ET Summit 2025

Presented by

Pool Heating Analysis

Saurabh Shekhadar
Energy Engineer
ICF

SoCalGas
Glad to be of service®

Project Team

Saurabh Shekhadar, CEM, CDCP, EIT
Energy Engineer

Steven Long, P.E.
Director of Engineering (West)

Evan Davis
Program Manager

Agenda

- Background
- Project Objectives
- Literature Review and Subject Matter Expert (SME) Interview Findings
- Pool Heating Analytical Tool Development and Updates
- Parametric Analysis
- Results and Recommendations

Introduction

Pool Heater Market Characterization

- About 97% of the pools in the U.S. are residential (10.4 million)

- California: second highest number of pools per state in the U.S. (1.34 million)

- Most of the pools in California are outdoors

- Typical season for swimming: May through September

- **Total Estimated Impact Cost Saving Potential**: ~ 78 million USD for GAHP, ~ 70 million USD for Hybrid Pool Heater (assuming 60% adoption in California)

[1] Swimming Pool Statistics, Report by RubyHome, January 2024.
[2] Open Pool Time, Report by Pool Research, August 2023.
[3] https://www.energy.gov/energysaver/swimming-pool-heating-and-maintenance

Pool Heat Losses

- Evaporation heat loss is one of the major contributors to overall pool heat loss (approximately 60% of total heat loss)
- Factors affecting evaporation heat loss: air temperature, wind speed, humidity, pool water temperature
- Convective heat loss- due to temperature differences between the ambient air and pool
- Solar radiation- adds heat to the pool, reducing the pool heating energy requirements
- Conductive heat loss to surrounding materials is small and can be neglected
- Typical pool water setpoint temperatures: 78°F to 82°F
- Typical pool heater size: about 250 kBTU/h for 30,000 gallons average sized pool; range between 75 to 450 kBTU/h

Pool Heating Technologies

Traditional gas pool heater

- Typical efficiencies: 82% to 90%
- Useful life: 10 years
- Costs of outdoor pool gas heating by location

Location	Season	78°F	80°F	82°F
San Francisco	6/1–8/31	$2,126	$2,529	$2,954
Los Angeles	5/1–10/31	$2,540	$3,237	$3,957

Note: These are heating costs for a 1,000 sq. ft. swimming pool with an 80% efficient gas pool heater at $1.09 per therm

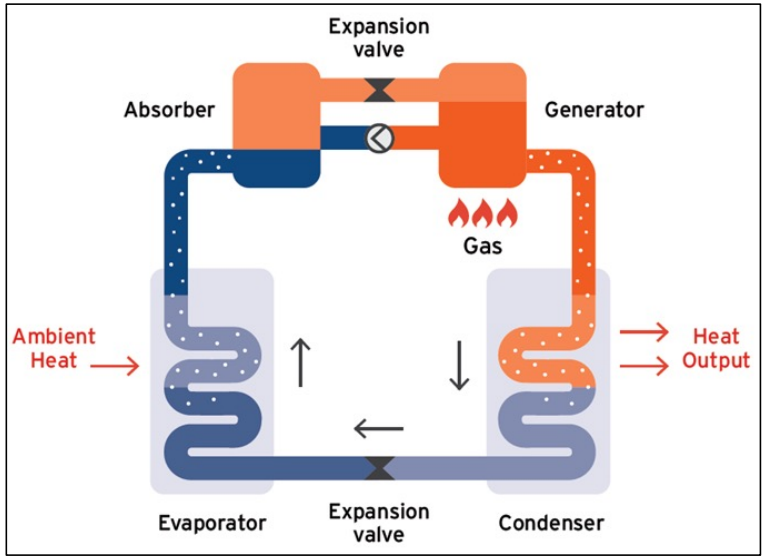
[1] https://www.energy.gov/energysaver/gas-pool-heaters

Pool Heating Technologies

Gas Absorption Heat Pump (GAHP)

- Heating output between 80 kBTU/h and 123 kBTU/h depending upon manufacturer
- Electrical draw of unit less than 1 kW
- Typical COPs between 1.2-1.4
- GAHPs would require external heat exchanger in the pool water loop and require outdoor installation
- Maintain high efficiencies at lower ambient temperatures
- GAHPs are ideal for base loads, integration of units with existing pool heater

Limitations: bulky, noisy, high contractor costs



[1] Gas Absorption Heat Pumps Best Practices Guide, Report by FortisBC, October 2023.

Pool Heating Technologies

Heat pump pool heater

- High efficiency, low emissions
- Relatively quiet systems, lower operating cost compared to traditional gas pool heaters
- Lower heating capacity output per unit, low speeds of heating (typically between 75 kBTU-125 kBTU)
- Reduced performance at low ambient temperatures

Solar pool heater

- don't require energy input in electricity or gas once installed
- Pool heating limited to solar energy availability
- No emissions post installation
- Glazed collectors are more suitable for cooler climates and year-round use
- May not be able to handle peak loads

Hybrid pool heater

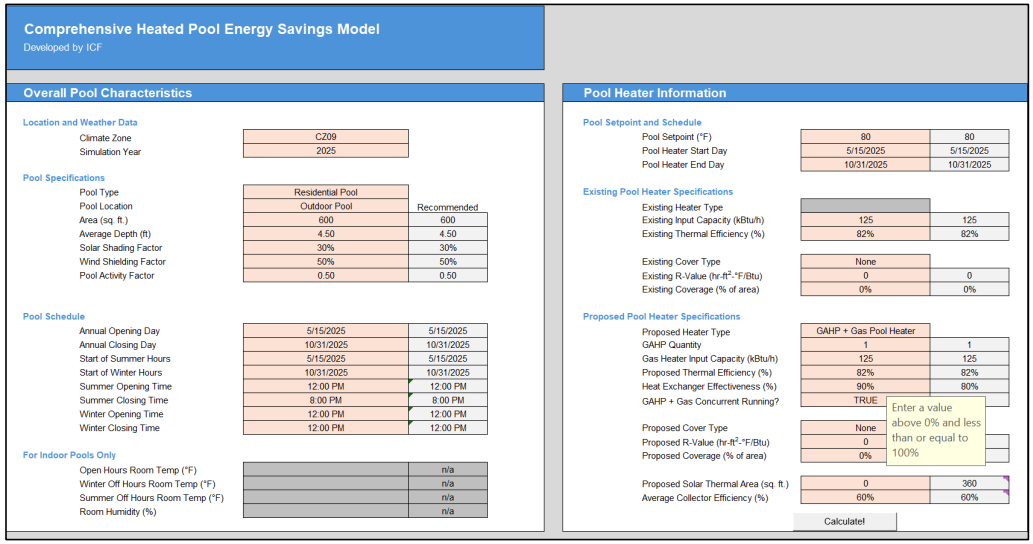
- Combine the benefits of both gas and electric technologies
- Switching based on efficiency and ambient air temperatures

[1] https://www.energy.gov/energysaver/heat-pump-swimming-pool-heaters
[2] https://www.energy.gov/energysaver/solar-swimming-pool-heater

Pool Heating Analytical Tool Development and Updates

Assumptions and Inputs:

- Swim season length assumptions per CA climate zone
- Built-in ASHRAE reference values of pool dimensions, pool activity factor, pool type
- Sizing of pool heater (BTU) - using pool temperature setpoint, average temperature of coldest month of pool use, pool surface area
- Effectiveness of GAHP Heat Exchanger- 0.97
- Same pool cover assumptions for both baseline and measure cases
- Minimum solar collector surface area- 65% of pool area



Comprehensive Heated Pool Energy Savings Model
Developed by ICF

Overall Pool Characteristics

Location and Weather Data

Climate Zone	CZ09
Simulation Year	2025

Pool Specifications

		Recommended
Pool Type	Residential Pool	
Pool Location	Outdoor Pool	
Area (sq. ft.)	600	600
Average Depth (ft)	4.50	4.50
Solar Shading Factor	30%	30%
Wind Shielding Factor	50%	50%
Pool Activity Factor	0.50	0.50

Pool Schedule

Annual Opening Day	5/15/2025	5/15/2025
Annual Closing Day	10/31/2025	10/31/2025
Start of Summer Hours	5/15/2025	5/15/2025
Start of Winter Hours	10/31/2025	10/31/2025
Summer Opening Time	12:00 PM	12:00 PM
Summer Closing Time	8:00 PM	8:00 PM
Winter Opening Time	12:00 PM	12:00 PM
Winter Closing Time	12:00 PM	12:00 PM

For Indoor Pools Only

Open Hours Room Temp (°F)		n/a
Winter Off Hours Room Temp (°F)		n/a
Summer Off Hours Room Temp (°F)		n/a
Room Humidity (%)		n/a

Pool Heater Information

Pool Setpoint and Schedule

Pool Setpoint (°F)	80	80
Pool Heater Start Day	5/15/2025	5/15/2025
Pool Heater End Day	10/31/2025	10/31/2025

Existing Pool Heater Specifications

Existing Heater Type		
Existing Input Capacity (kBtu/h)	125	125
Existing Thermal Efficiency (%)	82%	82%
Existing Cover Type	None	
Existing R-Value (hr-ft²-°F/Btu)	0	0
Existing Coverage (% of area)	0%	0%

Proposed Pool Heater Specifications

Proposed Heater Type	GAHP + Gas Pool Heater	
GAHP Quantity	1	1
Gas Heater Input Capacity (kBtu/h)	125	125
Proposed Thermal Efficiency (%)	82%	82%
Heat Exchanger Effectiveness (%)	90%	80%
GAHP + Gas Concurrent Running?	TRUE	
Proposed Cover Type	None	
Proposed R-Value (hr-ft²-°F/Btu)	0	
Proposed Coverage (% of area)	0%	
Proposed Solar Thermal Area (sq. ft.)	0	360
Average Collector Efficiency (%)	60%	60%

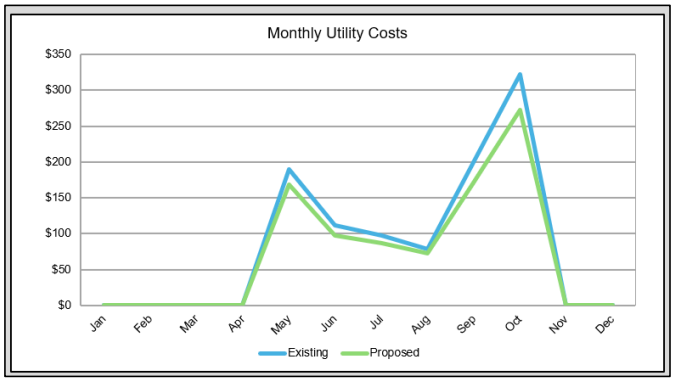
Enter a value above 0% and less than or equal to 100%

Calculate!

Parametric Analysis

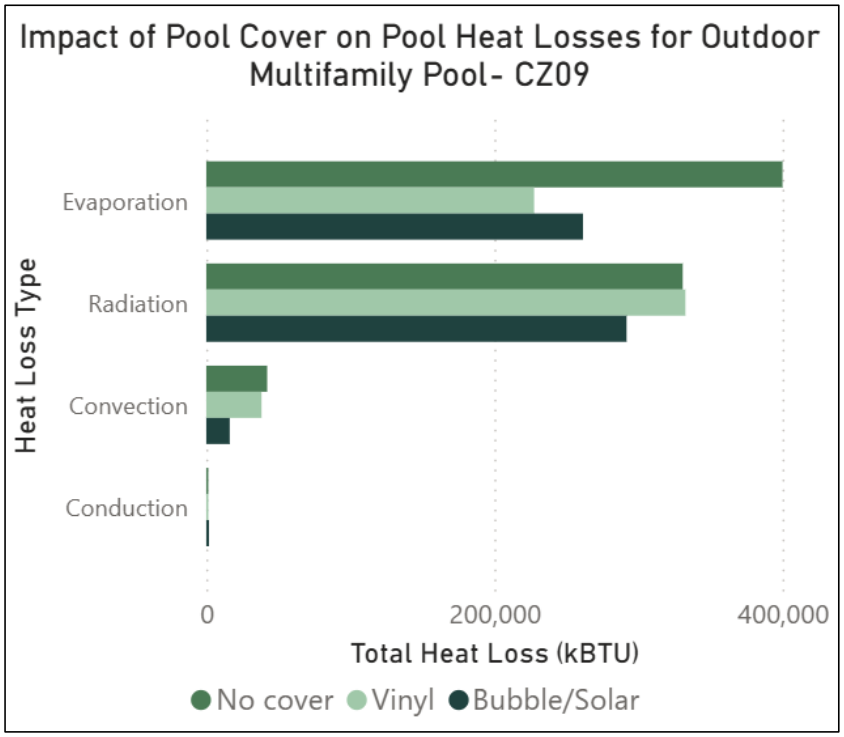
Parametric Analysis is a systematic approach used to analyze how variations in input parameters influence the outputs of the model. The goal is to identify critical parameters that significantly affect energy and emissions saving potential of pool heating technologies.

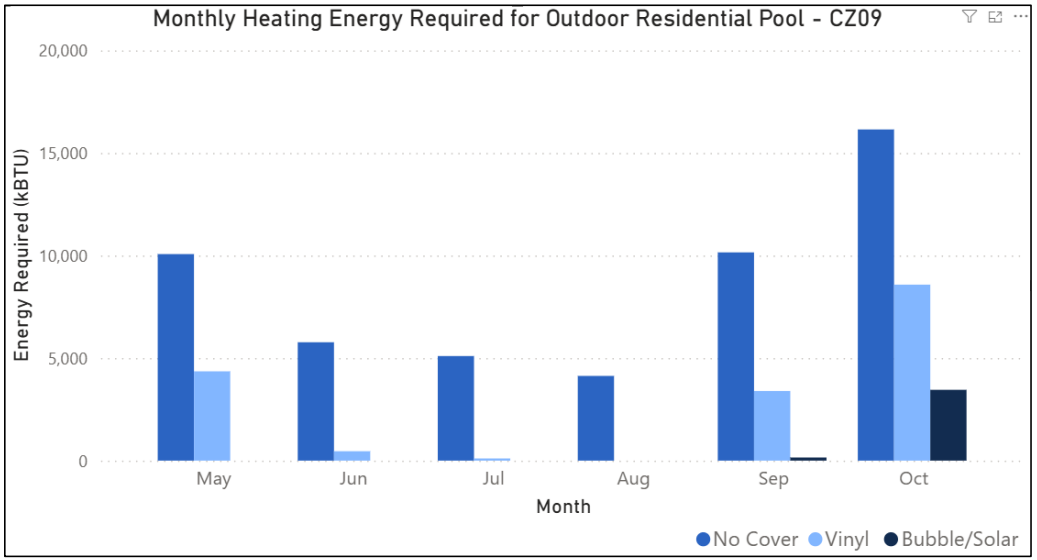
	Parameter	Level
1	Climate Zone (16)	CZ01-CZ16 (16)
2	Pool or Building Type (5)	Residential Multi-family Residence Hotel Schools/Colleges- Recreation Pool Private Health Club- Large Pool
3	Existing and Proposed Cover Type (3) (assumed same for baseline and measure cases)	None Vinyl Bubble/Solar
4	Proposed Heater Type (4)	GAHP + Gas Pool Heater Heat Pump Hybrid Heat Pump- Cost Mode Hybrid Heat Pump- Efficiency Mode
5	Proposed Solar Thermal Area (2)	0 Recommended
6	Effectiveness of GAHP Heat Exchanger (6)	0.5, 0.6, 0.7, 0.8, 0.9, 1



	Output Variables
1	Baseline and Measure Therms Usage
2	Measure kWh Usage
3	Baseline and Utility Costs
4	Baseline and Measure GHGs
5	% of load from GAHP (for GAHP Measure Case Equipment only)

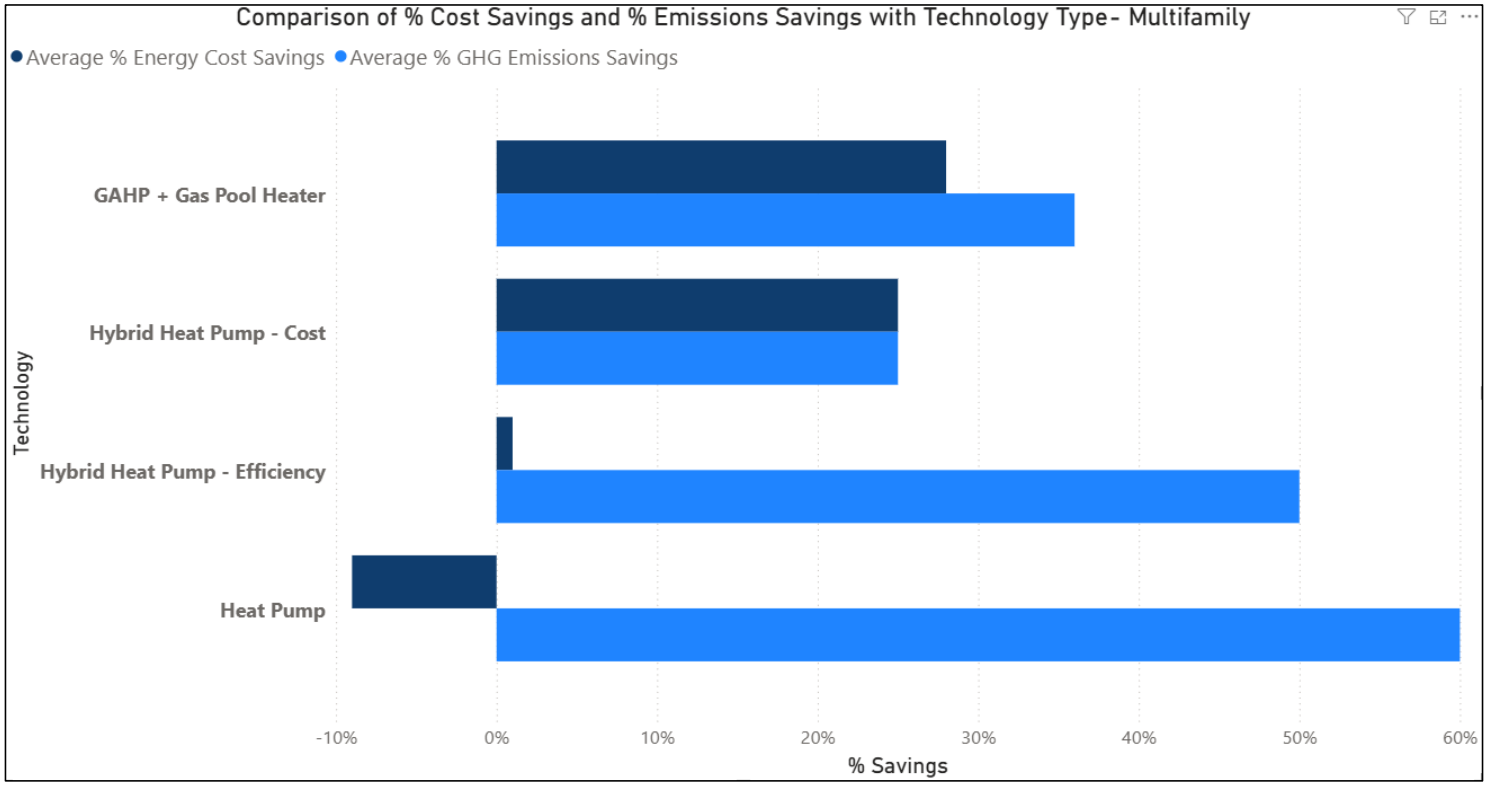
Impact of Pool Cover- Outdoor Pools



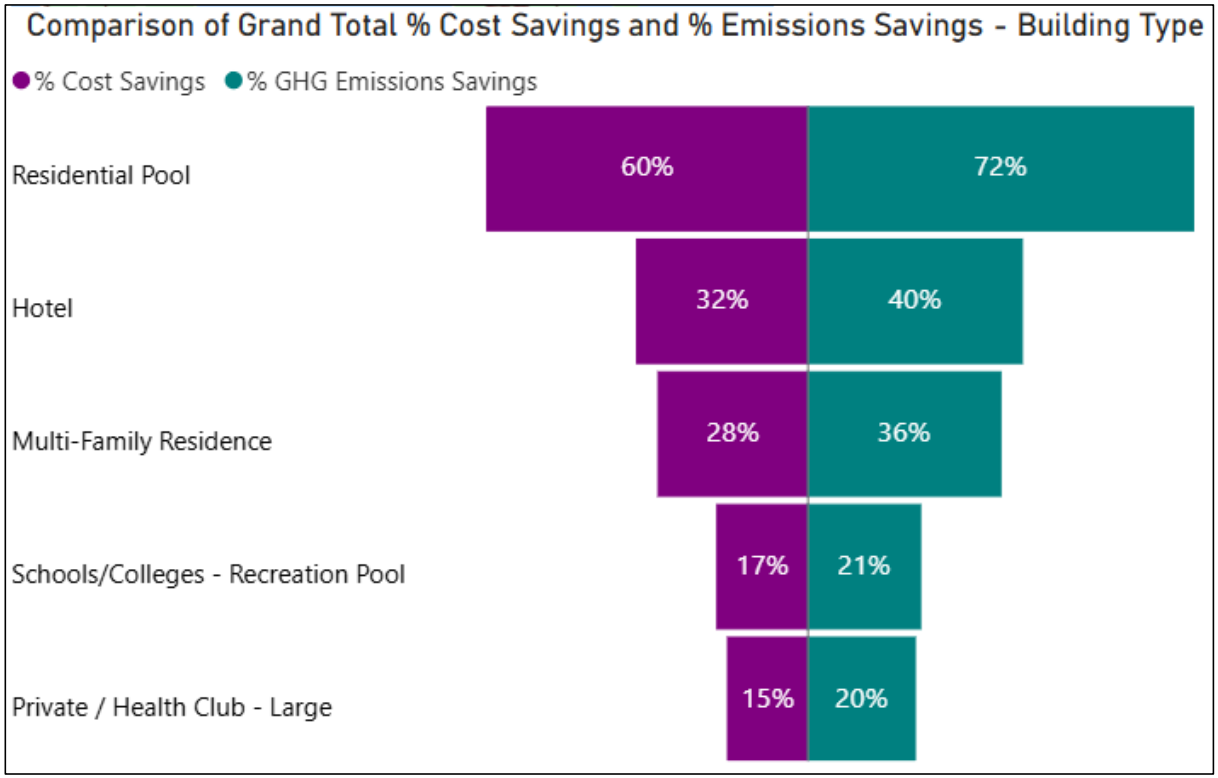


Remarks: Significant reduction in evaporation heat loss when pool cover is in place during the night or unoccupied pool hours. There is no or minimal heating required for outdoor residential pool, except October.

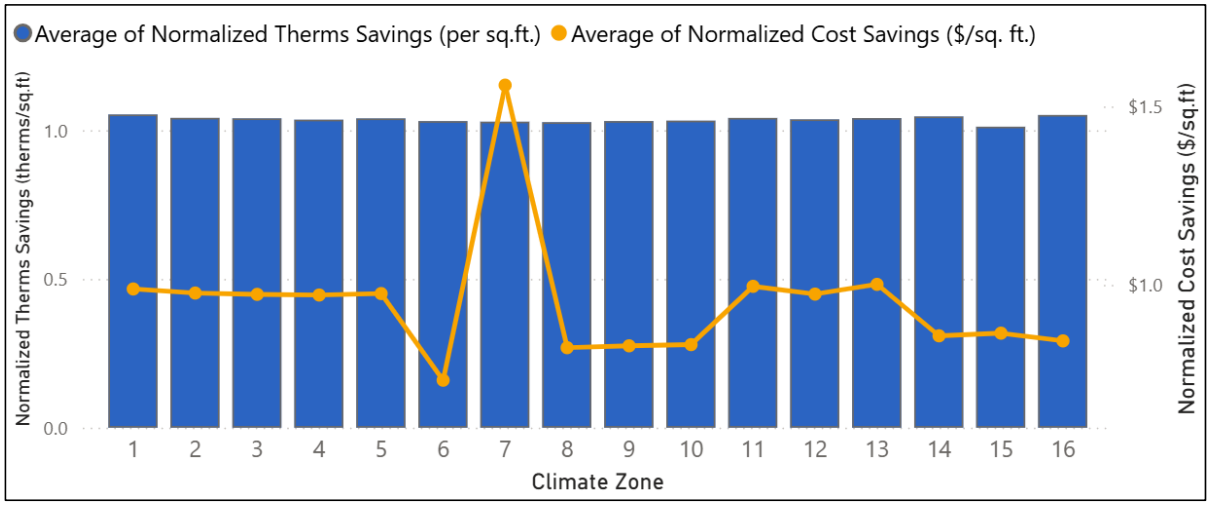
Comparison of energy and emissions savings- Outdoor Pools-Multifamily



Comparison of energy and emissions savings- GAHP for Outdoor Pools



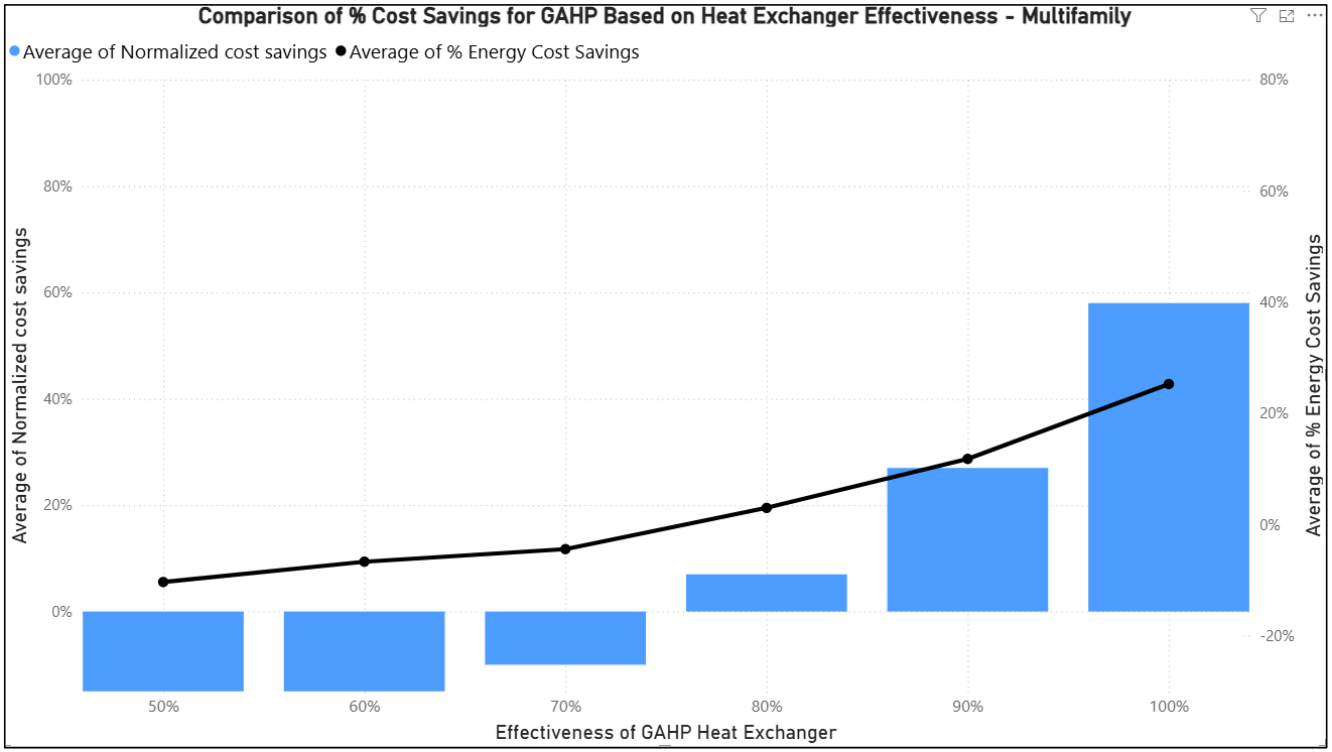
GAHP for Outdoor Pools- Multifamily



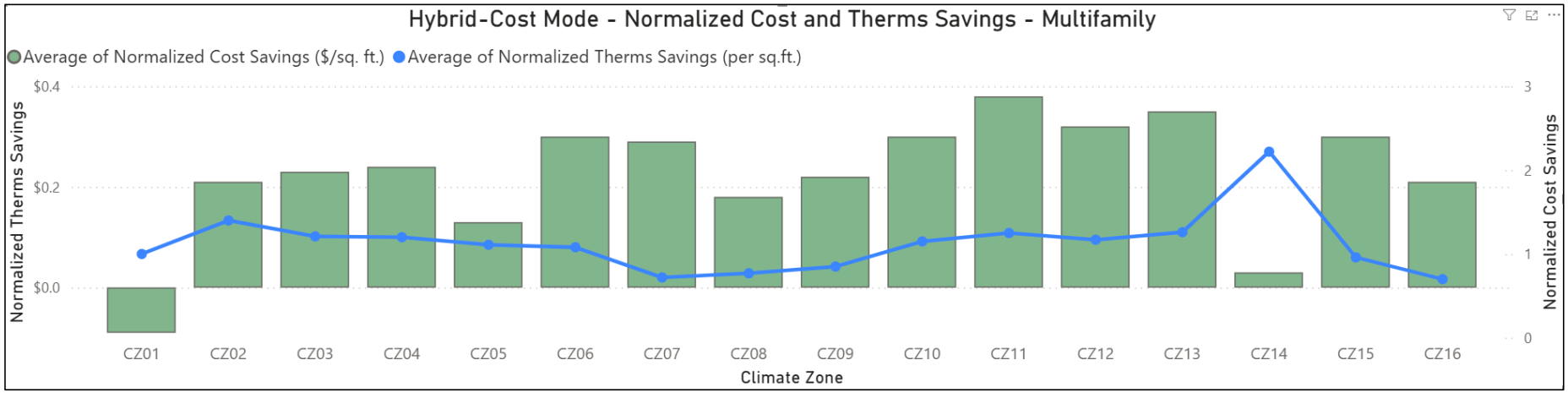
- Normalization of therms and cost savings w.r.t. pool surface area (sq. ft.)

- CZ07 (San Diego): highest normalized cost savings for multifamily and hotel sectors

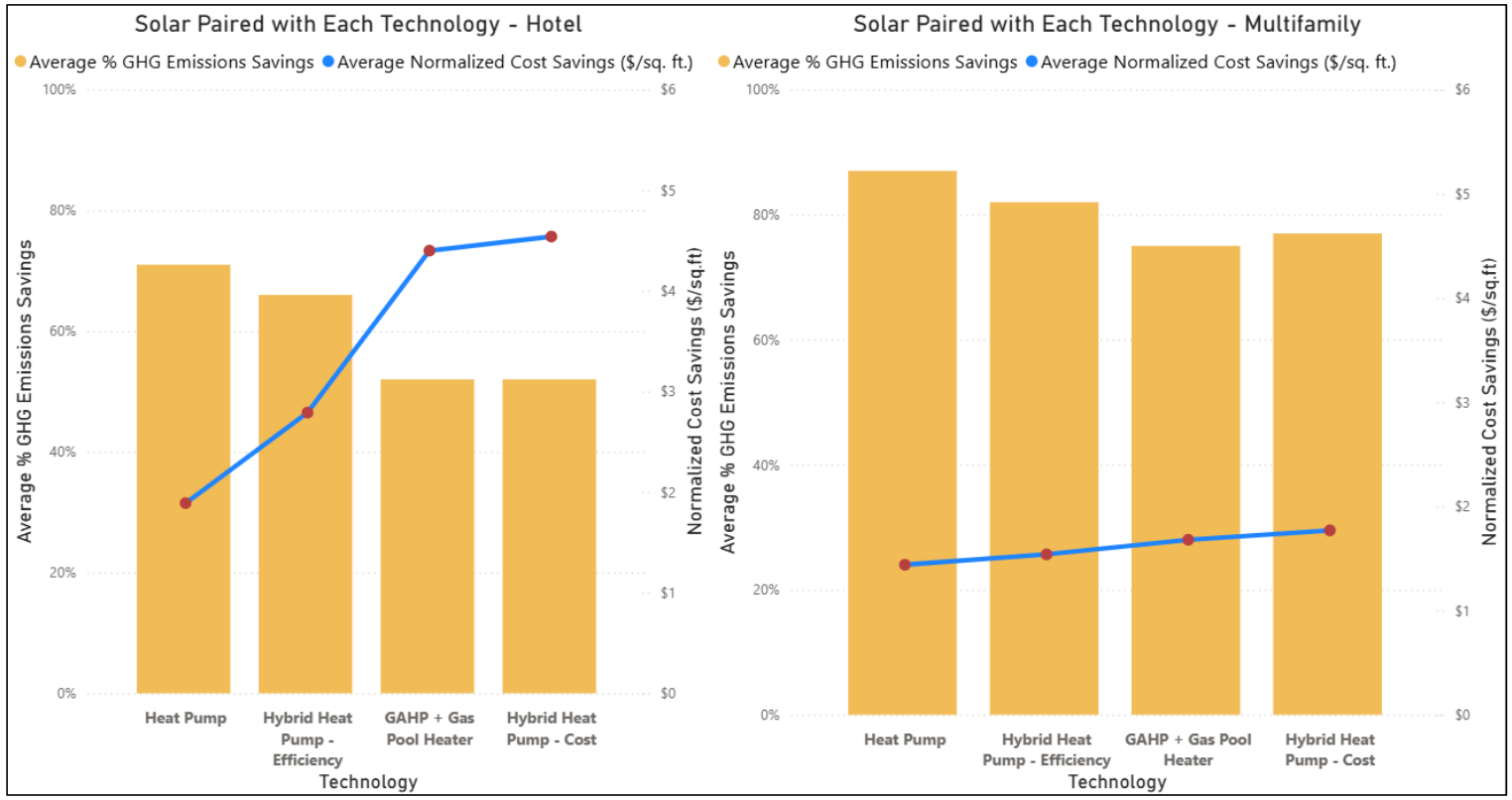
Impact of Effectiveness of GAHP Heat Exchanger on Cost Savings



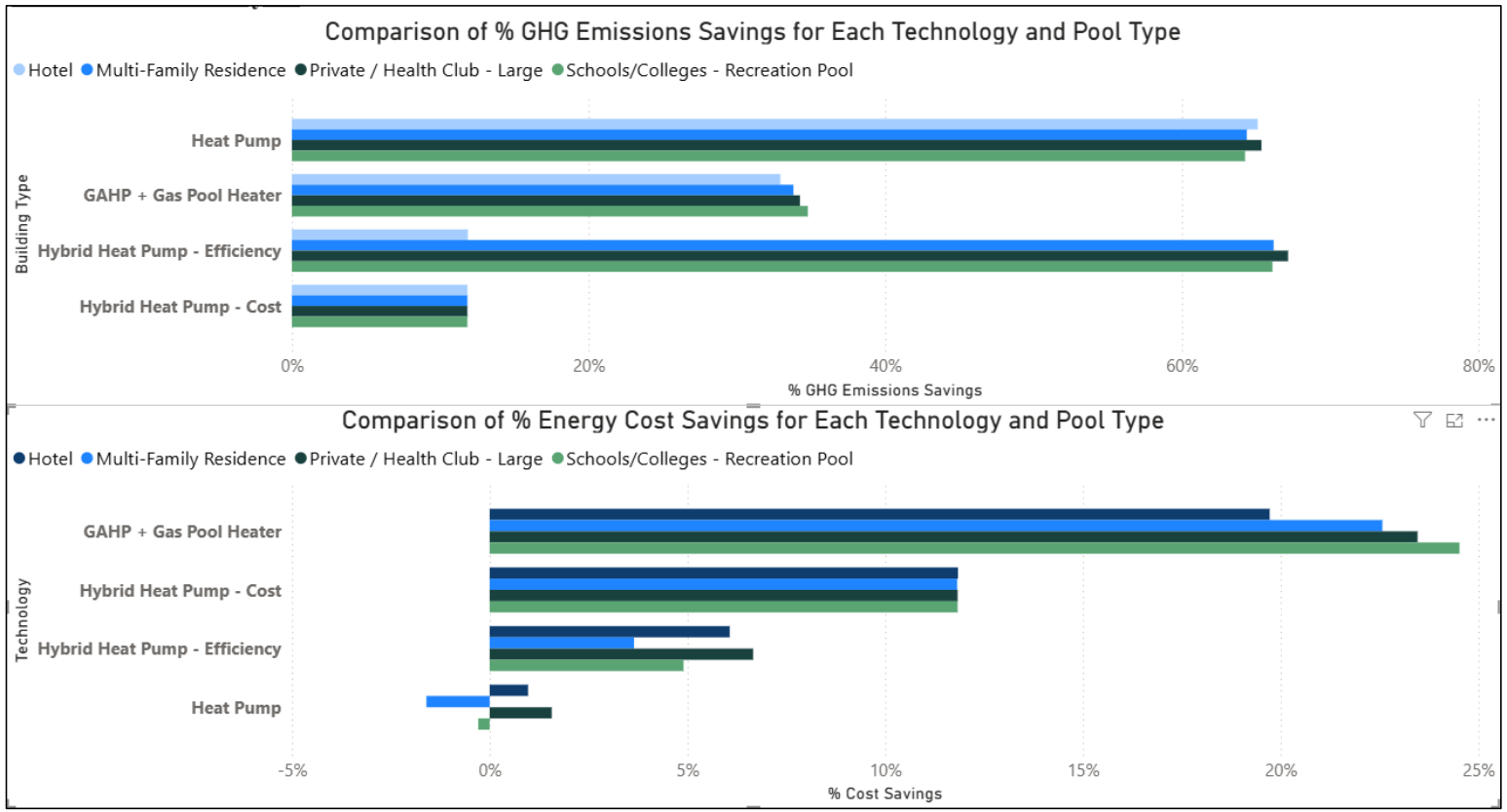
Hybrid Pool Heaters- Multifamily Outdoor Pools



Solar Thermal- Paired with each Outdoor Pool Heater Type



Comparison of energy and emissions savings- Indoor Pools



Recommendations

Key Takeaways

- Impact of pool cover on heating energy required
- GAHPs demonstrate the highest cost saving potential (~28%) after hybrid pool heater (~25%) for multifamily sector
- Heat pump pool heater and 'Hybrid pool heater- efficiency mode' demonstrates the highest GHG emissions savings for all pool types
- Effectiveness of GAHP Heat Exchanger is a critical system design parameter. Effectiveness should be greater than equal to 80% for positive energy savings
- 'Hybrid pool heater- cost mode' has the highest normalized cost savings, when paired with solar
- Cost saving potential of GAHP is the highest for Private/health club and School/colleges- recreational indoor pools

Future Studies

- Field Study of GAHP and Hybrid Pool Heater for pool heating application
- Tool updates for other climate zones/states and other GAHP manufacturer

This project was conducted through the ICF implemented, SoCalGas administered California Statewide Gas Emerging Technologies Program.

The project report can be found on cagastech.com

For more information, contact get@caenergyprograms.com

For more information, contact Program Manager, Ava Donald, at Ava.Donald@icf.com.

ICF

SoCalGas

Glad to be of service®