placement, operation, or condition of the facility. To introduce variable speed technology and optimize flow for energy savings, other components of the hydraulic system may need to be modified or replaced. The pool plant must also be recommissioned and tested across all operating conditions. Critical pool processes impacted by changing flow are described below.

Surface water skimming. Surface water accounts for at least 75% of flow to the pump and the remainder flows from the main drain. Lowering flow affects how fast floating solids are removed by skimmers or perimeter gutters. Lowering flow may work well under low bather loads but may not work well during peak bather conditions.

Filtration. The flow rate through the filter media affects the quality of filtration. Lower flow can improve the quality of filtration, but the impact depends on the type of filter, filter media and the operation and maintenance by the operator. As a filter clogs, filter pressure increases and flow decreases. The flow rate across the filter cycle must be considered to determine how much pump speed can be reduced to stay within code and maintain water clarity.

Disinfection. Large pools almost always use an automatic chemical controller to monitor water chemistry and feed disinfectant and pH-balancing chemicals. Lowering pump speed can disrupt flow to the chemical sensors limiting how low the speed can go unless the system is modified to work independently of the main filtration pump.

Heating and other processes. Heaters and other equipment are typically plumbed to secondary pipe loops that may use only a diverter valve rather than an auxiliary pump to maintain adequate flow.[7] Flow through equipment must be maintained within a range defined by

[7] Other equipment can include chemical feed systems, salt-based chlorine generators, ozone, CHP and solar heating systems.

the manufacturer to maintain proper function and prevent damage. Field testing shows that the main pump speed typically cannot be lowered more than 25% without affecting operation of the heater and other equipment. Limitations can be overcome but not without additional control capability and system modifications.

UV systems. Energy-intensive medium pressure UV systems may be installed to destroy organisms not easily captured by pool filters or quickly destroyed by chlorine, and to reduce unhealthful levels of chloramines that are not dissipated easily in indoor pool environments. Lowering the flow rate increases the UV dosage and loss of chlorine if the UV equipment is not integrated with variable speed control to adjust dosage.

Inlets. Water is returned to the pool through inlets spaced on the pool floor and/or walls. Lowering the flow rate can impact how quickly and well disinfectant is mixed throughout the pool.

In summary, large pool pump energy efficiency isn't as simple as installing a variable speed drive (VSD) and reducing pump speed.[8] Optimizing operation, energy savings, equipment life, and the overall health and safety of the pool can be adversely impacted if not controlled properly. Each pool's complete hydraulic system and treatment processes must be viewed holistically to determine what savings are possible and how best to accomplish it.

Current Practice in Pool Operation, Monitoring and Control

The greatest energy savings potential for large pool systems is achieved through process optimization of the hydraulic system, not hardware efficiency. Hence, how much is saved, if any, is dependent on how well the system is commissioned and operated over time. As in commercial HVAC and industrial processes, poor operation and maintenance can negate the savings potential of installed hardware. In addition to a well-engineered system, process optimization requires an adequate monitoring and control system, proper commissioning and well-trained operating staff.

Municipal water treatment plants typically use a supervisory control and data acquisition (SCADA) system to monitor and manage the treatment process. However, most large public pools lack such advanced controls and do not always have working vacuum, pressure, and flow meters, which are the only controls state health codes require.

Unlike requirements for municipal water treatment plant operators, states require little or no training to operate a pool required regardless of pool size or complexity. For some states which require certification, the National Swimming Pool Foundation (NSPF®) offers Certified Pool Operator (CPO®) credentials upon successful completion of a two-day workshop. CPO training provides an important introduction to code-required pool chemistry, health and safety practices. However, it does not substitute for the training required to optimally operate a pool's water treatment plant. At smaller facilities, aquatics, building maintenance or grounds staff may be responsible for plant operation in addition to their other duties.

There is also no professional class focused on pool plant operation. Engineers for pool design firms work primarily on new pools or major renovations, not optimization of ongoing plant operation. With limited educational resources and training, and lack of monitoring and controls, pool operators cannot be expected to operate a sophisticated pool plant to the degree needed to achieve deep and persistent energy savings. Equipment replacement and other future changes to the pool or plant may affect operation and energy use and require recommissioning of

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[8] Large pump motors, 5 HP and greater, are only single-speed. Variable speed drives are equipment designed to operate single-speed pumps at variable speeds.

the VSD and other components. Given the current level of training and knowledge, neither pool operators or contractors can be relied upon to know how to recommission the system.

Limitations and Failures of VSD Standard Practice. There are no regulations, guidelines or best practices for introducing variable speed technology into large public pool water treatment systems. Given manual gauges and limited pool operator training, it is difficult to integrate a VSD to maximize and sustain energy savings while maintaining safe operation. In commercial building and industrial applications, a VSD is typically installed and integrated into an HVAC control, building automation or energy management system (EMS), or SCADA system. Until recently, equivalent control systems had not been developed for pools. VSD installations on pool pumps typically have no control integration or are simply set up to maintain constant flow. This practice minimizes the savings that can be achieved at best, and may create operational problems or results in equipment failures.

Of nearly 50 large pool facilities audited in California, VSDs had been installed on 12. Of those 12 pools, nine VSDs had been disconnected or removed due to adverse operational impacts and three were still operating but achieved less than half of their energy savings potential. None had the level of integration and control required to realize the full savings potential.[9]

Of VSDs installed on large pools, many are set up to maintain constant flow at the code requirement. This results in higher pressure at the filter, as the motor speed increases to maintain a constant flow, which can reduce the quality of filtration and waste water due to more frequent filter cleaning. Maintaining a constant flow can also hide other serious system problems including degradation in filtration media, impeller wear, improper throttle valve settings and other restrictions in the pipes and fittings that can occur over time. Pool operators no longer can monitor for system problems when the flow meter always shows the same flow, nor how much energy savings are being achieved.

How Energy Savings are Achieved Through Process Optimization

As in any industrial process, pool water pumping efficiency is achieved by optimizing the process for desired outcomes. The primary objective of pool filtration is water clarity. Maintaining water clarity is dependent on many factors, including: size, age, design, and condition of the pool; type and level of use; seasonal and daily hours of operation; environmental loading; plant operation and maintenance; and water chemistry.

Ideally, the pump speed would vary to provide the flow rate required to maintain water clarity and other process requirements in real time using a turbidity sensor. However, current pool codes prescribe minimum turnover rates regardless of the actual need, so the savings potential for turbidity-controlled pump speed cannot be realized.

In lieu of turbidity control, similar savings can be achieved by scheduling pump speed for changing conditions and use. There are multiple types of adjustments that can be done under some (but not all) state codes:

- Reduce pump speed to code required flow rates when pumps have been oversized.

[9] In the case of 8 VSDs installed at the pools for one school district, the VSDs were never properly commissioned and the operators received no training, leading to treatment system malfunctions and some equipment failures. All VSDs were abandoned in less than a year.

- Reduce pump speed to the minimum required flow when pools are closed seasonally.[10]
- Reduce pump speed daily when the pool is closed each day.[11]
- Reduce pump speed when the pool is open for daily and seasonal changes in filtration requirements.[12]

In addition to scheduling daily and seasonal bather loading, optimizing pump speed requires the VSD be controlled by a SCADA-type control system designed specifically to monitor and integrate operation of the flow-dependent filtration, disinfection and heating processes. Given the current level of pool operator training, remote monitoring is critical to maintaining savings over time.

Finding no control systems specifically designed for process optimization of public pools, two companies, HMW International Inc. (HMW) and Pool Solutions Group (PSG) partnered in 2012 to develop and test an "aquatic management system" (AMS) for this purpose. The AMS was built from standard components used in building management systems designed and programmed for the specific needs and operation of public pool systems. The first generation AMS used a controller to schedule and integrate a VSD with other equipment. The second generation AMS added electronic monitoring, data logging and control both at the plant and remotely. To optimize operation and energy savings, the AMS uses electronic sensors to monitor flow, vacuum, pressures, and temperatures in the process. The AMS operates the pump at multiple speeds based on pool use and bather levels scheduled by pool staff. Treatment and heating systems are integrated so that the lowest flow possible can be achieved when a pool is closed daily and seasonally. Operating data are logged to identify trends, optimize savings, and ensure safe operation over time.

As of 2017, HMW and PSG had completed comprehensive audits and pump measurements on more than 50 public pools and pre- and post- measurements of AMS retrofits at 18 pools. The team achieved annual energy savings ranging from 25% to 75%, depending on conditions unique to each site. These include: size, age, design, and condition of the pool and treatment plant; type and level of use during seasonal and daily hours of operation; environmental loading; plant operation and maintenance; and water chemistry.

Retrofits are generally very cost-effective. The simple payback for the 18 projects cited above ranged from less than one year up to 4 years.[13] In addition to the conditions listed above, cost-effectiveness is affected by the energy tariff and what each state code allows. Cost-effectiveness typically increases with pool size due to the fixed cost of the monitoring and control components. This cost would decrease through innovation and increased competition, once policies and programs promoting pool plant process optimization are implemented.

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[10] Pump speed can be reduced to 50%, saving roughly 80% of pump energy use, or 6.5% of annual energy use for each month the pool is closed.

[11] When a pool is closed, flow can be reduced roughly 25% when the heater is on, and 50% when the heater is off.

[12] Bather loads may be lower during certain times of the day and year allowing water clarity to be maintained at lower flow rates. For example, filtration designed for a maximum of 200 bathers is more than is needed for 10 swimmers in the morning. California code allows flow to be reduced to 75% of the design rate when the pool is open as long as water clarity can be maintained.

[13] While the California statewide custom rebate for generic use of VSDs was taken by most projects, the projects were financially viable without them. The rebates did help motivate customers but, perhaps more importantly, the independent review and approval of the savings estimates for the rebate application by the utility helped validate the projects to the customer.

Determining Energy Use and Savings Potential

Public pools are not explicitly aggregated in commercial energy end-use or efficiency potential studies. They are typically only identified in such studies to estimate and exclude their energy use from buildings with which they may share a gas or electric meter. For example, the ENERGY STAR Portfolio Manager program provides a method for deducting pool energy use because it skews a building's energy rating (ENERGY STAR 2018).

For this paper, the energy demand and annual energy use of large public pools in the United States is estimated based on field data collected by HMW for 47 outdoor and indoor pools in Northern California and aggregated based on publicly-available data for the installed base of public pools grouped by size (Pkdata 2014). Large public pools are defined in this paper as pools of 100,000 or more gallons in capacity requiring at least a 7.5 HP or greater single-speed filtration pump. Field measurements reflect a very good correlation between flow rates and pump kW demand as shown in Figure 3.[14] Annual energy use can be reasonably estimated since public pool pumps are operated year-round 24/7, whether open or closed, to maintain the chemical balance and water quality.[15]

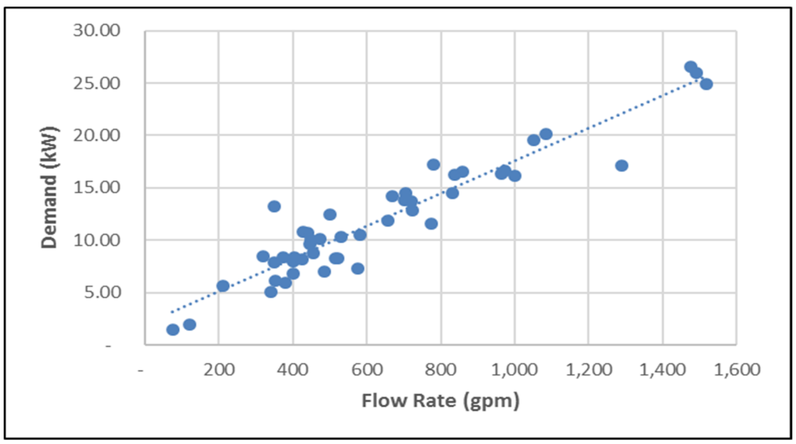

Figure 3. Correlation between measured flow rates and kW demand for public pool filter pumps.

How State Codes Regulate Public Pools

Public pools are a well-recognized vehicle for the transmission of waterborne pathogens; they are also common sites of accidents resulting in injury, and fatal and near-fatal drowning. Therefore, design and operation of public pools is regulated primarily through state and local health codes.

The primary treatment methods continue to be filtration, to maintain water clarity and disinfection to kill pathogens. Over the last century, most states adopted health and safety codes for pools that specify levels of disinfectant known to control pathogens, and turnover rates to maintain water clarity. Turnover rates, often expressed in the number of hours required to

[14] Since pools use centrifugal pumps with a design head typically between 60 to 70 feet, flow rate is the primary variable affecting the load.

[15] Assumes 8,424 hours of annual operation to adjust for an average of 2 weeks downtime for maintenance each year.

circulate the entire capacity of the pool, are based on the worst case of bather, loading for the type and use of the pool. Since large pool pumps are a single-speed design, the pumps run as if it is worst case all the time.

For general competition and recreation pools, states typically adopted an 8-hour turnover rate (or three complete turns in one day) for the oldest pools still in operation today and, starting in the 1980's, many states adopted a 6-hour turnover rate (four complete turns in one day) for new pools and major renovations.[16] The change from an 8-hour to 6-hour turnover rate meant the pump capacity (thus energy demand) increased approximately 33%.

The European Union promotes a 4-hour turnover rate and there has been interest from some health officials in the United States to adopt that standard. Assuming an average large-pool size of 360,000 gallons, the pumping energy demand for an 8, 6 or 4-hour turnover rate is 14, 18 and 28 kW, respectively. The average large-pool energy use in the United States is increasing as older pools are renovated or replaced with pools designed for a 6-hour turnover rate and would rise much higher if the European Union guidance were adopted.

A key argument given for increasing the turnover rate is pathogen control (CDC 2016b). However, disinfection, not filtration, is the primary method of pathogen control. High-rate sand filters used by most large pools today cannot filter out pathogens, so raising the flow rate would not help. Historically, little consideration has been given to energy use or the cost of upsizing treatment systems that increasing the flow rate requires.

Need for Performance-based Standards in State Codes. Maximum turnover rates are required by codes primarily to maintain water clarity since it isn't accurately measured. Codes and current practice determine water clarity by looking for the main drain at the deep end of a pool. If you can't see it, close the pool.[17] Ideally, pool codes would provide a performance-based option as is available in energy codes for buildings. This would allow pool pumps to be operated based on the need for filtration rather than at worst case all the time.

Water clarity can be measured using a turbidity meter that, with an AMS, can do a better job of maintaining water clarity under changing conditions than current practice as well as optimize energy use.[18] Some state codes and the World Health Organization promote a turbidity goal of less than 0.5 nephelometric turbidity units (NTU) (CDC 2016b). However, turbidity meters are rarely used because they are costly, would require an AMS be installed, and codes don't allow turbidity control in lieu of the turnover rate. Thus, manufacturers have no incentive to develop a lower cost turbidity sensor for pool applications and public pool owners have no incentive to install them.

Barriers and Recommendations

As an unrecognized and relatively untapped, hard-to-reach market, the list of barriers to public pool energy efficiency is long and cannot be fully explored in this paper. They are

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[16]State codes and the MAHC require faster turnover rates for specialized pools. Turnover rates may range from 1 hour or less for wading pools and specialty pools for slides and other water features to 8 hours for dive pools.
[17] For example, see California Administrative Code Title 22, § 65527. Clarity of Water and the MAHC, Section 4.5.1.2 (CDC 2018).
[18] Turbidity sensors allow filtration to be adjusted to match the need. Combined with a control algorithm to track the rate of change in turbidity, filtration can be ramped up to match the deterioration in water clarity and alert staff ahead of dangerous conditions. This would improve public safety over current practice.

grouped here into the categories that reflect the priority with which actions may be required to achieve the energy savings potential of this market.

Lack of Market Recognition and Accounting for Energy Use

Large public pools are effectively invisible to energy policymakers because they are not identified as a unique subsector of the commercial building market; their energy use has not been aggregated by state or federal energy agencies; and they are excluded from commercial energy end-use, and savings potential studies. Without a specific mandate from state energy officials (or legislators) to assign responsibility and resources to spearhead a market transformation initiative for the public pool sector, the large potential for savings will likely go unrealized.

Actions:

(1) At the state level, task energy agency staff with responsibility for developing a market transformation program for the large public pool sector.[19]

(2) Create a classification for large public-pool industry within the commercial sector that can apply to multiple customer segments. Include large pool energy end-uses in energy use and efficiency-potential studies.[20]

(3) Establish interagency cooperation between state energy and health agencies to promote both health and safety and energy efficiency goals. Through this process, develop standards and best practices for use of variable speed drives with integrated monitoring and control that ensure both persistent energy savings and safe operation of the treatment plant.[21]

Lack of Performance-based Codes and Industry Innovation

Unlike energy codes for buildings, pool codes are prescriptive and lack performance-based options that foster innovation. Codes do not reflect the significant differences between residential-size public pools located at motels and apartments and large recreational and competition pools located at schools, colleges and community centers. Most state codes don't allow flow rates to reflect the actual demand for filtration such as the actual bather loading of the pool. The lack of a performance-based code discourages innovation and investment in energy saving technology and services for this sector.

Actions:

(1) Develop a model performance-based code option, and measurement and verification methods to ensure both energy savings and safe operation.

(2) Participate in the CDC Model Aquatic Health Code revision process to advocate for the consideration of energy impacts and inclusion of performance-based options.[22]

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[19] Given their market share, California, Florida or Texas would reap great benefits from attention to this sector.
[20] More accurate estimates of pump energy use and aggregating data might be done at little cost if the correlation between flow and kW demand is adopted for end-use studies and the ENERGY STAR Building Benchmarking program.
[21] This initiative would inform building code and health and safety code revisions, and requirements for incentives specific to large public pool retrofits.
[22] The principal participants are key players to engage in energy efficiency initiatives such as state health officials, manufacturers and health researchers from academia.

(3) Explicitly include technology for large public pools in existing emerging technology and commercialization funding programs.[23]

Lack of Technical Information and Education

The public pool industry lacks the robust market of engineers, educators and contractors for energy efficiency services available to commercial building and industrial customers. Engineers that do work on pools focus on new construction and renovation, not operation of existing facilities. There are no trade organizations for large public-pool operators to provide technical support and training, and no college or technical school programs for large pool treatment plant operation. No standards or best practices could be found for integrating variable speed technology into large pool plants.

While some states have offered incentives for high-efficiency water heaters, pool covers and solar pool heating, only generic incentives for VSDs, if any, are available for large pools. Since there are no specific rules or best practices established for VSD retrofits on pool systems, utilities reviewing incentive applications have no way to determine the efficacy of proposed retrofits.

Actions:

(1) Develop best practices, technical and educational materials to support information, incentive and marketing programs.

(2) Develop an informational and educational initiative to work with key organizations related to the public pool industry (such and the NSPF that sponsors the Certified Pool Operators training, and the World Aquatic Health Conference that works with state health officials.)

(3) Develop standards to support incentives for variable speed technology retrofits on public-pool pumps.[24]

Lack of Customer Demand and a Fragmented Customer Base

While a large pool plant is an industrial process, the customer base is neither industrial nor homogeneous. Public pool owners fit commercial market segments such as K-12, colleges, lodging and local governments. There are no public pool owner or operator associations that straddle the multiple customer segments, sponsor trade events, or provide educational materials and training. There is little market demand for energy efficiency or process optimization technology for large public pools because the owners and operators are largely unaware of what is possible.

Actions:

(1) Develop a model large public-pool program that can be used across all customer segments (K12, college, local governments, lodging) by their respective program providers.

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[23] For example, a program could solicit proposals for the development of a low-cost turbidity meter to support a performance-based code.

[24] Standards could specify the type of equipment, controls and system integration needed to ensure both savings and safe operation and performance monitoring needed to verify savings and obtain incentives.

(2) Develop specific pay-for-performance incentives that promote use of continuous monitoring and process optimization of large pool plants.

Conclusion

Large public pools present a significant, yet unrecognized opportunity for deep energy savings, deserving of attention from energy agencies and utilities. The energy savings potential of this market will be realized only by characterizing and accounting for its energy consumption and savings potential, and implementing a multi-prong strategy for market transformation. This paper attempts to shed light on the market and its potential, start a discussion, and point the way forward.

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