ET Summit 2024

Presented by

ETCC
ENERGY TRANSITION
COORDINATING COUNCIL

Gas Absorption Heat Pumps (GAHPs) in DHW Systems

Cristalle Mauleon
Engineering Manager
Lincus, Inc.

Agenda

- Advantages of GAHPs
- Previous Work
- Field Study Screening and Design
- GAHP Installation
- Baseline & Post Data
- Follow On Work

Advantages of GAHPs

Reduced Energy Usage
GAHP can operate at >100% Efficiency. Overall DHW energy use decreased.

Lower Emissions
Higher efficiency reduces energy consumption reducing emissions. Electric HPWH emissions fluctuate based on time of day.

Underserved Communities
Reduction in energy usage = lower utility bills.

Decarbonization
Potential for further reduction of emissions when carbon capture is incorporated.

Previous Projects

In two (2) previous Emerging Technology Studies, a GAHP was installed and saved energy at two sites with existing gas-fired boilers with storage tanks.

Equipment Efficiency (COP)

Project	Existing	Post with GAHP	
NEEA Project in Salem, OR[1]	0.70	1.06	18% Natural Gas Savings
TAF Project in Ontario, Canada[2,3]	0.54	1.14	

1. GAHP installed in a nursing home to augment space heating and DHW systems
2. GAHP installed in a multifamily building to augment space heating and DHW systems
3. TAF Study did not provide % natural gas savings

California Gas Emerging Technology (GET) Analysis

Goal: Determine energy savings potential in California buildings[1]

Methodology:

- GAHP COP f(OAT) data extracted from NEEA field study
- Extract space heating loads from DEER eQuest prototypes[2]
- Modify DEER Water Heater Calculator[2] to include GAHP and space heating loads
- Building types selected based on how well DHW/space heating load matched GAHP capacity

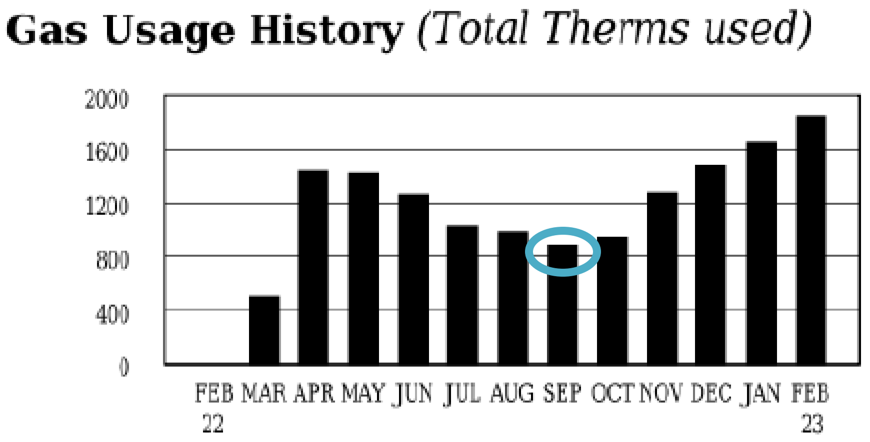
Building Type/Application	Savings %	Cost-Effectiveness Indicator *(Portfolio Goal = 1.25)*
Assembly: DHW Only	31%	0.88
Small Office: DHW & Space Heating	31%	0.21
Nursing Home: DHW & Space Heating	26%	0.62

1. Study ET22SWG0002. Details on methodology can be found in final project report (see references slide for link)
2. These resources are California Energy Efficiency program specific modeling tools

Initial Site Screening Criteria

Site Selection Criteria (Manufacturer #1)

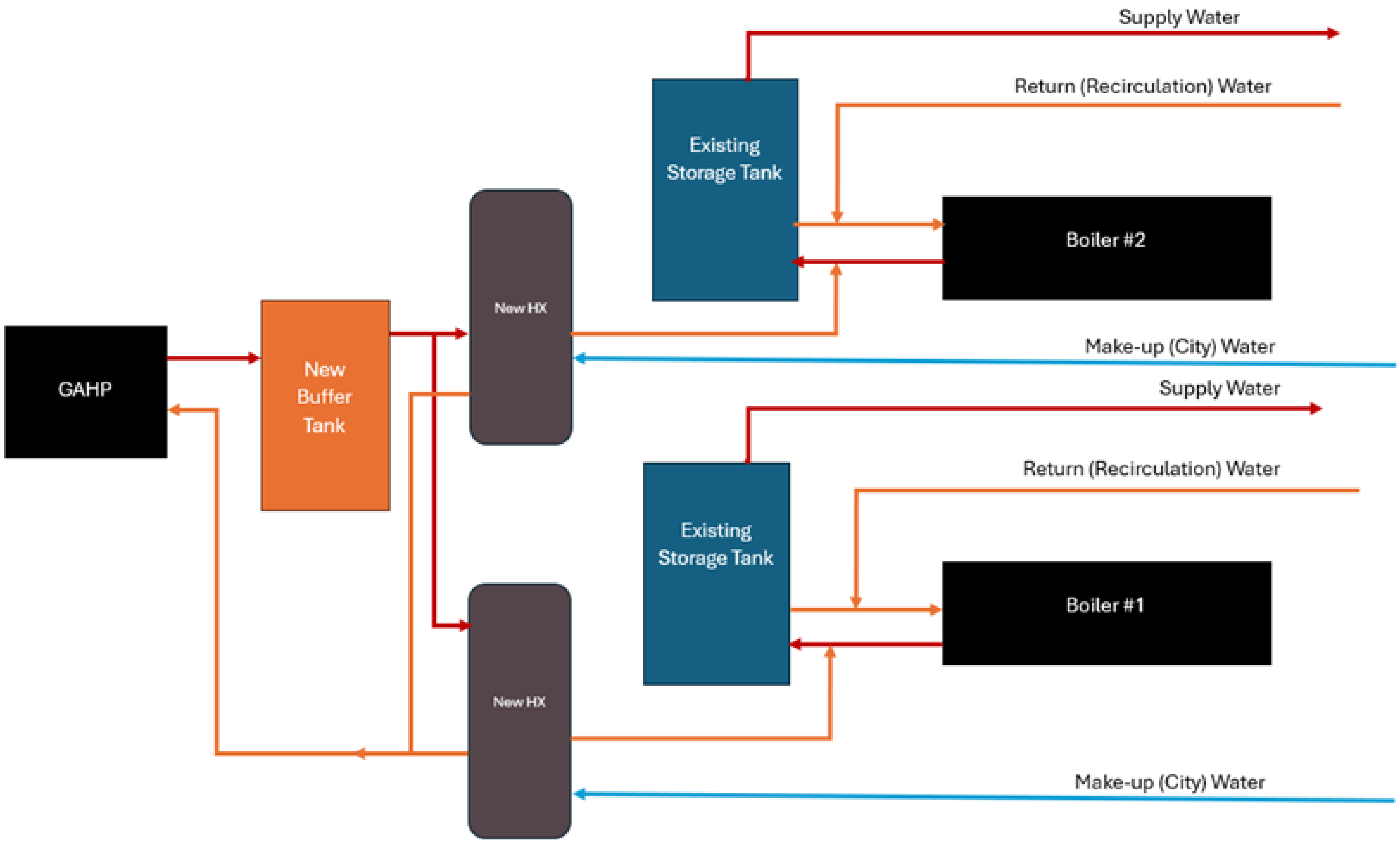
- Multifamily or hotel
- 70+ multifamily units on (1) DHW system
- Use monthly summer gas use – 900 therm minimum desired
- Mechanical room/boiler enclosure on ground floor
- Space for new HX & buffer tank
- Minimum 6ft x 9ft of space outside for mounting GAHP
- GAHP
    - Enough airflow
    - Not near a window



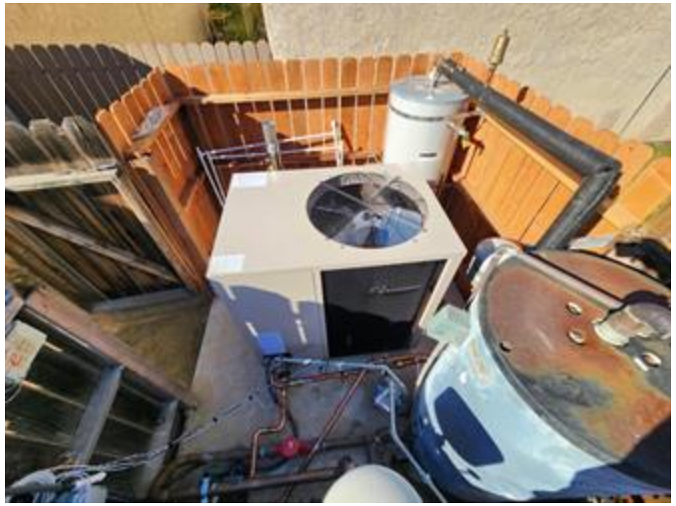
Design Criteria

- Design Criteria
- 40-60% of peak load, retain existing boiler for peak load
- Control strategy; supply >135F or ≤135F
- GAHP Controls: Mfg provided or interface with existing system
- DHW recirculation
    - Pump VSD controls such that return temp <122F, OR
    - GAHP NOT integrated into recirculation loop

Piping Schematic



Installation Pictures



- Upper Left: Installed GAHP Unit
- Upper Right: Piping to and from HX (insulated per T24)
- Lower Left: GAHP DDC control
- Lower Right: New Concrete Pad

Challenges

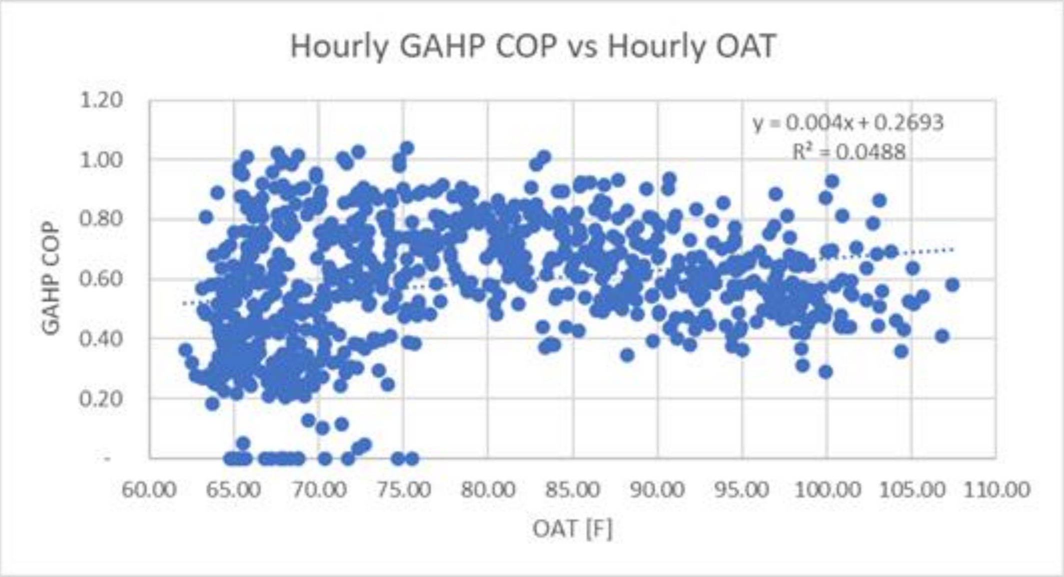
- Design:
  - No design support provided by mfg
  - Contractor struggled with HX size and buffer tank size
- Controls
  - Mfg has two controls
  - Contractor struggled to set up
- Site Specific Challenges
  - Water pressure regulator
  - Failed supply flow meter
  - Boiler #2 failure

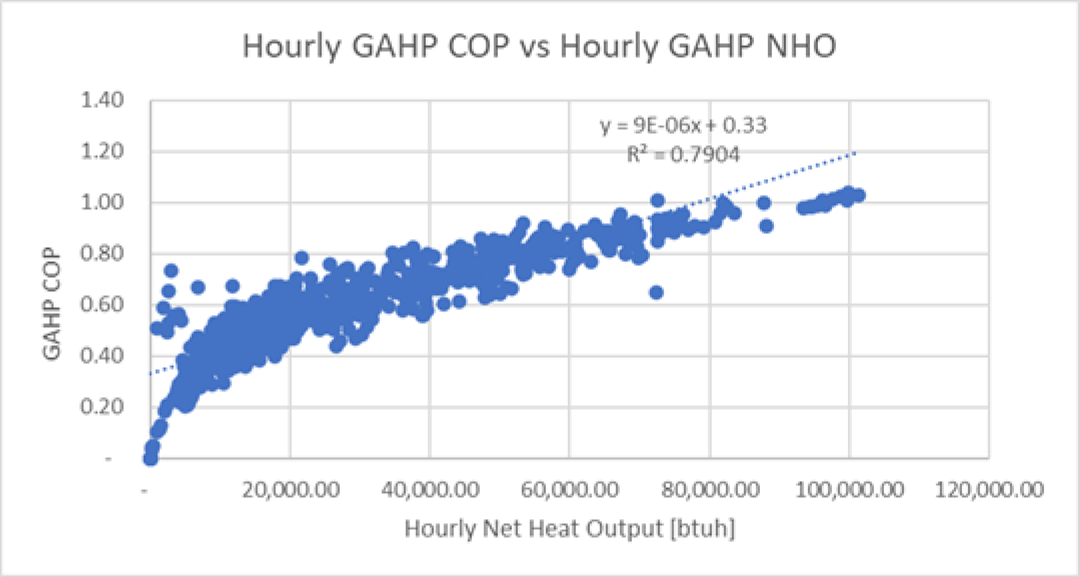
(L) Low water pressure DHW system #1
(R) Failed supply flow meter DHW system #1

Baseline

	DHW System #1	DHW System #2	Total
Total Measured Net Heat Output [Btu]	95,956,358	85,113,320	181,069,678
Total Measured Gas Energy Input [Btu]	164,866,793	123,139,675	288,006,467
Total Measured Gas + Electric Energy Input [Btu]	166,354,401	125,077,418	291,431,819
System COP_{Gas}	0.58	0.69	**0.63**
System $COP_{Gas+Electric}$	0.58	0.68	0.62
Data Period	10/14/23 – 12/15/23		

Post-Installation - COPs

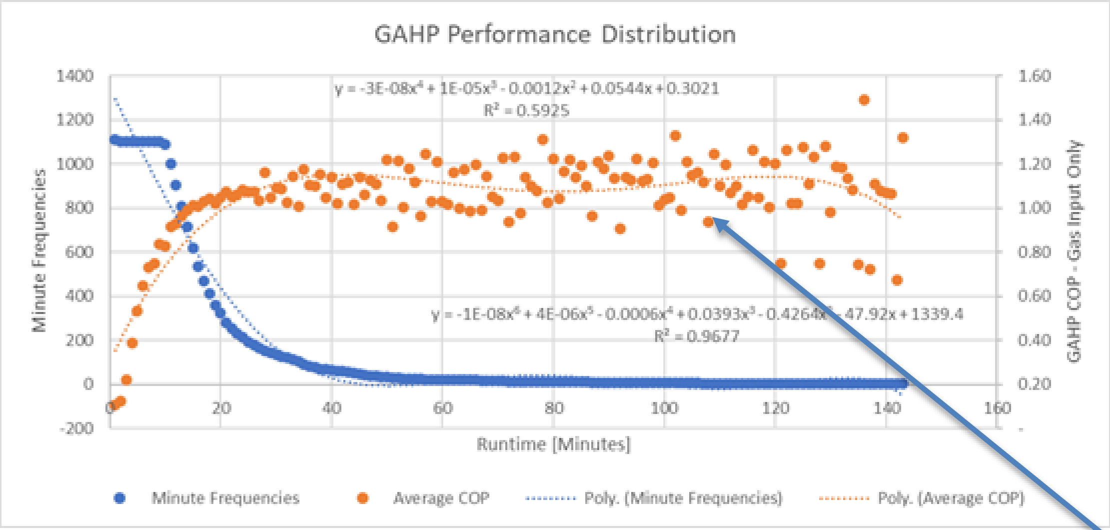


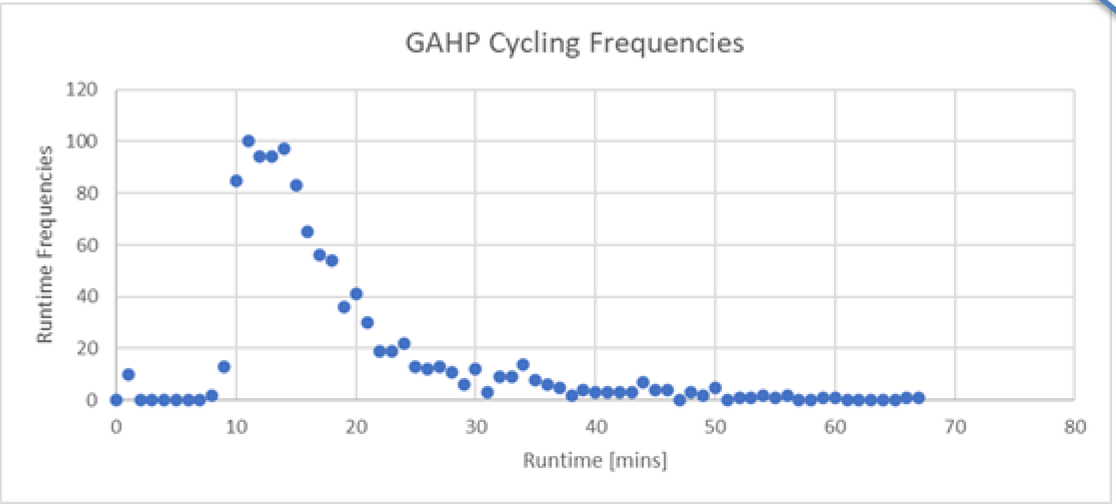


- GAHP COP does not regress well with OAT
- Not enough DHW load
  - No recirc
  - Summer
  - Gas bills include boiler inefficiencies

- GAHP COP regresses well with Net Heat Output (NHO)
- This is a proxy for GAHP continuous run time

GAHP COPs by Run Time





Findings:

- GAHP COPs reach **steady-state** after 20 min
- Avg GAHP COP equals **condensing boiler** at 45 min

Vacillation after 30 min due to pulsing meters combined with few data points. Expected to converge with more run times >30 min

Post-Installation Energy Savings

Metric	Value
Post-Installation Net Heat Output [btu]	88,941,311
Theoretical Baseline Gas Use [btu]	141,176,685
Post-Installation Gas Use [btu]	130,262,062
Savings [btu]	10,914,622
Savings [therm]	109
% Savings	**8%**
Post-Installation Data Period	6/7/24 to 7/9/24

Baseline

- 0.63 COP

Post

- Two-Variable regression: f(OAT & NHO)

Notes:

Two-Variable regression Min Temp = 62.4°F

CZ2022 Min Temp = 39.0°

Future Plans

- Incorporate recirculation load into GAHP
- Use indirect storage tank (IST) instead of plate and frame HX
- Modify controls with lower minimum IST temp
- Additional field studies: (1) more launched, (2) more in the pipeline
- Field Study #2 incorporating design engineering firm

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

Cristalle Mauleon

Engineering Manager

Lincus/GET

cmauleon@lincus.com

ICF

SoCalGas

1. NEEA Study: *Robur Heat Pump Field Trial.* (https://neea.org/resources/robur-heat-pump-field-trial
2. TAF Study: Gas Absorption Heat Pumps. Technology Assessment and Field Test Findings (https://taf.ca/publications/gas-absorption-heat-pumps/)
3. GET Studies
    1. ET22SWG0002: Evaluation of Emerging Water Heating Technologies. (https://www.etcc-ca.com/reports/evaluation-emerging-water-heating-technologies)
    2. ET22SWG008: Gas-Fired Heat Pump Water Heating & Combi System Pilot Phase 1. (https://www.etcc-ca.com/reports/gas-fired-heat-pump-water-heating-combination-system-pilot-phase-1)
    3. On-going: ET23SWG002: Gas-Fired Heat Pump Water Heating & Combination System Pilot – Phase 2F – Site #1. (https://www.etcc-ca.com/reports/gas-fired-heat-pump-water-heating-phase-2f-site-1)