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WATER HEATING

GAS HEAT PUMP WATER HEATER, MULTIFAMILY

SWWH033-01

CONTENTS

MEASURE NAME

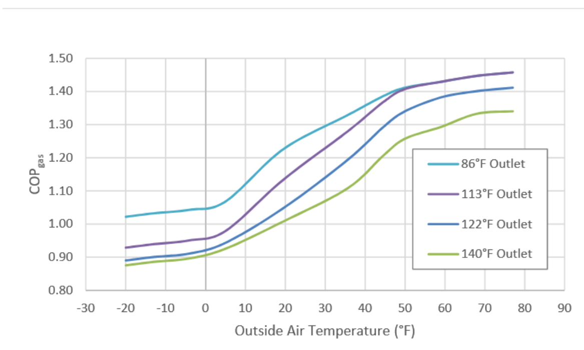
Gas Heat Pump Water Heater, Multifamily

STATEWIDE MEASURE ID

SWWH033-01

TECHNOLOGY SUMMARY

Gas Heat Pump (GHP) technology is the high efficiency gas water heating solution for replacing standard water heating technology. Natural gas heat pump systems typically utilize an absorption cycle or engine-driven gas refrigeration cycle to produce heating and/or cooling effects in a sometimes reversable cycle. By utilizing this refrigeration cycle, the GHP is capable of delivering hot water more efficiently, with Coefficients of Performance (COP) between 1.2-1.8, yielding an Annual Fuel Utilization Efficiency (AFUE) of 140% or more as shown in Figures 1 &2 (*source: Robur Gas Absorption Heat Pump, GAHP-A spec.*)[1]



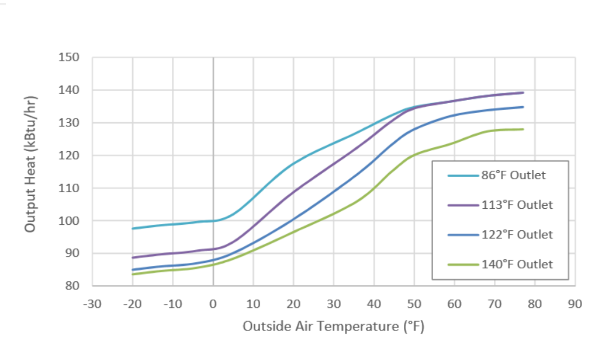


Figure 1: GAHP Performance vs. Ambient temperature

Figure 2: GAHP Output Capacity vs. Ambient temperature

Gas absorption heat pumps (GAHP) use an ammonia-water absorption cycle to provide hot water for domestic and sometimes space heating. Some absorption heat pumps can be reversed allowing them to operate in cooling mode as well. As in a standard heat pump, the refrigerant (Ammonia) is condensed in one coil to release its heat; its pressure is then reduced, and the refrigerant is evaporated to absorb heat. If the system absorbs heat from the interior of the home, it provides cooling; if it releases heat to the interior of the home, it provides heating. Absorption heat pumps are expected to offer energy and carbon-dioxide (CO_2) emissions savings of up to 30 percent or more, compared with condensing boilers.

Several brands of gas absorption heat pumps are available on the market. Similar products are under development and should be available in the market in the near future.

[1] Robur Gas Absorption Heat Pump, model GAHP-A, https://www.roburcorp.com/heat_pumps/air_to_water_gas_absorption_heat_pump_gahp_a

In several field tests, gas absorption heat pumps serving domestic water heating and space heating systems were able to achieve COPs of up to 1.29 as shown in Figure-3 (*source: NEEA heat pump field trial, March 11, 2020*)[2] and Figure-4 (*source: Enbridge Gas Distribution and Union Gas report*)[3]

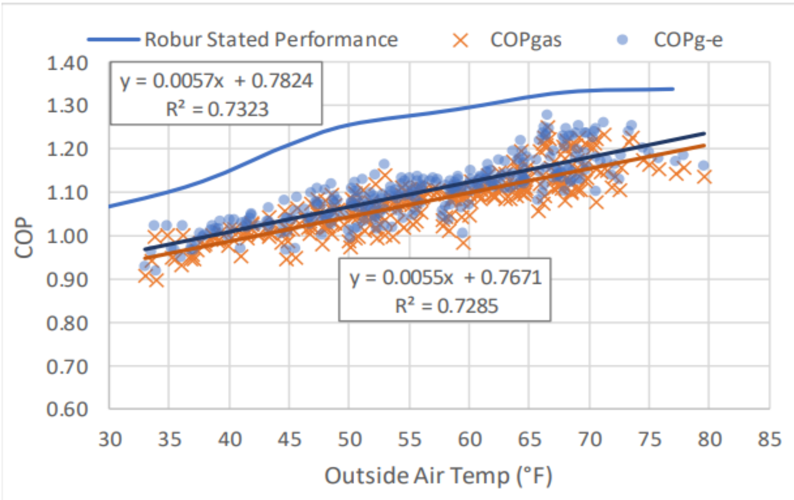


Figure 3 : Daily heat pump performance (from NEEA)

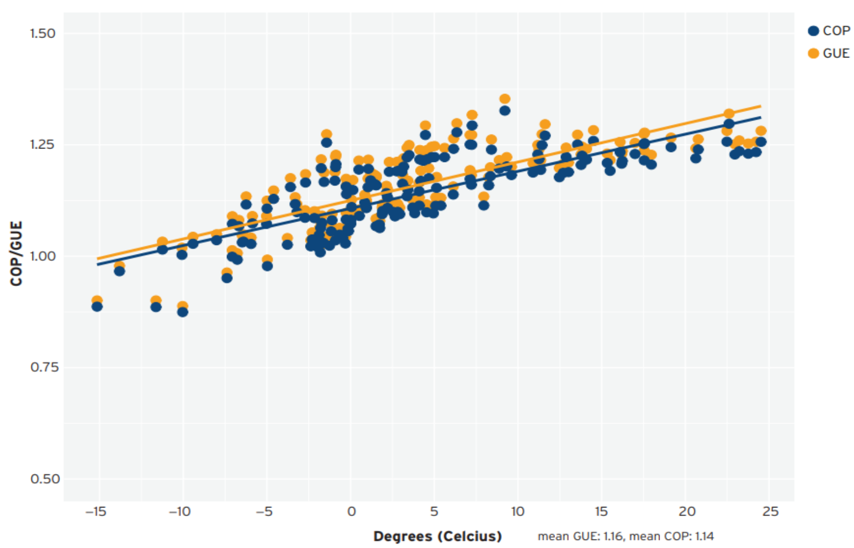


Figure 4: Daily GAHP performance plotted against the average daily exterior temperature (from Enbridge Gas and Union Gas)

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[2] Energy 350, 2020. *Robur Heat Pump Field Trial (Page 20).* Prepared for the Northwest Energy Efficiency Alliance, (NEEA). Report # E20-309. March 11, 2020. https://neea.org/resources/robur-heat-pump-field-trial

[3] TAF, Gas Absorption Heat Pumps TECHNOLOGY ASSESSMENT AND FIELD TEST FINDINGS (Page 15), https://taf.ca/wp-content/uploads/2018/10/TAF_GAHP-White-Paper_2018.pdf

The primary advantage of this technology is the ability to provide hot water for domestic hot water (DHW) at significantly higher efficiencies than natural gas boilers. The application of gas heat pumps is introduced for large residential with high water use applications making the product not only environmentally, but also economically, attractive to the customer.

MEASURE CASE DESCRIPTION

The measure case is defined as a Gas Absorption Heat Pump water heater system sized to satisfy the base load of the domestic hot water system and improve the efficiency of the conventional gas-fired domestic water heating system. The measure offerings designated below distinguish by system type and input capacity; the impacts of each offering are derived for each California climate zone. The efficiency requirement of COP ≥ 1.25 is at standard conditions. Standard conditions are defined as 70 °F outdoor air temperature and 130 °F outlet temperature.

Measure Case Specification

Statewide Measure Offering ID	Building Type	Measure	Input Capacity (kBtu/hr)
A	Multifamily	Gas absorption heat pump added to DHW system (COP ≥ 1.25)	< 200

BASE CASE DESCRIPTION

The base case is defined as a gas standard efficiency centralized hot water boiler for commercial and multifamily buildings. The minimum base case efficiencies are consistent with the federal U.S. Department of Energy (DOE) standards (see Code Requirements).

Base Case Specification

Building Type	Baseline Water Heater Type	Efficiency (TE)	Input Capacity (kBtu/hr)
Multifamily	Central Hot Water Boiler	0.80	≥ 300 and ≤ 2,500

CODE REQUIREMENTS

The efficiency requirements for gas-fired commercial hot water boilers are governed by the California Appliance Efficiency Regulations (Title 20);[4] Section 1605.1 (Table E-2) specifies the minimum efficiencies. Applicable state and federal codes and standards for commercial boilers and commercial water heaters are noted below. Currently, there is no code or standard for gas absorption heat pump.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2019)	Section 1605.1 (f)(2)	January 1, 2019

[4] California Energy Commission (CEC). 2014. *2014 Appliance Efficiency Regulations*. CEC-400-2014-009-CMF.

Code	Applicable Code Reference	Effective Date
CA Building Energy Efficiency Standards – Title 24	Section 110.3	January 1, 2019
Federal Standards	10 CFR 430.32 (d)	December 29, 2016

NORMALIZING UNIT

kBtuh input capacity (Cap-kBtuh)

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Normal Replacement (NR)	DnDeemed	Residential
Normal Replacement (NR)	DnDeemDI	Residential
New Construction (NC)	DnDeemed	Residential
New Construction (NC)	DnDeemDI	Residential

Eligible Products

Eligible products must meet the specifications in the Measure Case Description. Systems must conform to manufacturers' specifications and with all applicable mechanical, plumbing and building codes and standards. Sizing the GAHP for the DHW heating load is extremely important for the performance of the system. The sizing of the GAHP system will affect the energy output, response time and temperature differential across the heat pumps. In this measure the GAHP is sized to serve the base load of the building, not the whole building load.

All system components (gas heat pump, piping, valves, tanks, pumps, insulation, and controllers) must be new and must not have been previously placed in service in any other location or for any other application. Rebuilt, refurbished, or relocated equipment is not eligible to receive incentives.

The efficiency requirement of COP ≥ 1.25 is at standard conditions. Standard conditions are defined as 70 °F outdoor air temperature and 130 °F outlet temperature.

Existing DHW Heating System:

In general, multifamily buildings domestic water heating system are served by a central gas-fired hot water boiler(s) (operating with redundancy) and storage tank, as shown in figure-6 (for base case boiler heating rates.)

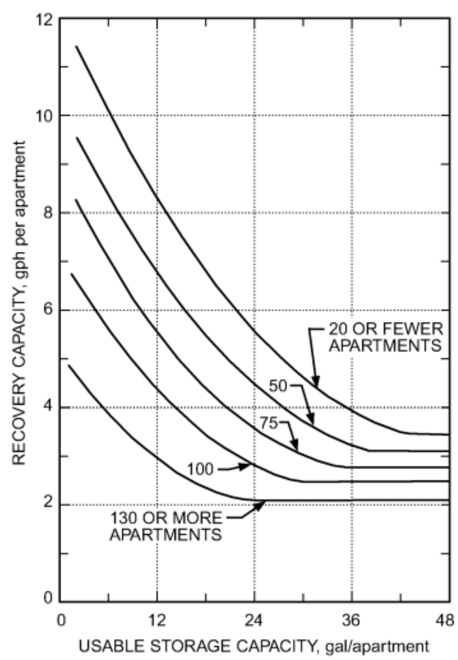
New DHW Heating System using GAHP:

The new system will include a gas heat pump water heater that operates as the primary or a baseload equipment and supplemented by an existing DHW boiler(s) operating as a peak shaving unit in this hybrid system, as shown in figure-11 (for measure case boiler & GAHP heating rates.) Baseload for this application is defined as the constant water heater demand due to environmental losses and times of low hot water use. In general, the gas heat pump should not have output capacity larger than half of the existing boiler which will serve as the peak shaving unit.

Range of applicable building sizes for this measure:

The performance of the GAHP systems varies across different DHW load profiles and occupant behavior in each MF building. Therefore, correctly sizing the GAHP for the DHW heating load is extremely important for the performance of the system. The sizing of the GAHP system will affect the energy output, response time and temperature differential across the gas heat pumps. The intermittent nature of DHW loads provided undesirable conditions for the heat pump performance due to constant cycling of the hot water temperature differential.

Generally, one of the sources used for selecting a DHW system in multifamily building is the 2019 ASHRAE Applications textbook. In the figure below, it shows a graph for the selection of the heating source (boiler) size and the hot water storage tank size depending on the number of apartments served in a multifamily building. For this measure, multifamily buildings smaller than 20 apartments would not be applicable due to their lower hot water demand.



Source: 2019 ASHRAE Handbook – HVAC Applications

Eligible Building Types and Vintages

This measure is applicable for new or existing multi-family residences of any vintage which utilize a centralized domestic water heating system.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

None.

DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

USE CATEGORY

Service and Domestic Hot Water (SHW)

ELECTRIC SAVINGS (KWH)

See gas Savings Section.

PEAK ELECTRIC DEMAND REDUCTION (KW)

Not applicable.

GAS SAVINGS (THERMS)

Baseline Energy Use Simulation

The gas unit energy savings (UES) of this measure were derived from building energy use simulation results and were calculated as the difference between the baseline and measure building unit energy consumption (UEC). Building energy use and demand were estimated using OpenStudio Application Version 1.2.0 which is based on OpenStudio SDK (core) Version 3.2.0 and EnergyPlus Version 9.5.0.

Gas absorption heat pumps cannot be modeled in OpenStudio or EnergyPlus except perhaps by complex and custom-written objects. Furthermore, the OpenStudio Application and perhaps the OpenStudio SDK do not support central heat pump water heaters without complex and custom-written objects. As a workaround, the gas absorption heat pumps were modeled as boilers. The maximum outlet temperature was specified such that the maximum inlet temperature was not violated. However, the maximum efficiency for boilers was 1.0, so post-processing of the hourly OpenStudio output data was performed in

Excel to apply the appropriate efficiency curve. All input and output files are provided in a compress zip folder[5].

Unit Energy Consumption (UEC) Modeling Tool Summary

PLATFORM	ENERGYPLUS
Model Type	IOU Modeled
Energy Modeling Engine	EnergyPlus version 9.5.0
Energy Modeling Interface	OpenStudio Application version 1.2.0/OpenStudio SDK (core) Version 3.2.0
Batch Processor	Manually edited input file modifications
Weather files	California Climate Zone files from CBECC-Com 2022[6]
Prototype Source	N/A, custom large multifamily with 84 residential units

The OpenStudio Application, which is based on the OpenStudio SDK and EnergyPlus, was used. The initial energy model was the baseline energy model from a past SoCalGas workpaper[7]. That model was created in OpenStudio Version 2.4.0 using the "Create DOE Prototype Building" measure within OpenStudio's Building Component Library. "Midrise Apartment" was selected as the building type, ASHRAE 90.1-2007 was selected as the energy code, and "ASHRAE 169-2006-3B" was selected as the climate zone.

The weather files were switched to the California Climate Zone files from CBECC-Com 2022. Cold water temperature schedules were created in the OpenStudio Application to match the monthly cold-water temperatures in the Climate Zone files.

An hourly draw schedule for one residential unit was created to be equivalent to the draw schedule of a multifamily unit in the DEER Water Heater Calculatorv4.2. All versions of the DEER water heater calculator use the same DEER2014 hourly hot water draw profiles. The draw schedule in the calculator is for hot water only at 135°F, but OpenStudio requires the draw schedule to be at the mixed water flow rate and mixed water temperature at the fixtures. Assuming a mixed water temperature of 105°F, a hot water temperature of 135°F, and cold-water temperatures for Climate Zone 9, the revised draw schedule was calculated in Excel. This mixed water draw schedule was then used for all climate zones so that mixed water usage would be consistent. However, hot water usage varies by climate zone since that is calculated within OpenStudio using the climate zone-specific cold-water temperatures.

To create diversity, the above-described mixed water draw schedule was shifted in time. Three were created by shifting the schedule forward by one to three hours, and two were created by shifting backward by one to two hours. These six were then all shifted by one week to create six more for a total

[5] SoCalGas (SCG). 2021 "Model_Files.zip."

[6] http://bees.archenergy.com/software2022.html

[7] SoCalGas' Multi-Family Central Boiler Dual Setpoint Temperature Controller workpaper

of 12. An OpenStudio Ruby script was then written to turn these 12 sets of hourly data into 12 OpenStudio-formatted hourly schedules that were then manually copied into the OpenStudio model file (i.e., the file with extension ".osm"). Each of the 12 draw schedules was then assigned to seven residential units for a total of 84.

There are two main reasons that 12 draw schedules were created instead of 84 or some other amount. First, using fewer draw schedules multiple times was simpler. Second, the building geometry in the models match the MASControl2 multifamily building (i.e., 12 1,000 square foot residential units), but this project called for a larger building. To avoid the complexity of modifying the building geometry in SketchUp and having 84 water use equipment objects (one per residential unit), the 12 draw schedule instances were assigned to the 12 water use equipment objects and those objects were multiplied by 7 to mimic 84 residential units.

The water heating system consists of a primary loop with two gas-fired, non-condensing boilers in parallel, each with its own constant flow pump, that heat an unfired storage tank. The secondary loop has a constant speed pump.

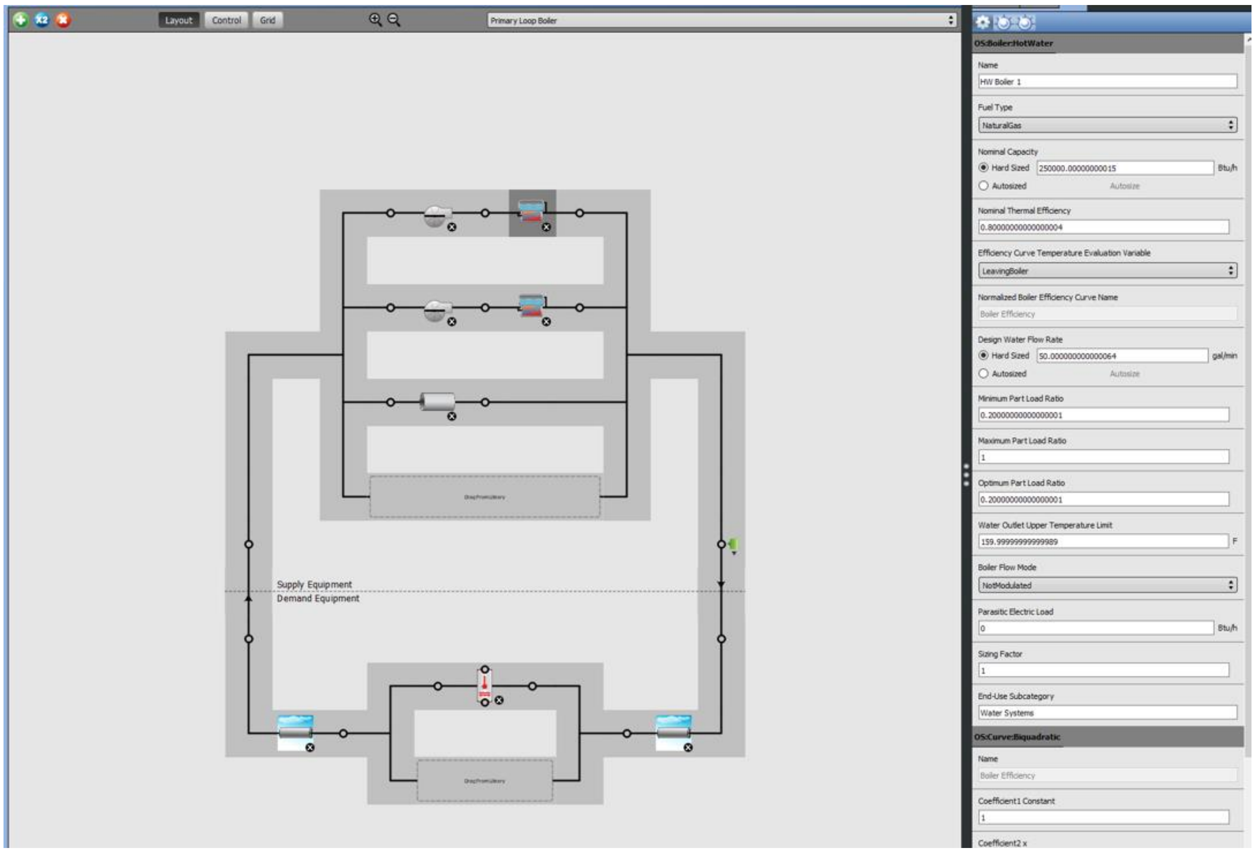
All major assumptions and results are shown in the below table, followed by OpenStudio screenshots of the primary and secondary loops. A sample for the results from the three climate zones is shown in the table.

EnergyPlus Baseline Modeling Inputs

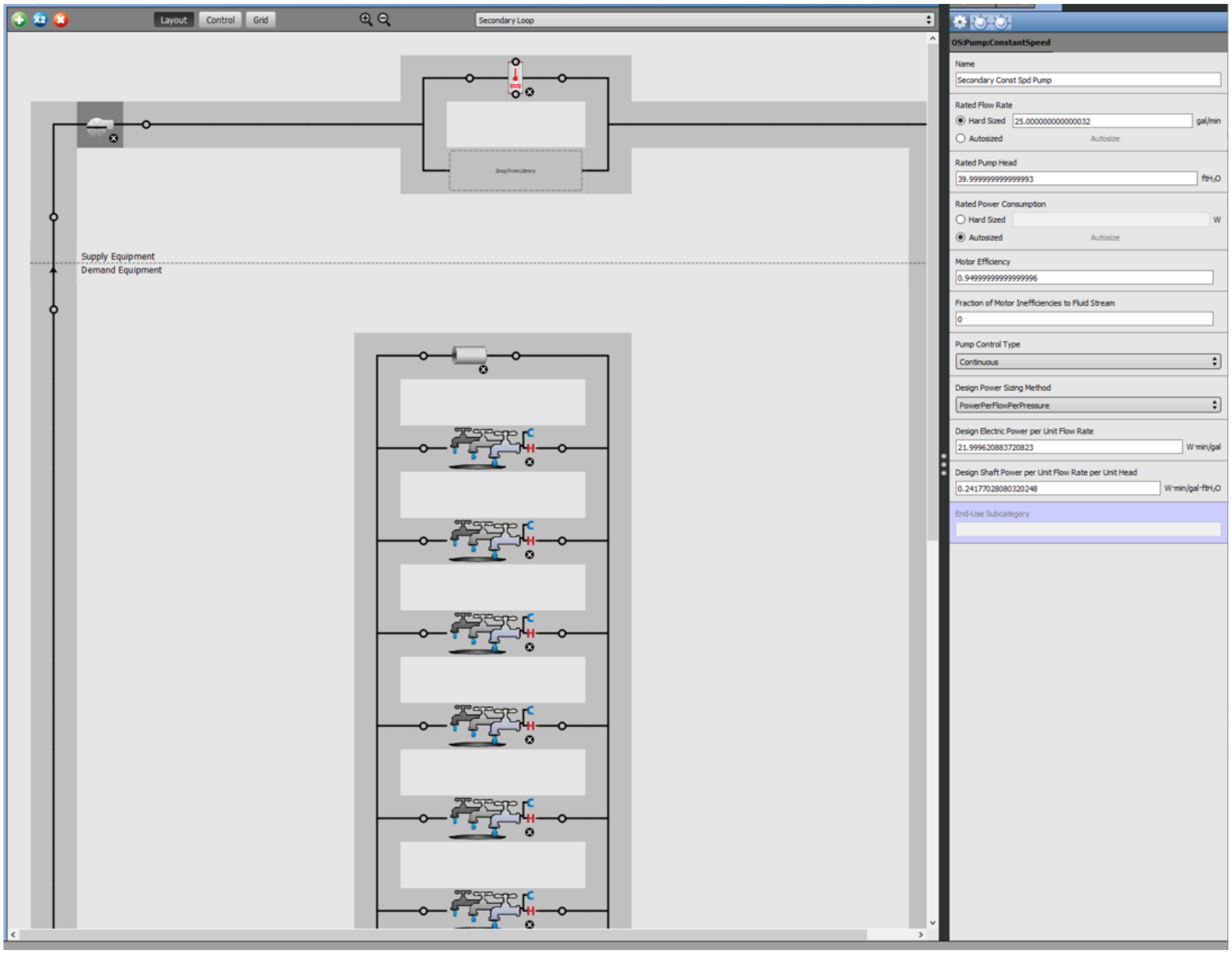
Item	Value
Building Type	Residential multi-family
Climate Zone	California 16 weather zones
Residential Unit Qty.	84 residential units
Water heating system configuration	Primary loop with two gas-fired, non-condensing boilers in parallel, each with its own constant flow pump, that heat an unfired storage tank. The secondary loop has a constant speed pump and only serves domestic hot water uses (no space heating)
Water heating system location	Outdoors
Boiler quantity	2
Boiler input capacity	300 kBtu/hr each (600 kBtu/hr total)
Boiler output capacity	250 kBtu/hr each (500 kBtu/hr total)
Boiler nominal thermal efficiency	0.80
Boiler primary pump flow rate	50 gpm each
Boiler primary pump head	15 feet H_2O
Boiler design temperature delta	250,000/(500*50) = 10°F
Boiler supply water temperature setpoint	130°F
Boiler maximum temperature limit	160°F
Boiler minimum part load ratio	20%
Boiler optimum part load ratio	20%
Boiler maximum part load ratio	1
Tank supply water temperature setpoint and differential temperature	130°F, 5°F temperature differential
Tank loss coefficient to ambient temperature	7.996 Btu/hr-°R
Tank capacity	200 gallons

Tank indirect water heating recovery time	0.25 hr
Secondary pump flow rate	25 gpm
Secondary pump head	40 feet
Hot water usage	All CZ: 65.1 gallons/day/residential unit of 105°F mixed water at fixtures CZ06: 45.9 gallons/day/residential unit of ~130°F hot water CZ09: 44.9 gallons/day/residential unit of ~130°F hot water CZ16: 49.5 gallons/day/residential unit of ~130°F hot water
Domestic hot water gas usage	CZ06: 138.74 therms/yr/residential unit CZ09: 131.98 therms/yr/residential unit CZ16: 168.58 therms/yr/residential unit

Baseline Simulation Primary Loop



Baseline Simulation Secondary Loop



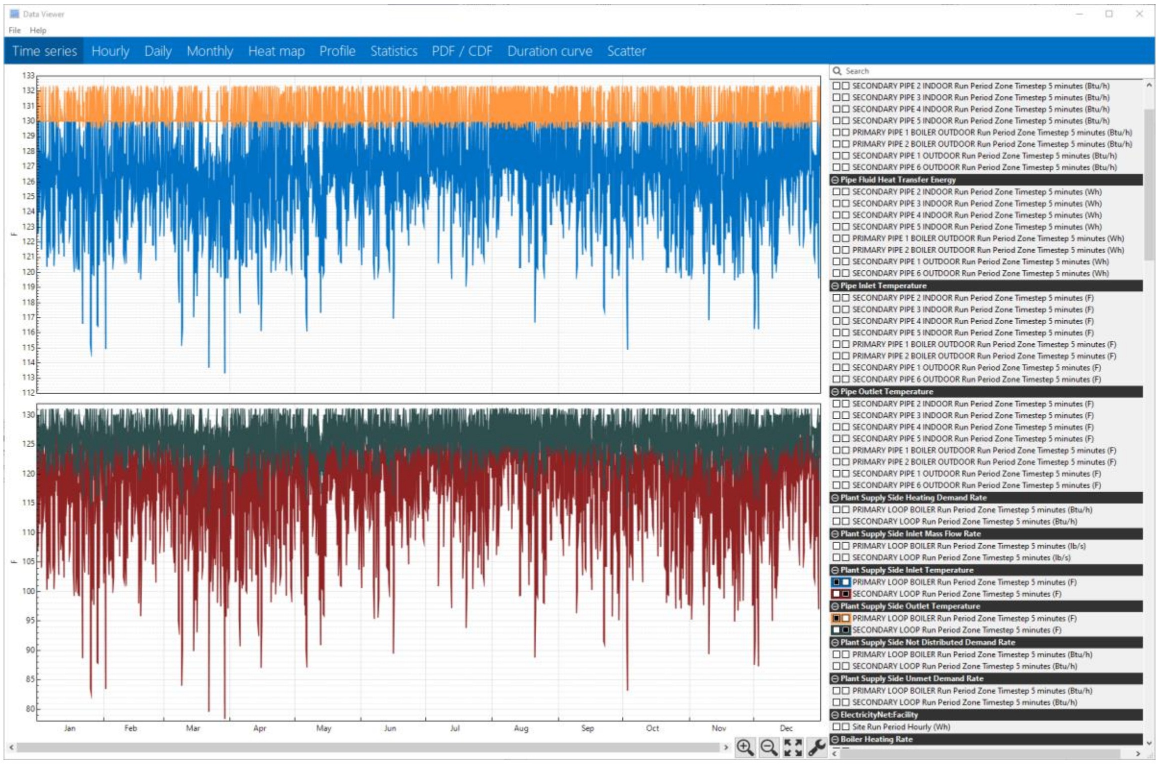


Figure 5: Baseline Case, CZ9, 5-minute intervals, Boiler Loop Inlet and Outlet Temperatures (top), Secondary Loop Inlet and Outlet Temperatures (bottom)

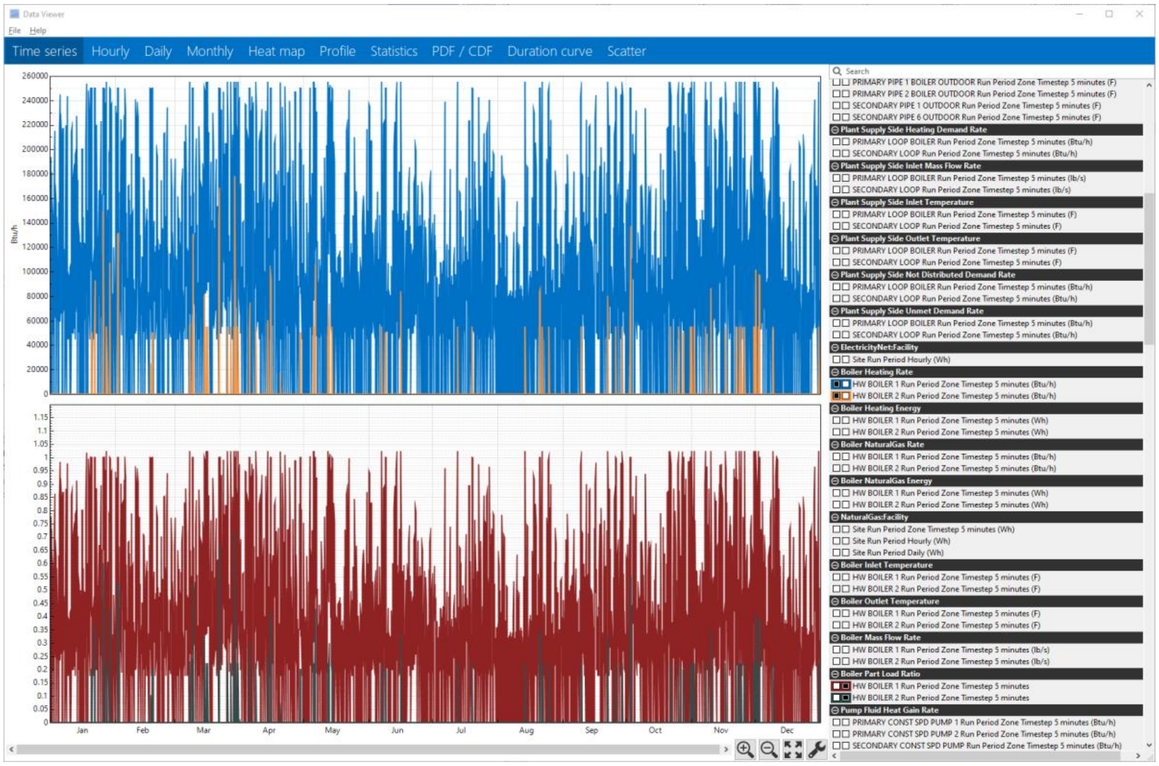


Figure 6: Baseline Case, CZ9, 5-minute intervals, Boiler Heating Rates (top), Boiler Part Load Ratios (bottom)

Measure Case Energy Use Simulation

The measure case model is similar to the baseline model except that a more efficient gas absorption heat pump with a nominal heating efficiency of 1.3 COP was added to represent the GAHP. Due to software limitations, those GAHPs are represented by boilers with fixed efficiency of 1. However, all equipment metrics match the specification of the given commercially available GAHPs to the extent possible. The output capacity matches the nominal output capacity of the GAHP, there is no capacity turndown, the constant flow rate and temperature delta are from an example system spec sheet, and the GAHP was set to run as a baseload equipment before the boilers.

The maximum outlet temperature delta was selected from the spec sheet to force the maximum inlet temperature to not be exceeded. Post-processing in Excel was only required to implement the ambient temperature dependent efficiency curve which often had a COP greater than 1.

Post-processing consisted of a few steps, some of which were only to verify proper modeling results. First, the hourly GAHP heat output was compared to the hourly GAHP inlet temperature to verify that the GAHP did not run when the inlet temperature exceeded the allowed maximum. This was successful for all energy models, so post-processing was not required. Second, the GAHP efficiency curve was created based on the GAHP specifications and the hourly ambient temperature. It was then applied to GAHP heating output to calculate the gas usage, and this result was used in place of the GAHP gas usage data from OpenStudio.

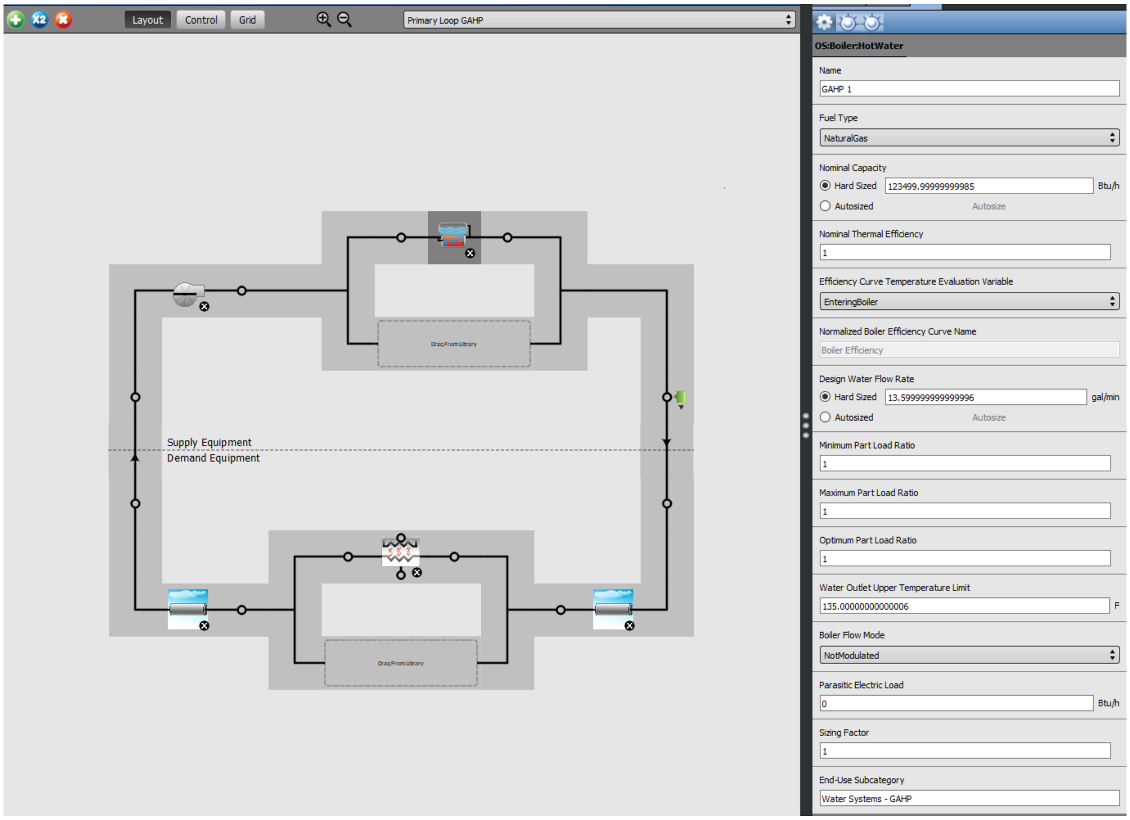
All major assumptions and results are shown in the below table, followed by OpenStudio screenshots of the primary and secondary loops and the GAHP efficiency curve. Sample of the results from the three climate zones are given in the table.

EnergyPlus Measure Case Modeling Inputs

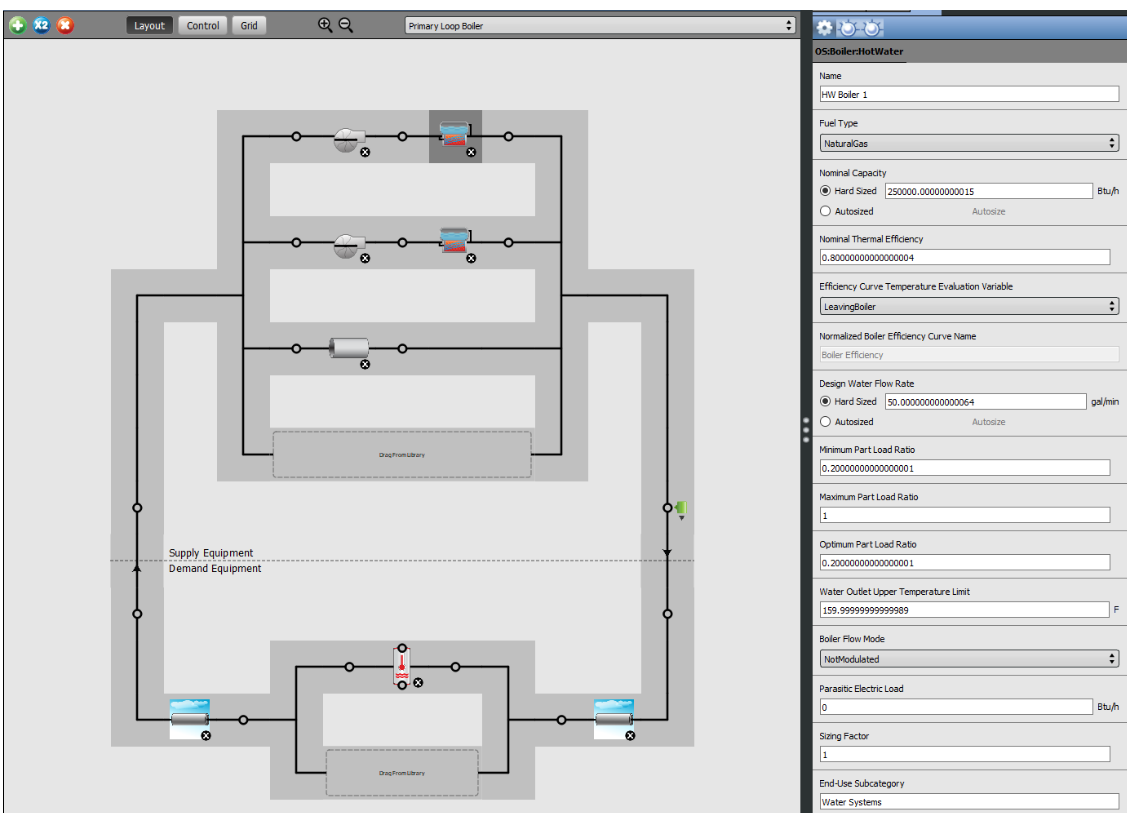
Item	Value
Building Type	Residential multi-family
Climate Zone	California 16 weather zones
Residential Unit Quantity	84 residential units
Water heating system configuration	Primary loop with two gas-fired, non-condensing boilers, with constant speed pumps heating an unfired storage tank, and one GAHP with a constant flow pump connected to a heat exchanger in the secondary loop before the tank. The secondary loop has a variable speed pump and only serves domestic hot water uses (no space heating)
Water heating system location	Outdoors
Boiler quantity	2
Boiler input capacity	300 kBtu/hr each (600 kBtu/hr total)
Boiler output capacity	250 kBtu/hr each (500 kBtu/hr total)
Boiler nominal thermal efficiency	0.80
Boiler primary pump flow rate	50 gpm each
Boiler primary pump head	15 feet H2O
Boiler design temperature delta	250,000/(500*50) = 10°F
Boiler supply water temperature setpoint	130°F
Boiler maximum temperature limit	160°F
Boiler minimum part load ratio	20%
Boiler optimum part load ratio	20%

Boiler maximum part load ratio	1
GAHP quantity	1
GAHP input capacity	95.5 kBtu/hr
GAHP output capacity	123.5 kBtu/hr
GAHP heating efficiency	129%
GAHP primary pump flow rate	13.6 gpm
GAHP primary pump head	15 feet H2O
GAHP design temperature delta	123,500/(500*13.6) = 18.16°F
GAHP supply water temperature setpoint	130°F
GAHP maximum supply temperature limit	135°F (max is 140°F per the GAHP specifications)
GAHP maximum return temperature limit	122°F per the GAHP specifications, but this cannot be entered in OpenStudio
GAHP minimum part load ratio	1
GAHP optimum part load ratio	1
GAHP maximum part load ratio	1
Tank supply water temperature setpoint and differential temperature	130°F, 5°F temperature differential
Tank loss coefficient to ambient temperature	7.996 Btu/hr-°R
Tank capacity	200 gallons
Tank indirect water heating recovery time	0.25 hr
Secondary pump flow rate	2-25 gpm variable speed
Secondary pump head	40 feet
Hot water usage	All CZ: 65.1 gallons/day/residential unit of 105°F mixed water at fixtures CZ06: 48.0 gallons/day/residential unit of ~130°F hot water CZ09: 47.1 gallons/day/residential unit of ~130°F hot water CZ16: 51.4 gallons/day/residential unit of ~130°F hot water
Domestic hot water gas usage	CZ06: 86.62 therms/yr/residential unit CZ09: 81.1 therms/yr/residential unit CZ16: 116.1 therms/yr/residential unit

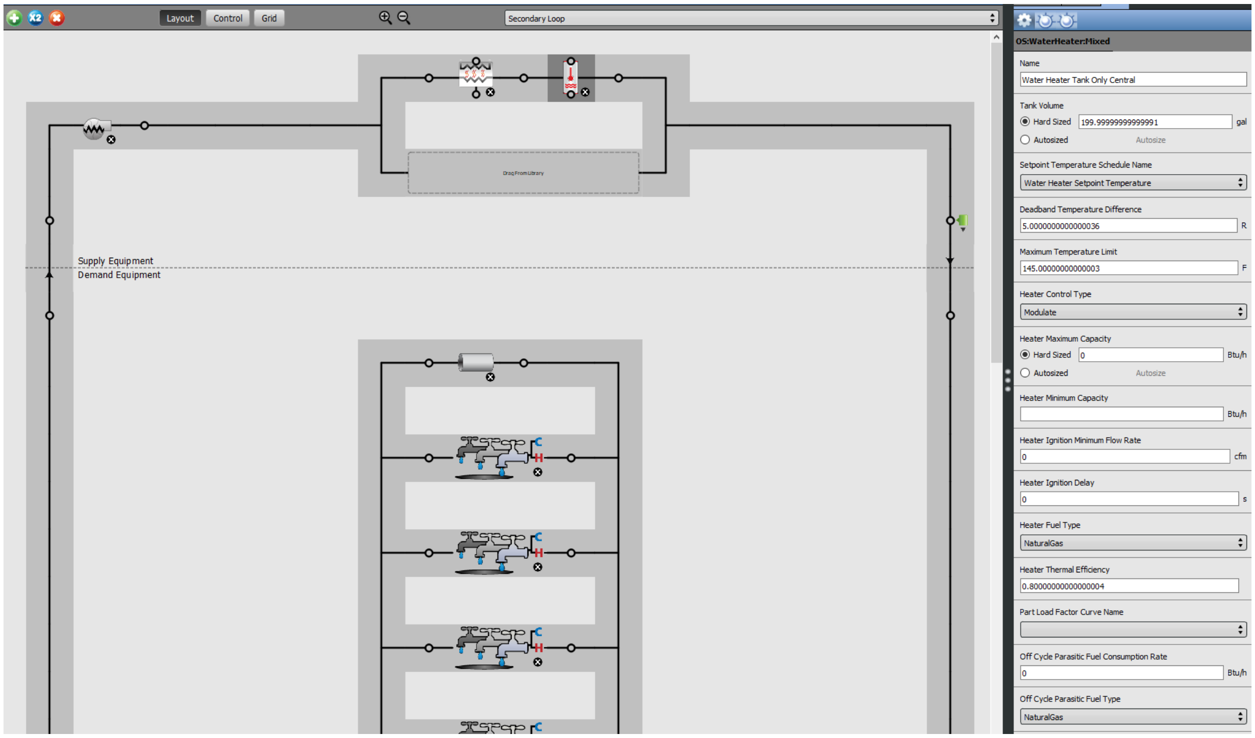
Measure Case Primary Loop GAHP



Measure Case Primary Loop Boiler



Measure Case Simulation Secondary Loop



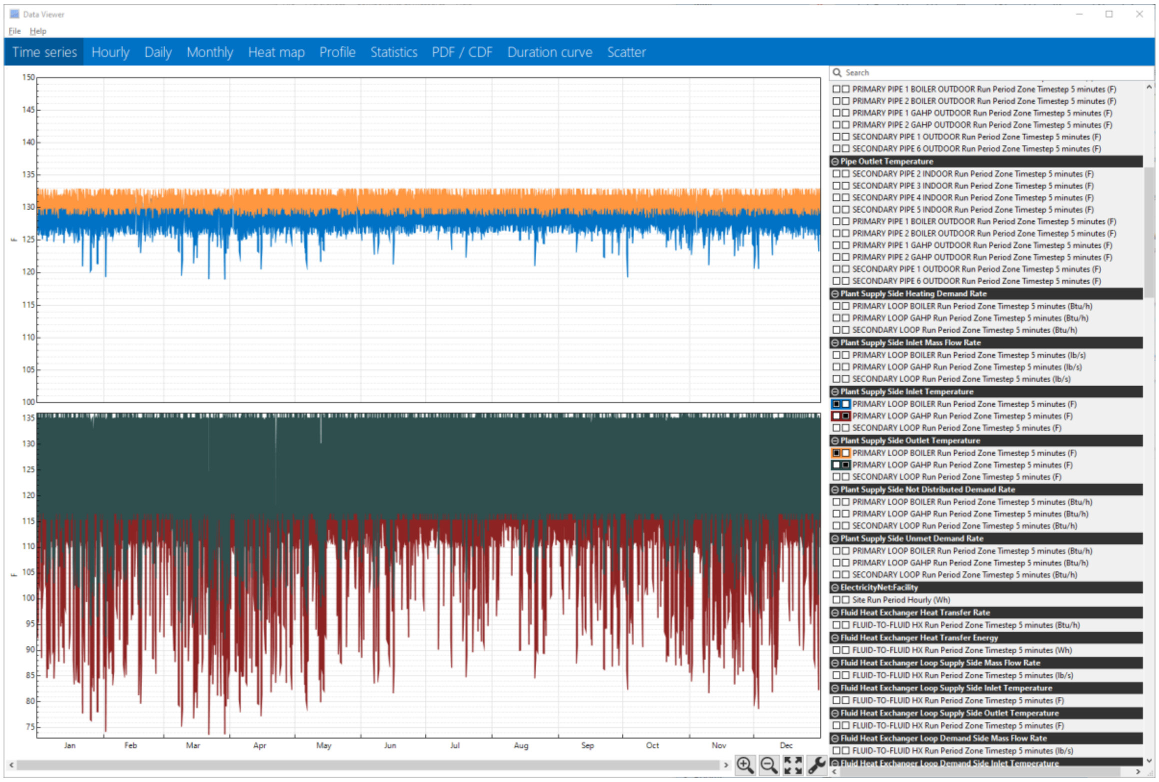


Figure 7: Measure Case, CZ9, 5-minute intervals, Boiler Loop Inlet and Outlet Temperatures (top), GAHP Loop Inlet and Outlet Temperatures (bottom)

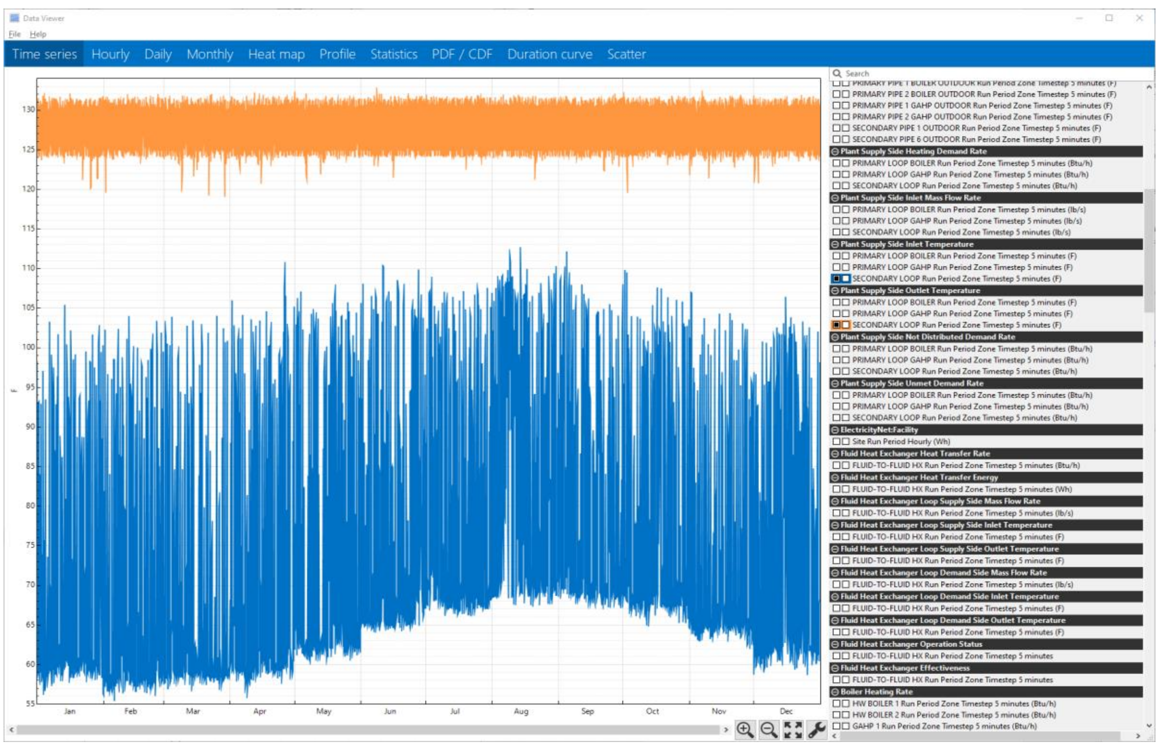


Figure 8: Measure Case, CZ9, 5-minute intervals, Secondary Loop Inlet and Outlet Temperatures

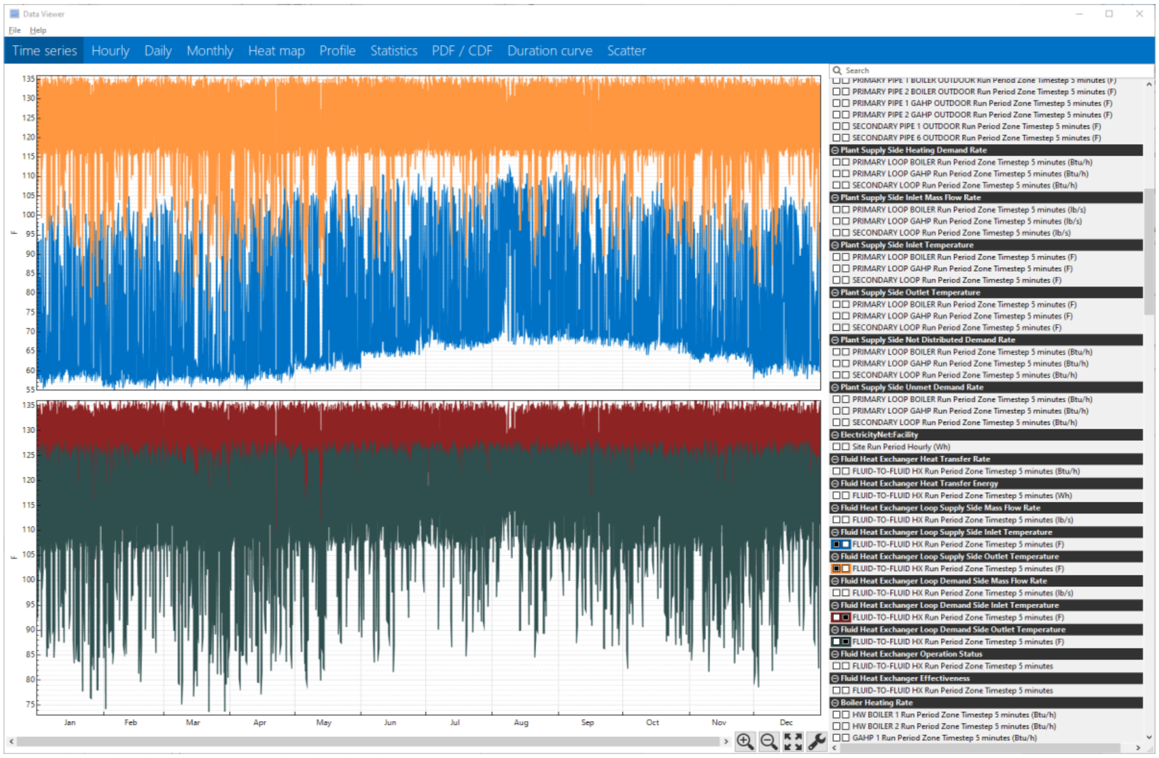


Figure 9: Measure Case, CZ9, 5-minute intervals, HX Loop Supply Side Inlet and Outlet Temperatures (top), HX Loop Demand Side Inlet and Outlet Temperatures (bottom)

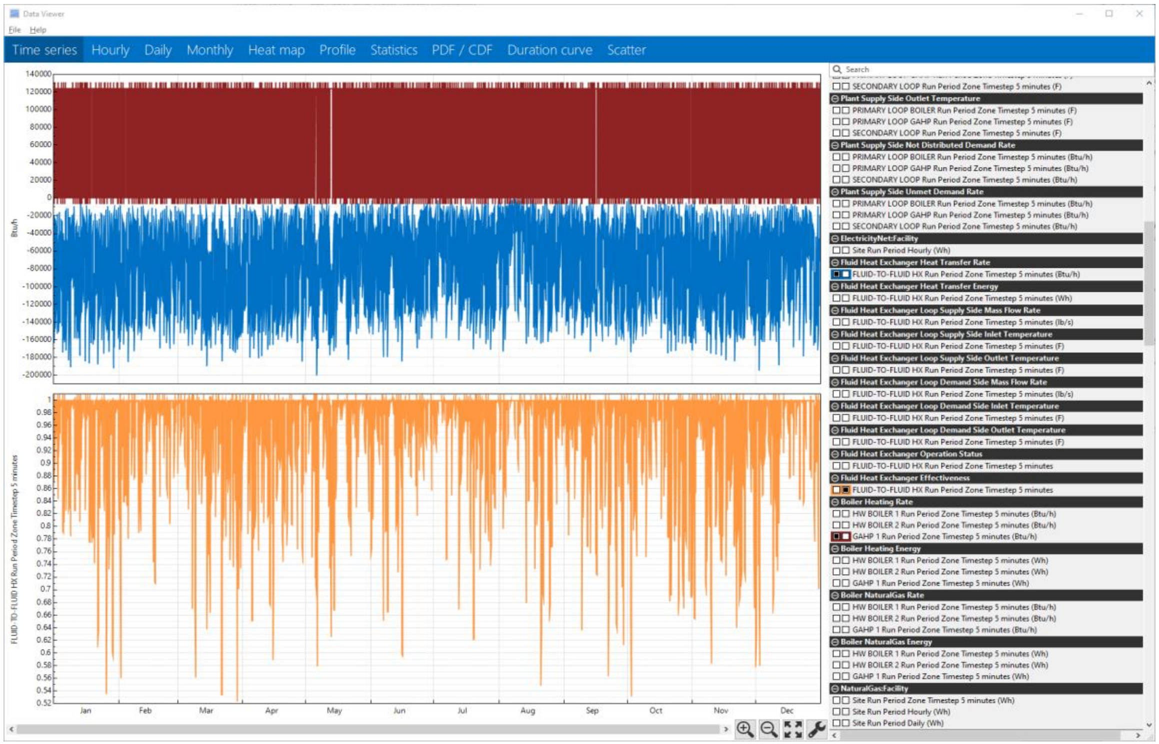


Figure 10: : Measure Case, CZ9, 5-minute intervals, HX Heat Transfer Rate & GAHP Heating Rate (top), HX Effectiveness (bottom)

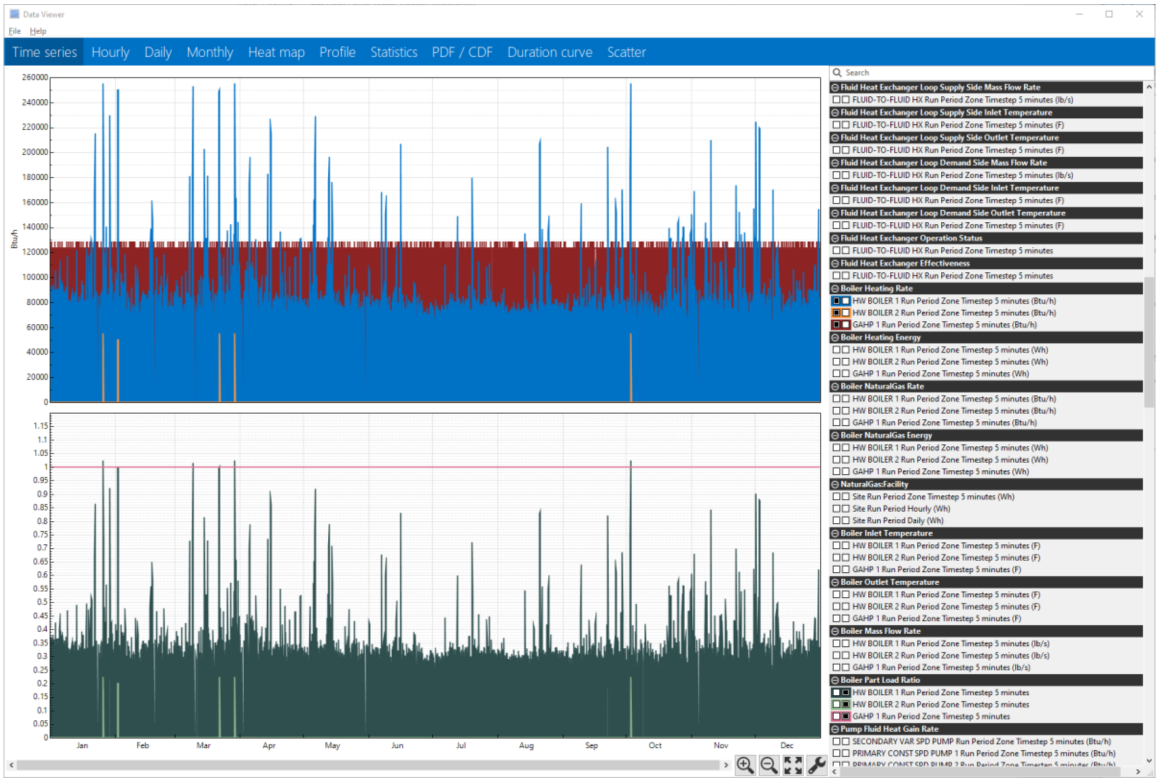


Figure 11: Measure Case, CZ9, 5-minute intervals, Boiler & GAHP Heating Rates (top), Boiler & GAHP Part Load Ratios (bottom)

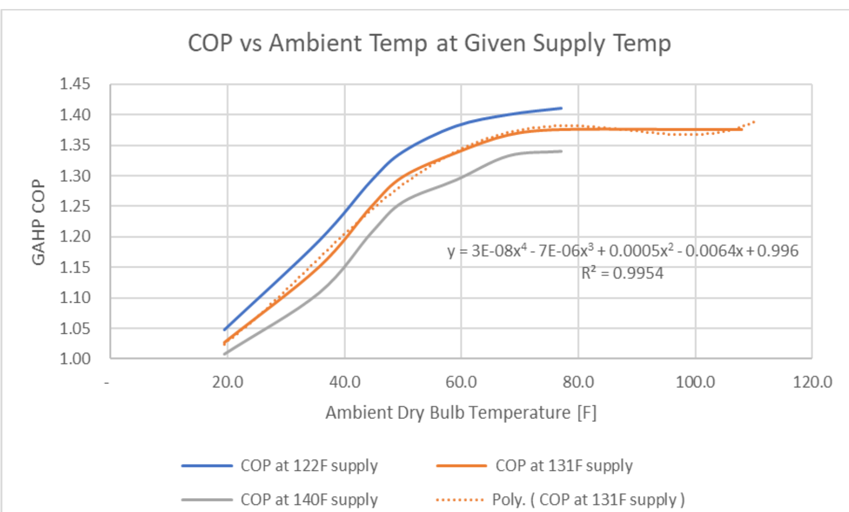


Figure 12: GAHP Efficiency Curve (the trendline was used)

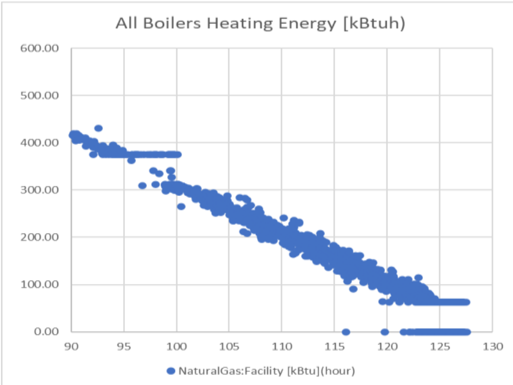


Figure 13: Base Case: CZ09 All Heating Plant Energy

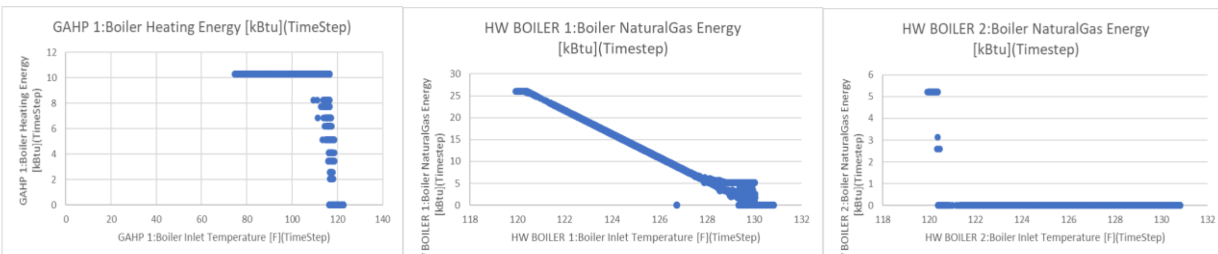


Figure 14: Measure Case: CZ09 Heating Energy Use by Equipment

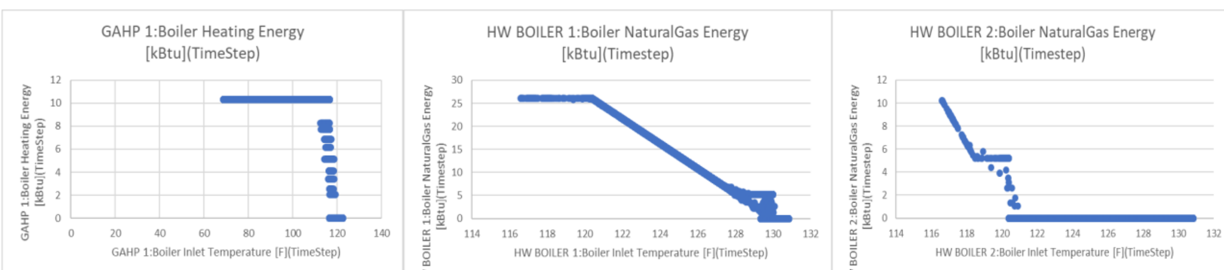


Figure 15: Measure Case: CZ03 Heating Energy Use by Equipment

Unit Energy Savings

Gas unit energy savings (UES) values were derived using the methodology presented in the Energy Use Simulation.

Climate Zone	UES Gas (Therm/kBtuh)
1	47.52
2	46.01
3	46.80
4	45.77
5	46.72
6	45.84
7	45.29
8	44.88
9	44.80
10	44.35
11	44.23
12	45.05
13	43.77
14	44.39
15	38.89
16	46.20

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The estimated lifetime is expected to exceed 15 years. Since EUL of gas heat pump are not available from the Database of Energy Efficient Resources (DEER), the estimated life of a high efficiency multifamily central water heater is adopted for this measure.

The EUL and RUL specified for this measure are presented below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures and is not applicable for this measure.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	15.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs)	n/a	-

BASE CASE MATERIAL COST ($/UNIT)

The base case material case was calculated as the average of different manufacturer suggested retail prices (MSRPs) **of an equal hot water boiler output capacity size category**.

Hot Water Boiler Plant: ***Hot Water Boiler @ 135 kBtuh 84% AFUE Output cap., 160 kBtuh gas input***

One (1) Weil-McLain Nat. gas HW boiler model# CGi-6

Boiler Cost	*$ 2,960*
Misc. (Primary Pump) Cost	*$ 700*
Material cost	***$ 3,660***
	$22.90 per kBtuh input cap.

MEASURE CASE MATERIAL COST ($/UNIT)

The measure case cost is equal to the manufacturer suggested retail price (MSRP) for the Gas Absorption heat pump and supporting system equipment: primary/secondary pumps, buffer tank, and miscellaneous.

Gas absorption heat pump: ***(Robur) model GAHP-A, 123.5 kBtuh Output cap., 95.5 kBtuh gas input, (COP=1.3)***

One (1) Robur GAHP-A heating only unit $10,821

1-Primary Pumps 95906630 UPS 26 150F $700

*$**11,521** equipment cost to contractor*

$120.64 per kBtuh input cap.

BASE CASE LABOR COST ($/UNIT)

The installation cost for the HW boiler is assumed to be:

Labor Cost *$ 2,864 (HW boiler workpaper $17.90 x 160 kBtuh input)*

$17.90 per kBtuh input

MEASURE CASE LABOR COST ($/UNIT)

The installation cost for the GAHP is assumed to be:

Labor estimated 150-160% increased cost in installation

Labor cost $5,761

$60 per kBtuh input

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The relevant NTG values for this measure are specified in below.

Net-to-Gross Ratios

Parameter	Value	Source
All-Default<=2yrs	0.70	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current "default" rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

Parameter	Value	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY IMPACTS

Non-energy benefits for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	No
DEER Operating Hours	No
DEER eQUEST Prototypes	No
DEER Version	n/a
Reason for Deviation from DEER	This measure is not in DEER.
DEER Measure IDs Used	n/a
NTG	Source: DEER. The NTG of 0.70 is associated with NTG ID: *All-Default<=2yrs*
GSIA	Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	The value of 15 years is associated with EUL ID: *WtrHt-MF-Gas*

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	8/27/2021	Raad Bashar, SoCalGas	New workpaper.
	10/11/2021	Anders Danryd, Engineer SoCalGas	Removed electric savings from workpaper since these come from the secondary loop pump
	12/9/2021	Anders Danryd, Engineer SoCalGas	Added reference files with modeling assumptions and post processing data
	1/18/2022	Anders Danryd, Engineer SoCalGas	Text edits in response to CPUC comments
	2/28/2022	Anders Danryd, Engineer SoCalGas	Added sizing system sizing and building size criteria to the program requirements section