Spa Heating Analysis Literature Review and Market Assessment

ET26SWG0006

GAS EMERGING TECHOLOGIES PROGRAM (GET)

August, 2026

Prepared by ICF for submission to Southern California Gas Company

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Acknowledgements

This project, **ET26SWG0006**, was developed as part of the Statewide Gas Emerging Technologies Program (GET) under the auspices of SoCalGas as the Statewide Lead Program Administrator. Saurabh Shekhadar, Project Manager, conducted this technology evaluation with overall guidance and management from Steven Long, Director of Engineering at ICF. For more information on this project, contact Steven.Long@icf.com.

Disclaimer

This report was prepared by ICF and funded by California utility customers under the auspices of the California Public Utilities Commission. Reproduction or distribution of the whole or any part of the contents of this document without the express written permission of ICF is prohibited. This work was performed with reasonable care and in accordance with professional standards. However, neither ICF nor any entity performing the work pursuant to ICFs authority make any warranty or representation, expressed or implied, with regard to this report, the merchantability or fitness for a particular purpose of the results of the work, or any analyses, or conclusions contained in this report. The results reflected in the work are generally representative of operating conditions; however, the results in any other situation may vary depending upon particular operating conditions.

Executive Summary

Spas and hot tubs are a unique segment of the pool heating market because they operate year-round at elevated temperatures, typically between 100°F and 104°F. As a result, spa heating systems exhibit different load characteristics than heated swimming pools. Given the high energy intensity of spas and limited research studies on their market characterization, this study was conducted to better understand the best practices in spa heating, energy consumption practices, and opportunities for emerging energy efficiency technologies.

Residential spas typically range from 300 to 500 gallons, while commercial and multifamily spas can exceed 1,000 gallons. This study reviewed the available literature on spa energy consumption and sizing of heaters. The energy consumption of spas is primarily driven by standby heat losses, temperature maintenance and the requirement of rapid heat-up performance. The evaporation heat loss is the dominant heat loss mechanism during the period when the spa cover is removed. Whereas for covered spas, conduction heat losses through the shell, cabinet walls, and floor become more significant.

This study aimed to evaluate the spa heating market characterize common spa types above-ground spas and in-ground spas, and pool-spa combo configurations including shared heater systems, separate plumbing systems with a common heater, and fully dedicated systems. This study summarizes the advantages and limitations of each configuration.

As California transitions toward lower-emission heating technologies, understanding spa operating characteristics is essential for evaluating opportunities for Gas Absorption Heat Pumps (GAHPs), Hybrid heat pumps, and combinations of solar thermal with existing gas fired heaters and electric heat pumps. This study also examines the suitability of GAHPs for different pool-spa configurations based on the heating demand and type of usage. The findings from this study provide a technical foundation for future mathematical modeling of spas and updating the previously developed tool for swimming pools.

Background

Spas or hot tubs are normally used year-round, unlike heated pools. Spa heating systems use electric resistance heating, gas fired heating, or heat pump technology to maintain comfortable water temperatures. These heating systems typically maintain water temperatures between 100-104°F which require fast heating for better customer experience and thermal comfort. Residential spas typically range from 300 to 500 gallons, while commercial and multifamily spas can exceed 1,000 gallons.

Previously completed Gas Emerging Technology Study (ET24SWG0001) evaluated energy saving potential of emerging technologies such as gas absorption heat pumps (GAHPs), electric heat pumps, solar thermal systems, and hybrid gas-electric heaters across various pool heating systems. The scope of this project covered updating an existing Excel-based tool for pool heating systems but did not include the spas [1]. The modeling study demonstrated that GAHPs paired with existing gas pool heaters, have the highest average percent cost savings in multifamily sectors in California. In this system, the higher efficiency system (GAHP) serves as the primary heating source, reducing operational costs and environmental impact. The traditional gas fired heater is integrated into the system to provide both quick heating and peak load heating as necessary. This study evaluates the opportunities for GAHPs in various pool-spa configurations.

Assessment Objectives

This study aims to conduct a market assessment of spas and research available literature on spa energy consumption and the sizing of spa heaters.

This study aims to research standalone spas and the following types of pool-spa configurations in residential, multifamily, and commercial sectors:

a) Standalone spa (in-ground and above-ground)
b) Pool and spa combo: shared heater and plumbing circuit
c) Pool and spa combo: shared heater but separate plumbing circuits
d) Pool and spa combo: separate heaters and plumbing circuits

Market Characterization

This section summarizes the most cited California spa market statistics. According to the 2009 Residential Appliance Saturation Survey (RASS), 10 percent of California residences own a spa or a hot tub (portable and non-portable). 92 percent of these are in single family homes. Of these, about 50 percent are heated by natural gas, 45 percent by electric and the remainder are heated by a combination of solar and natural gas. About 79% percent of the units roughly are outdoors above-ground, 18% are in-ground spas and the remainder are indoors [2].

The 2019 RASS data does not appear to contain the same detailed statewide spa/hot tub market characterization that was cited in 2009 study. Even though not directly reported, the market segment of portable above-ground spa heating has shifted from gas heating to electric heating. Whereas natural gas heating remains common in in-ground spas and pool/spa combinations with a gradual shift towards heat pumps.

According to the 2009 RASS data, spa unit energy consumption (UECs) is estimated separately for filter pumps and spa heating. The estimated UEC for spa filter pumps is 322 kWh for single-family homes. Spa heating UEC is much higher, ranging from 683 kWh for townhomes to 1,032 kWh for single-family homes. The UEC for gas pool heating for single-family homes is 162 therms, and spa heating is 38 therms per year [2].

Literature Review

Findings from field study: monitoring of energy use in residential spas

Most residential hot tubs or portable spas are prefabricated units that are installed above ground. They consist of a fiberglass tub with nominal water capacities ranging from about 1,000 liters (roughly 264 gallons) to 2,000 liters (roughly 528 gallons) depending on the number of seated places available in the spa. The underside of the tub is typically insulated with sprayed foam, and the supporting frame is enclosed in walls that typically include insulation panels or foam. The spa is typically protected by insulated cover and aims at reducing evaporation heat loss when not in use. The spa control is primarily based on the water temperature measured in the spa or at the heater inlet. The setpoint can typically be adjusted by the user between 15 °C (59 °F) and 40 °C (104 °F), the higher limit being normally selected when people are using the spa.

Yannick Allard, Michael Kummert, and Alain Moreau conducted research on detailed monitoring of energy use in residential spas installed in two cities of Canada [3]. This field study collected dynamic data on actual spas in operation for several months to understand their energy usage and their impact on electrical demand. Standby days denote days when the spa was left covered and not used for the whole day. The profile for 'non-use' or 'standby' days is flat with two peaks corresponding to the start of each filter cycle. The filtration cycle typically occurs every 12 hours. The experimental results indicate that the daily average power used by pumps and accessories during the standby days is remarkably constant, with an average value of 150 W and a standard deviation of 20 W. The power consumed by pumps and accessories is about 40% of the total power consumption in standby. Based on conversations with various spa manufacturers as noted in the CASE Study 2014, this is the baseline energy consumption needed to run pumps, controls, etc. [4].

However, the evaporative heat loss is proportional to the surface area of the spa. The 'use' days denote when the spa was used for short periods. The profile for use days has a significant peak in the evening, corresponding to the period when most of the spa sessions take place. Refer to Figure 1. The daily average power used for heating depends on the ambient conditions- mainly outdoor air temperature and wind.

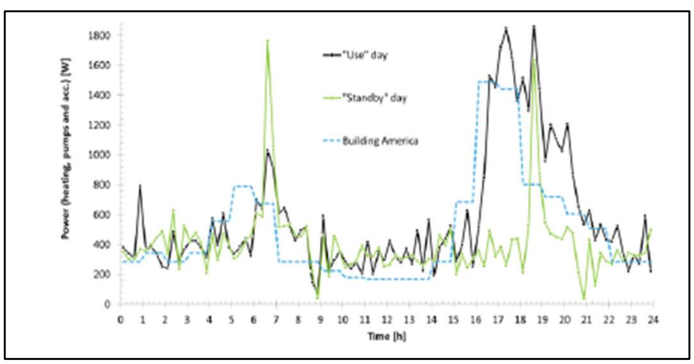

Figure 1: Spa consumption profile: Average standby and use days

The field study results demonstrate that the evaporation heat losses seem to have the greatest impact on system losses compared to radiation and convection. About 48% of heat losses are related to evaporation, 26% to convection and radiation heat losses, and 26% to conduction losses. The evaporation heat losses occurred when cover is not in use, also depend on wind velocity, water vapor pressure, along with the temperature difference [3].

Circulation in spas:

The spa circulator pumps are categorized as 24-hour dedicated circulation pumps and two-speed jet pumps. Based on the CASE Team's observed research, many of the entry level spas only have 1 pump, often two-speed, whereas more mid-range to high-end spas use small circulator pumps to save energy [4]. Spa circulator pumps are small, energy efficient pumps that continuously circulate water through the spa's filter and through the heater to maintain set temperature. These pumps operate at much lower flow rate and typically run 24 hours per day. Unlike jet pumps, which provide high-flow water for hydrotherapy jets.

Standby Heat Losses:

Unlike heated swimming pools, where evaporative heat losses typically dominate, spa energy consumption is often dominated by standby heat losses or by maintaining the high-water temperatures (102-104 °F). The heat loss through the cover, shell, and plumbing during non-use periods can be a major component of annual heating demand.

Standby heating loss is the heat that spa loses while it maintains a typical temperature setpoint (102-104 °F) and not actively being used. These standby losses occur 24 hours per day, even if nobody is in the spa. When the cover is on, heat conducts through the insulated cover and is then lost to the surrounding air. Heat loss also occurs through the spa shell, cabinet walls, through the insulation. When the spa is off or pumps are off, hot water in the plumbing loses heat to the surroundings. This heat loss occurs through piping, pumps, and heater housing. Using air jets while heating increases heat loss because cold air is introduced into the water, which can lower the overall temperature and increase energy consumption.

Codes: ANSI/APSP/ICC-14 Portable Electric Spa Energy Efficiency Standard defines the standardized standby-power testing procedures. California Title 20 Portable Electric Spa Regulations require certified testing and reporting of standby power for portable spas [6]. California Title 20 Portable Electric Spa Regulations limits standby power to

$$Maximum\ Standby\ Loss\ (kW) = 5\ V^{\frac{2}{3}} \quad (1)$$

where V is spa volume in gallons.

For example, this limits the maximum allowable standby losses of 400-gallon spa to 930 BTU/hr according to Equation (1).

The previous research demonstrates that choosing right sized spa heater is important in providing a trouble-free heating system [6]. If the heater is selected appropriately, the water will be heated to the desired temperature in the desired time frame. An undersized spa heater will heat too slowly. Whereas the oversized unit will increase the overall system operational cost and energy consumption.

Conduction heat loss:

Conduction heat loss represents a significant portion of standby losses of a covered spa. For a spa, conduction heat transfer through the side walls, floor and cover (top side) can be estimated using the standard heat transfer equation. Refer Equations (2) - (4).

$$Q\ (conduction - side\ walls) = \frac{A_{wall}\ (T_{water} - T_{ambient})}{R_{wall}} \quad (2)$$

$$Q\ (conduction - \ floor) = \frac{A_{floor}\ (T_{water} - T_{ground})}{R_{floor}} \quad (3)$$

$$Q\ (cover) = \frac{A_{cover}\ (T_{water} - T_{ambient})}{R_{cover}} \quad (4)$$

Whereas A_{wall}, A_{floor} , and A_{cover} denote side wall area and floor area respectively.

R_{wall} denotes side-wall thermal resistance which depends on the spa construction and materials. R_{cover} denotes thermal resistance of the cover.

A well-insulated cover reduces the standby losses significantly.

Typical R-value for minimally insulated above-ground spas is R-5 to R-8. Whereas R-value for full foam insulation construction type is typically R-12 to R-20.

The effective R-value of in-ground concrete spas is typically R-2 to R-4. Therefore in-ground spas generally lose more heat through the shell than insulated above-ground or portable spas.

Similarly, the conduction heat loss through the ground will be more significant for in-ground spas compared to above-ground spas as there is usually little or no insulation between the hot water and the surrounding soil. Whereas the portable spa or hot tub usually has full foam insulation and often use insulated base. For a preliminary estimate, a ground temperature of 60-70 °F can be assumed. For portable spas with concrete pads, the ground temperature can be assumed slightly higher than the ambient temperature.

Note: The analytical tool developed for estimating energy consumption for pools through previously completed Gas Emerging Technology Study (ET24SWG0001) can be updated for spas with the addition of above conduction heat transfer equations [1].

Sizing the spa heater:

This section summarizes the guidelines and the basic rules of thumb for sizing the spa heater. For determining the heater size for heated swimming pools, the heat evaporative loss from the surface or surface area is a significant factor. However, minimizing heat-up time is a more significant factor for determining the heater size of spas compared to the surface area losses. Equations (5) and (6) are the basis for sizing the heater. Note that specific heat capacity of water is 1 BTU/lb°F.

$$Number\ of\ BTUs\ required = \ Volume\ of\ water(gal) * 8.34\ (pounds\ per\ gal) * Temperature\ rise\ (\text{°F}) \quad (5)$$

$$Heater\ Size\ (\frac{BTU}{hr}) = \frac{\text{Number of BTUs required to heat}}{\text{Heatup time (hr)}* Heater\ Efficiency} \quad (6)$$

Table 1 is a spa heater sizing chart. It shows how long it takes a heater of given size to raise the water temperature by 30 °F, assuming ideal conditions and negligible heat losses [5]. For example, a spa with volume of 500 gallons and 125,000 BTU/hr capacity heater, it takes 75 minutes to raise the temperature by 30 °F. Thus, if the spa has a ~100% efficient electric resistance heater, the heat up time is 75 minutes. However, this number needs to be divided by efficiency of the heater to find the required input rating. This chart also shows that larger the heater size, the faster the recovery and start up heating.

This chart also explains why a typical residential spa (400 gallons volume) with a 5.5-6 kW (roughly equivalent to 18,700 BTU/hr – 20,400 BTU/hr) electric resistance heater may take several hours to achieve a typical temperature difference of 30 °F. Whereas in-ground spa with gas heater of 250,000 BTU/hr capacity can achieve the same temperature rise in 30 minutes.

Table 1: Spa Heater Sizing Chart- intermittent heating (volume based)

Typical Spa Heater Sizing Chart					
Heater Input (BTU/hr):	**125,000**	**175,000**	**250,000**	**325,000**	**400,000**
Spa Volume (gal.)	**Minutes required for each 30° temperatur e rise**				
200	30	21	15	12	9
300	45	32	23	17	14
400	60	43	30	23	19
500	75	54	38	29	23
600	90	64	45	35	28
700	105	75	53	40	33
800	120	86	60	46	37
900	135	96	68	52	42
1,000	150	107	75	58	47

Note that these spa heater sizing charts are based on an insulated and covered spa. Also, this chart assumes of 3.5 miles per hour wind speed and elevation up to 2,000 ft above sea level. This chart primarily provides a reference point based on volume of water and temperature rise added. However, other factors also have a significant impact and must be considered while sizing the heater. These include efficiency of the spa heater, wind speed, presence of spa cover, occupancy, presence of jet pumps, and usage pattern (continuous use or intermittent use). For example, if the spa has intermittent usage, it typically requires faster heat up time before occupancy and thus larger sized heater is preferred. Ideally, the spa heater should be designed for maximum heat-up time of 30 minutes to 1 hour. Whereas, if the spa has continuous usage, the heater typically offsets standby losses, and smaller sized heater may also suffice to maintain the setpoint temperature.

Table 2 shows the theoretical heater capacity required to increase spa water temperature at rates of 1°F/hr, 2°F/hr, and 4°F/hr for various spa sizes under ideal recovery heating conditions (when spa is not in active use). Required heating capacity increases linearly with both spa water volume and desired heat-up rates. These values represent the sensible heat required and assume ideal conditions. For example, a 400-gallon spa requires approximately 13,300 BTU/hr for 4°F per hour heat-up rate in ideal conditions. Whereas the same sized spa requires approximately 16,625 BTU/hr for an 80% efficient gas heater. This chart can be viewed as a recovery heating chart and underestimates the heating time when spa is in active use with jets.

Table 2: Spa Heat-Up Capacity Chart

Water Volume (gal)	1°F/hr Heat-Up	2°F/hr Heat-Up	4°F/hr Heat-Up
300	2,500 BTU/hr	5,000 BTU/hr	10,000 BTU/hr
400	3,300 BTU/hr	6,700 BTU/hr	13,300 BTU/hr
500	4,200 BTU/hr	8,300 BTU/hr	16,700 BTU/hr
800	6,700 BTU/hr	13,300 BTU/hr	26,700 BTU/hr

New Requirements and Code Impacts: CA 2025, Title 24, Part 6

According to the latest California's 2025 Title 24 update effective January 1, 2026, for **newly installed heated pools and spas or installation of a new heater for an existing unheated pool/spa**, the primary heating source must generally be one of the following:

a) Solar Thermal with minimum requirements of solar collector area
b) Heat Pump Heater
c) Renewable Energy: with at least 60% of annual heating energy from on-site renewable energy
d) Combinations of above systems
e) Supplemental gas heat under specific controls

However, following are listed as exceptions [6]:

a) Portable electric spas compliant with Title 20 regulations
b) Alterations to existing spas
c) Spas solely heated by solar heating systems without any backup heater
d) Addition of permanent spas to existing buildings when gas is available
e) New spas in which there is inadequate solar access roof area (SARA)
f) Alterations to existing heated pools

Types of Pool-Spa Configurations

a) Standalone spa: comparison of in-ground spas and above-ground spas

When choosing a spa, the customer can choose between in-ground and above-ground spas. In-ground spas are permanently installed into the ground or a custom-built enclosure, often integrated into the landscaping. Whereas the above-ground spas are self-contained units that sit on a foundation above the ground, designed for easier installation and portability. Table 3 summarizes the comparison of in-ground spa and above-ground spa [7].

Table 3: Comparison of in-ground spa and above-ground spa [6]

Parameter	In-ground Spa	Above-Ground Spa
Installation cost	Higher (~$15,000)	Lower ($2,000-$4,000)
Installation time	Weeks/1-2 months as it requires excavations and permits	1-2 days
Design	Highly customizable	Limited to available models in the market
Portability	Permanent	Portable/can be relocated
Ease of maintenance	More difficult and expensive repairs	Easier than in-ground spa
Energy Efficiency	Less energy efficient due to larger water volume and exposed plumbing	Better insulated and more energy efficient

Above-ground spa (portable hot tub) is the preferred option for single family homes, small hotels and fitness centers. Most residential above-ground spas sold in the U.S. are 4-6 person units with 300-450 gallons of water capacity, balancing cost, available space in the backyard and energy consumption. This is the common configuration found in the U.S. residential market. The spas whose capacity is 2-3 persons or 7+ persons have limited market share compared to the one with 4-6 persons capacity.

In-ground spas are the preferred option for common amenities in multifamily properties, luxury residential properties, municipal recreation centers, hotels, and resorts.

Figure 2: Above-ground spa

b) Pool and spa combo: shared heater and plumbing circuit

In many old hotels, multifamily and residential properties with old pool-spa combinations, the pool and in-ground spa share a common pump, filter, and heater. Automated three-way valves direct water flow either through the pool loop or spa loop. In pool mode, the system circulates and heats the pool only. In spa mode, the spa is isolated and the system heats the spa only. The heater is usually based on spa heating requirement for the highest temperature rise required. Although the spa contains a much smaller volume than the pool, it often requires comparable heating capacity because spa water is typically maintained at higher temperature setpoints (100 °F – 104 °F) than the temperature commonly maintained in swimming pools (78 °F-82 °F). Also, the users expect rapid heat-up time for spas (typically 30 minutes to 1 hour). The shared heater and plumbing circuit configuration minimize equipment and maintenance costs but provides less flexibility than dedicated pool and spa heating systems which require heaters with larger heating output and control sequencing.

c) Pool and spa combo: shared heater and plumbing configuration with spillover

Some multifamily properties and hotels use an elevated spa that continuously spills hot water into the pool. This provides the aesthetic waterfall effect and helps prevent stagnant water. In this spillover mode, the suction valve draws water from the pool, and the heated water returns to the spa only. See Figure 5.

The key advantages of this pool-spa combo system are enhanced aesthetics due to waterfall, reduced stagnancy of water in pool-spa and simpler plumbing circuit than configuration described in section (d). However, the limitations of spillovers are losses associated with spillovers (splash losses and increased evaporation heat losses) and this spillover can become a substantial year-round heating load for spas. This configuration has lower operational flexibility than section (d) as operators cannot shut down one body of water without affecting the other.

Figure 3: Pool-Spa Combo: Spillover Mode

d) Pool and spa combo: shared heater but separate plumbing circuits

In this configuration, the pool and spa each have their own dedicated circulation system (including pump, suction piping, return piping, and filters) but both water bodies share a common heater. This arrangement provides more operational flexibility than a fully shared system as described in section b.

In most cases for pool and spa combo with a shared heater, a Gas Absorption Heat Pump (GAHP) could be retrofitted with an existing gas-heater with advanced controls. The supply water temperatures required by the pool-spa combo are within the GAHP operating range. GAHP can be used as the primary to pre-heat the full volume of water and the existing gas fired heater could be used for handling peak loads of spas. The key advantage of doing this is that the existing gas heater can remain in place and GAHP can be added upstream as a pre-heater. GAHPs are more suitable if there is steady heating demand. However, this system requires complex controls and sequencing logic. Also, GAHPs require outdoor installation, and this can be challenging for facilities with space constraints.

e) Pool and spa combo: dedicated heaters and plumbing circuits

In a dedicated heating and plumbing circuits, the pool and spa each have their own independent circulation and heating systems. Each heater is sized specifically for its water body. Pool and spa can operate simultaneously without affecting each other. Also, independent temperature setpoints can be maintained. One advantage is that the maintenance of one system doesn't affect the operation of another. Such configuration is typically seen in luxury multifamily apartments, new constructions, and resorts.

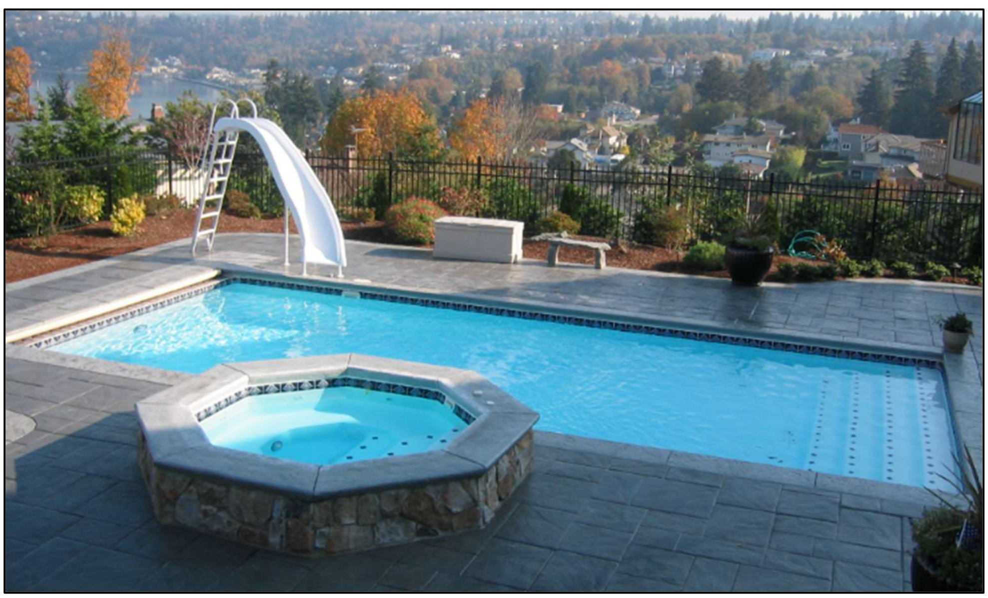

Figure 4: Pool and spa combo

Pool-Spa configurations ranked for GAHP suitability

For gas absorption heat pumps (GAHPs), the best application is typically where the system can operate for long hours at a relatively steady load. When the unit runs continuously at a significant fraction of its nominal capacity compared to frequent ON-OFF cycling, the energy efficiency gains associated with GAHPs are higher. Steady loads also avoid the startup penalties associated with frequent ON-OFF cycling as the unit takes about 20-30 minutes to reach a steady state COP [1].

Refer to Table 4 for rankings of pool-spa configurations for GAHP suitability from poor to excellent.

Table 4: GAHP Suitability for Pool-Spa Configurations

Configuration	GAHP Suitability	Reason
a) Standalone spa heater	**Moderate**- if maintained year-round at 102-104 °F (in-ground spas) **Poor**- if heated only before use (on-demand above-ground spa)	Load is relatively small if compared to pool + spa configurations; the suitability depends on the size of spa/type of use as GAHPs are not ideal for rapid heat-up and less suitable for spas with intermittent usage
b) Shared pool-spa heater with shared plumbing circuits	**Moderate**	GAHP is more suitable when it operates during the pool heating mode and existing gas heater can provide rapid heat-up during the spa mode
c) Shared pool-spa heater with spillover	**Good**	This configuration is more suitable for GAHP applications compared to (a) and (b) due to continuous heating load
d) Shared pool-spa heater with separate plumbing circuits continuous heating demand	**Good to Excellent**	Large and steady load requirement paired with less cycling enables GAHP to operate at high utilization and efficiency- GAHP can take the base load, and existing gas heater can handle the peak loads
e) Separate pool and spa heater and plumbing circuits- spa maintained at temperature setpoint continuously	**Good**	Steady heating load requirement, but smaller than configuration (d)

Results

The literature review and market assessment identified several key findings regarding spa energy consumption, market assessment, and heating system configurations.

a) Market characterization: The California spa market consists primarily of portable above-ground spas and in-ground spas installed in residential, multifamily, and commercial facilities. Portable spas are generally preferred in single-family homes due to lower installation and equipment costs and superior insulation performance. In-ground spas and pool-spa combinations are more common in multifamily properties. Standard electric resistance heaters are commonly installed in portable spas and gas fired heaters are commonly installed for in-ground spas for rapid heat-up.

b) Energy Consumption: Unlike heated outdoor swimming pools where heating demand is seasonal, spas maintain elevated temperatures year-round. When the spa is not covered, evaporation heat loss is the largest heat loss component. Conductive heat losses are important during the covered operation of spas.

c) Heater Sizing: Heater sizing is primarily governed by temperature rise and user expectations on rapid heat-up. For a given spa volume, heater capacity requirements increase linearly with desired temperature rise and decrease heat-up time accordingly.

d) Pool-Spa Configurations: The research assessed four types of primary pool-spa configurations. Here is the summary of advantages and limitations of each configuration. Refer to Table 5.

e) GAHP suitability for pool-spa configurations: GAHPs are more suitable when the heating demand associated with pool-spa configurations is steady and year-round. GAHPs are not ideal for rapid heat-up and are less suitable for spas characterized by intermittent usage.

Table 5: Pool-Spa Configuration Assessment

Configuration	Advantages	Limitations
a) Shared heater and plumbing configurations	Lowest first cost between (a)-(d) pool-spa configurations	Limited operational flexibility compared to (c) and (d): can either heat pool or spa
b) Shared pool-spa heater with spillover	Attractive aesthetics, continuous circulation of water in pool-spa	Additional heat loss as water gets spilled from spa to pool by a waterfall
c) Shared heater with separate plumbing configurations	Separate plumbing configurations allow separate pool and spa filtrations	More valves and controls; higher installed cost than (a)
d) Separate heaters and plumbing configurations	Maximum operational flexibility: pool and spa can operate at different temperature setpoints simultaneously	Highest installed cost between (a)-(d) pool-spa configurations

Recommendations

The research findings from this study indicate that the spa heating represents a technically viable opportunity for future research and technology demonstrations in California. This study recommends expanding the previously developed analytical pool heating tool to include spa-specific conduction, evaporation, and occupancy changes, which will improve the ability to evaluate and estimate potential energy savings of alternative heating technologies. This study also recommends assessing the energy savings potential of GAHPs and its suitability for pool and spa configurations with continuous heating demand through tool development efforts and field studies.

References

[1] https://ca-etp.com/node/13607 logies (ET24SWG0001- Pool Heating Analysis)

[2] 2009 Residential Appliance Saturation Study (RASS), California Energy Commission (CEC)

[3] Yannick Allard, Michael Kummert, Alain Moreau, "Detailed Monitoring of Energy Use in Residential Spas", Ecole Polytechnique de Montreal Canada.

[4] CASE Report prepared by Energy Solutions and Pacific Gas and Electric Company, "Portable Electric Spa", 2014.

[5] www.poolspanews.com/how-to/ultimate-tech-manual/heater-sizing-techniques_ohniques

[6] California 2025 Title 24, Part 6 Fact Sheet, Non-residential, Single-Family, and Multifamily: Pool and Spa Heating, Energy Code Ace Resources

[7] https://casablui.com/blogs/news/in-ground-vs-above-ground-spas-a-complete-comparison