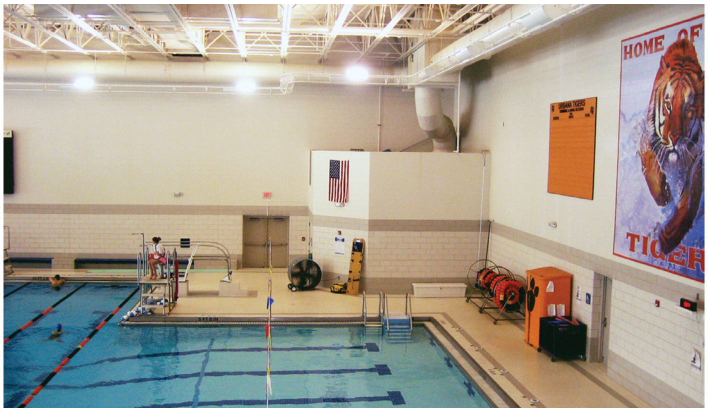
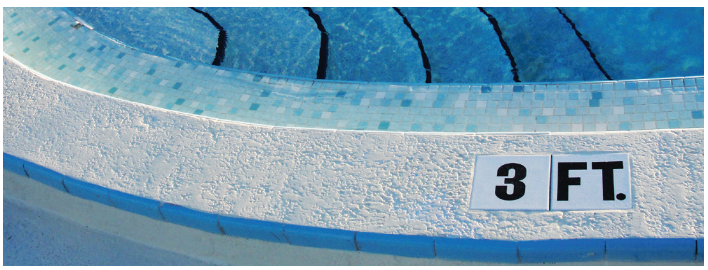
SEDAC ENERGY SMART TIPS

Pools





Swimming pools and spas have become standard features in municipal recreation facilities and subdivisions, and they can use a lot of energy. Thankfully pools can adopt several measures to reduce energy consumption.

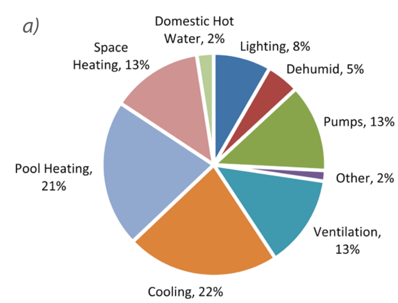
The Smart Energy Design Assistance Center (SEDAC) has identified five areas for potential energy savings: pool evaporation, pool water heating, dehumidification and ventilation, and pool filtration pumping. Savings can also be achieved through typical building recommendations, including lighting and building envelope improvements.

Indoor and outdoor pools consume energy in drastically different ways. Both need heating and filtration, yet dehumidification is exclusive to indoor pools and spas. Figure 1 shows how energy was used at an indoor pool (above) and an outdoor pool (below) examined by SEDAC and indicates possible areas for improvement. Keep in mind that energy use is different from energy cost because energy costs for natural gas and electricity differ. Generally speaking, pool water heating and space cooling/heating make up a significant portion of energy consumption, in addition to pumping, ventilation, and lighting. Naturally, the percentages of these categories will differ from facility to facility.

These charts illustrate how SEDAC assesses pools and subdivides total energy consumption by end use. SEDAC staff can perform energy assessments at your pool and help you find financial incentives to lower the cost of energy efficiency projects. Apply for personalized help at SEDAC.org.

This fact sheet examines how pools lose heat, how to reduce that heat loss, how to efficiently heat pool water, and what additional ventilation and mechanical issues facility operators may want to consider for energy conservation.

a)



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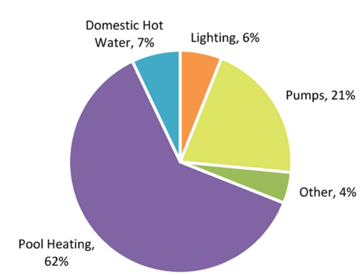


Figure 1. Energy Breakdown for a) indoor pools, b) outdoor pools

The Smart Energy Design Assistance Center performs energy assessments on various building types. Each building type has different energy requirements. **SEDAC's Energy Smart Tips** help building operators identify energy cost reduction measures.

ENERGY STAR®'S 7 STEPS OF ENERGY MANAGEMENT

1 Make a Commitment
Recognize that the economic, environmental and political impacts of energy consumption are sufficient motivation to change our energy use patterns.

2 Assess Performance
Make a personalized accounting of energy use and costs. Benchmark your facility by comparing its energy performance with similar sites.

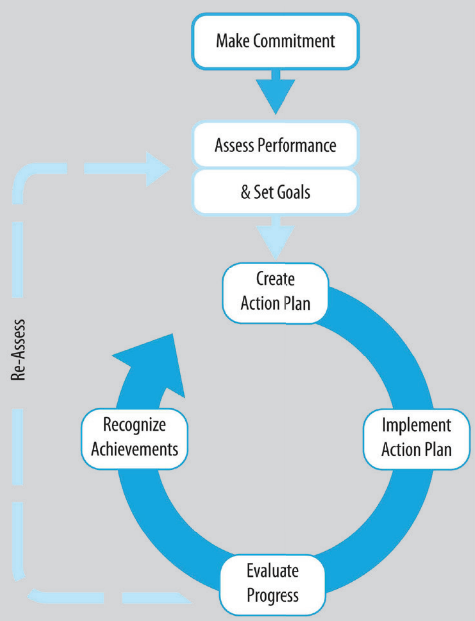
3 Set Goals
Review your objectives and constraints. Establish priorities and set measurable goals with target dates.

4 Create an Action Plan
Define the technical steps. Apply proven methods to increase energy efficiency or get specialized guidance. Assign roles and resources. Consider rolling savings from earlier efforts into future, more complex initiatives.

5 Implement Action Plan
Install equipment and change operational procedures. Establish a maintenance schedule. Train equipment operators and building occupants on the changes. Track and monitor conditions.

6 Evaluate Progress
Compare current performance to established goals. Understand what worked well in order to identify best practices. Adjust procedures and goals, and schedule the next evaluation.

7 Recognize Achievements
Provide internal recognition for the efforts and achievement of individuals, teams, and facilities. Seek external recognition from government agencies, media, or third party organizations.



ENERGY STAR®'s steps for energy management.
Descriptions have been modified by SEDAC staff.

WATER HEATING

The type of heating system you use can significantly impact utility costs. Options are electric resistance, electric heat pumps, gas fired boilers, solar thermal and using waste heat. Electric resistance heaters are the most expensive to operate. If electricity is the only resource available, focus on high-efficiency heat pumps. Heat pumps are rated by their coefficient of performance (COP) and pool heaters range from approximately 3 to 6. The higher the COP, the more efficient the unit is. A COP of 5.0 is five times more efficient than an electric resistance heater. Both gas fired boilers and heat pumps come in many different efficiencies, so shop prudently. Table 1 shows the results of a SEDAC analysis of various heating systems for an outdoor pool in Chicago.

POOL HEATING SAVINGS ANALYSIS	EXISTING ELECTRIC RESISTANCE	ELECTRIC HEAT PUMP COP = 4.0	85% EFFICIENT GAS HEATER	95% EFFICIENT GAS HEATER
Annual consumption	310,380 kWh	77,595	1,245 MBtu	1,114 MBtu
Annual operating costs	$31,985	$7,746	$14,025	$12,548
Savings over electric resistance	-	$23,239	$17,960	$19,437

Table 1. Utility costs for various pool heating systems (compiled by SEDAC)

Consider heating your pool with solar energy. Employing solar thermal may not eliminate the need for a heater, but can significantly reduce operation time. The collector area needed is anywhere from 50 to 100% of pool surface area. The further south you are, the more cost effective these systems become.

Finally, waste heat can also be used to heat pools. If you have a chiller or dehumidification equipment that is rejecting heat through a cooling tower, you can reject this heat to the pool instead through a plate-and-frame heat exchanger or water-to-water heat pump.

Table 2 provides ASHRAE recommendations for pool water temperatures. Lower temperatures are preferable for competitive swimming while higher temperatures are preferable for therapy and pools used by the elderly. Raising water temperature by only 1°F will increase energy costs an additional 10 to 30%, depending on your location. If the pool is used intermittently, reduce the heater thermostat setting during unused periods. Install a timer or a control system to automate the hours of operation.

TYPE OF FACILITY	AIR TEMP.	WATER TEMP.
Competition	78°F to 85°F	76°F to 82°F
Diving	80°F to 85°F	80°F to 90°F
Elderly Swimmers	84°F to 90°F	85°F to 90°F
Hotel	82°F to 85°F	86°F to 92°F
Recreational	75°F to 85°F	75°F to 85°F
Therapeutic	80°F to 85°F	85°F to 95°F
Whirlpool/Spa	80°F to 85°F	97°F to 104°F

Table 2. Recommended pool temperatures (ASHRAE)

POOL EVAPORATION

Swimming pools lose energy in a variety of ways, but evaporation is by far the largest source of energy loss for both indoor and outdoor pools (see figure 2). The single most effective way to reduce pool heating costs is to cover the water surface when not in use. This step can generate savings of up to 50–70%. For indoor pools, less evaporation also means less dehumidification, exhaust, and chemicals. Detailed results from a study of pool evaporation rates conducted by Reduce Swimming Pool Energy Costs (RSPEC) can be found here: http://www.rlmartin.com/rspec/whatis/studies.htm.

SEDAC analyzed outdoor pool covers for a client in Chicago and found that they are extremely cost effective when used with an electric resistance heating system. If applied to a pool with a more efficient heating system, absolute cost savings are reduced, but still can generate up to 40% energy savings.

Two other important considerations include how the pool cover is deployed (manually, semi-automatically, or automatically), and the material it is made from. Naturally, pool covers that automatically deploy and retract are the most convenient, but they are also the most expensive. Exterior pool covers need to be UV stabilized. Some covers primarily inhibit evaporation while others offer additional benefits by insulating or acting as solar heaters during the day.

Additionally, pool covers reduce the amount of additional water and chemicals that must be supplied to the pool, and they reduce the amount of debris that lands in the pool, thus reducing cleaning tasks.

A pool cover may not be desirable for outdoor odd-shaped pools or pools that are open for long periods of time. For these pools, strategically placed wind breaks can reduce air movement across the surface of the pool, thereby reducing evaporation rates.

HOW MUCH WATER IS LOST THROUGH EVAPORATION?

For an indoor aquatics facility that has a 25 x 20 yard pool with 80°F water, 82°F interior air at 50% relative humidity, water loss is equal to 216 pounds or 26 gallons of water per hour. Each pound of 80ºF water that evaporates takes 1,048 Btu of heat out of the pool . This means that every hour 226,368 Btu, or approximately $2-3 are lost due to evaporation. If pool covers are deployed during unoccupied hours, this heat loss is virtually eliminated. Assuming the same conditions, the same losses would occur from an outdoor pool, except there is no need for dehumidification equipment to deal with the evaporated water.

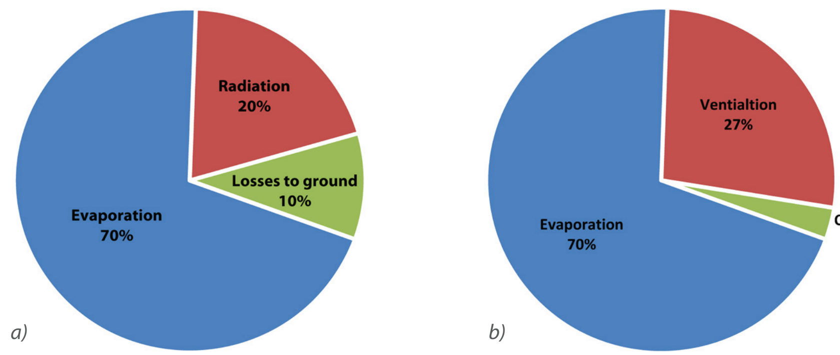


Figure 2. Pool energy loss characteristics, a) outdoor, b) indoor

POOL FILTRATION PUMPING

Pumps are needed to maintain the quality of pool water, and these pumps consume electricity. The pool water must be pumped through filters and treated with bactericides 24 hours a day to ensure good water quality.

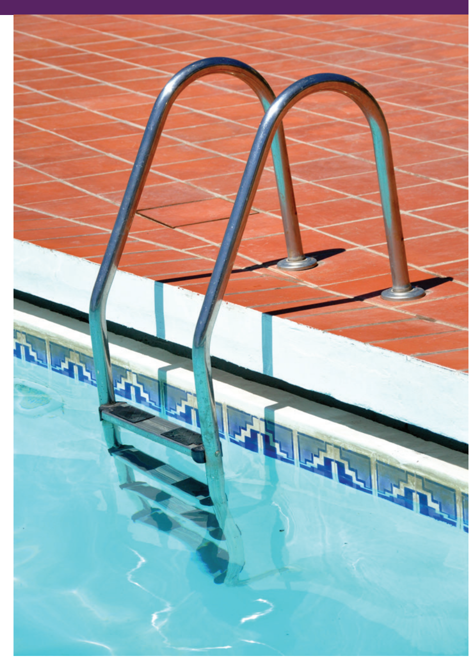
"Turnover" occurs when the amount of water equal to the volume of the pool is pumped through the filtration system. Turnover rates are dictated by the Illinois Department of Public Health (Table 3). The number of turnovers that occur in a pool can be calculated by dividing the pool volume (gallons) by the flow rate (gal/min).

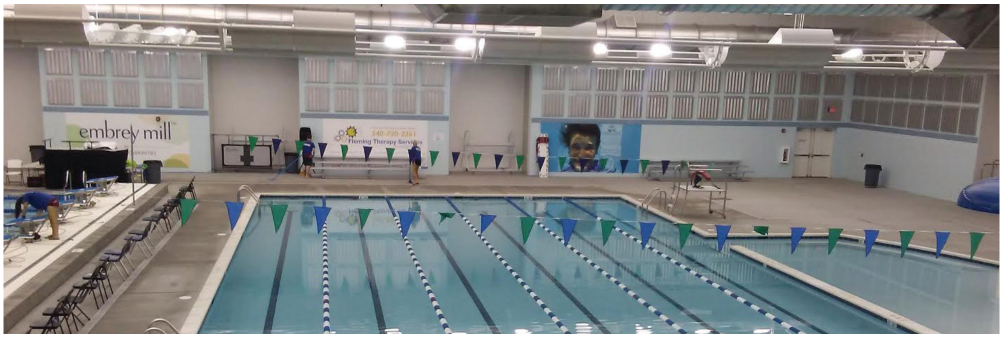
Properly-sized high efficiency pumps and electric motors can significantly reduce electric consumption and pool operating costs. This upgrade can be made either when replacing older pumps and motors in an existing pool or when designing new pools.

Motor for pumps consume electricity at a rate many times their initial cost over their lifetime. Therefore, the energy savings from a high efficiency motor can pay for itself in a very short time.

TYPE OF POOL	TURNOVER RATE	TURNOVERS/DAY
Diving Pools	8 hours or less	3 or more
Wading Pools & Areas, Plunge Pools & Areas, and Lazy Rivers	2 hours or less	12 or more
All Other Pools	6 hours or less	4 or more

Table 3. State of Illinois Pool Turnover Requirements





ENERGY SAVING TIPS FOR INDOOR POOLS

The design of ventilation and dehumidification systems is critical for energy efficiency. Ventilation and dehumidification of indoor pool areas is critical for maintaining acceptable indoor air quality, occupant comfort, and humidity control.

VENTILATION

ASHRAE Standards require a minimum outdoor air rate of 0.48 CFM/SF based on the area of the pool and deck, and a minimum outdoor air rate of 8.0 CFM/person based on occupancy for spectator areas (when spectators are present)[1]. Higher rates may be required for humidity control. The *ASHRAE HVAC Systems and Applications Handbook* also recommends 4 to 6 air changes per hour (ACH) for therapeutic pools and pools with no spectator facilities, and 6 to 8 ACH for pools with spectator areas.

To save energy, outdoor air ventilation should be set to minimum code-approved levels and increased based on the number of occupants. During unoccupied periods outdoor air flow may be closed. The *ASHRAE HVAC Handbook* recommends that interior relative humidity (RH) levels be maintained between 40-60%. If relative humidity is below 50%, evaporation rates from the pool and human body increase, and a relative humidity above 60% may pose mold and material degradation problems.

We also recommend maintaining a slight negative pressure in the interior environment to keep warm moist air from migrating into building assemblies and to prevent pool odors from seeping into adjacent spaces.

1 *ASHRAE Standard 62-2007: Ventilation For Acceptable Indoor Air Quality*

SPACE TEMPERATURE

Maintaining the proper balance between air and water temperature impacts user comfort and energy consumption. We recommend setting air temperature two degrees above pool water temperature. Air temperature should be less than water temperature only in pools with high water temperature requirements, such as pools that cater to the elderly, therapy pools, and whirlpools. In these cases, air temperature should be set in the mid 80s since higher temperatures could cause occupant discomfort. High water temperature and low air temperature can greatly increase evaporation rates and should be accounted for when designing the dehumidification system. Pool covers can eliminate most evaporation, allowing temperature setbacks during unoccupied periods.

DEHUMIDIFICATION

Due to evaporation, indoor pool environments need constant dehumidification, and there are extensive dehumidification requirements. Different dehumidification strategies have distinctly different initial costs and operating costs. Rather than rejecting heat from the refrigeration system to the exterior, several dehumidification systems recover this heat to pre-heat ventilation air or to heat pool water. The design of ventilation systems for natatoriums can be complex and must take into account many considerations including: proper air flow across building surfaces to avoid condensation problems, draft-free distribution for occupant comfort, and minimized air velocities across the surface of the pool to reduce evaporation rates.

ENERGY SMART RESOURCES FOR SWIMMING POOLS

Managing Swimming Pool Water Temperature for Energy Efficiency
http://energy.gov/energysaver/articles/managing-swimming-pool-temperature-energy-efficiency

Natatorium Dehumidification Design Manual
http://serescodehumidifiers.com/documents/brochures/Seresco-Natatorium-Design-Guide-2013.pdf

Moisture Load Calculation
http://www.prodrying.com/pdfs/SwimmingPoolCalculator.pdf

Solar Pools
http://energy.gov/energysaver/articles/solar-swimming-pool-heaters

DOE Reduce Swimming Pool Energy Costs
www.rlmartin.com/rspec/

WHO WE ARE

SEDAC, The Smart Energy Design Assistance Center assists buildings and communities in achieving energy efficiency, saving money, and becoming more sustainable. SEDAC also conducts energy and sustainability research.

SEDAC is a public-private partnership between the University of Illinois at Urbana Champaign and 360 Energy Group.

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