Commercial Gas Water Heaters in the Real World

Case Study

Presented at the 2019 ACEEE Hot Water Forum

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AGENDA

- Introductions
- ICE Heat Pump Trial
- Gas Absorption Heat Pump Replacement
- Design Challenges
- Next Steps

NEEA: NATURAL GAS COLLABORATIVE GOAL

To accelerate the development and market adoption of efficient natural gas products, practices and services resulting in

INCREASED CONSUMER CHOICES and INCREASED EFFICIENCY OF NATURAL GAS USE in the Northwest.

ENERGY 350

- 28 person firm based in Portland, OR
- Energy Efficiency Program Deployment & Support
- Building Tuning/RCx/SEM
- Energy Studies
- Research & Evaluation

Oregon Business 100 Best companies to work for in Oregon

CELEBRATING 10 YEARS!
Oregon Business 100 Best green WORKPLACES IN OREGON 2018

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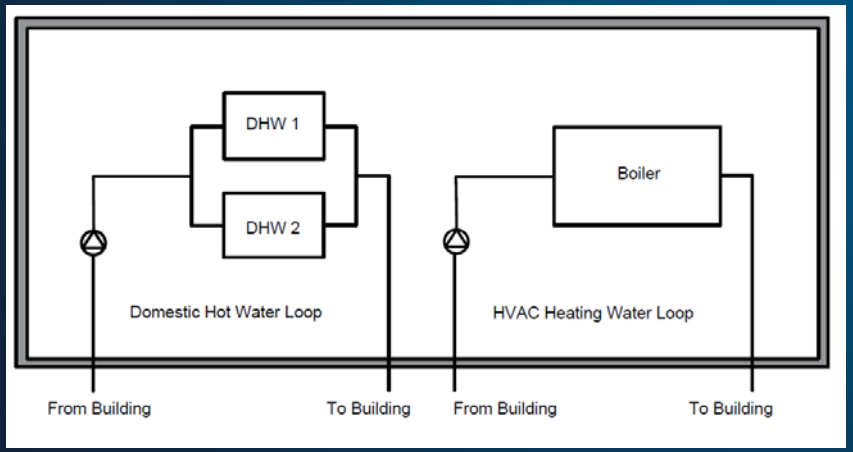
CAPITAL MANOR



Baseline Equipment	Capacity (kBtu/hr)	Nominal Efficiency	Measured Efficiency
HHW Boiler	1,900	80%	74%
DHW Heater	587	82%	68%

INTERNAL COMBUSTION ENGINE HEAT PUMP

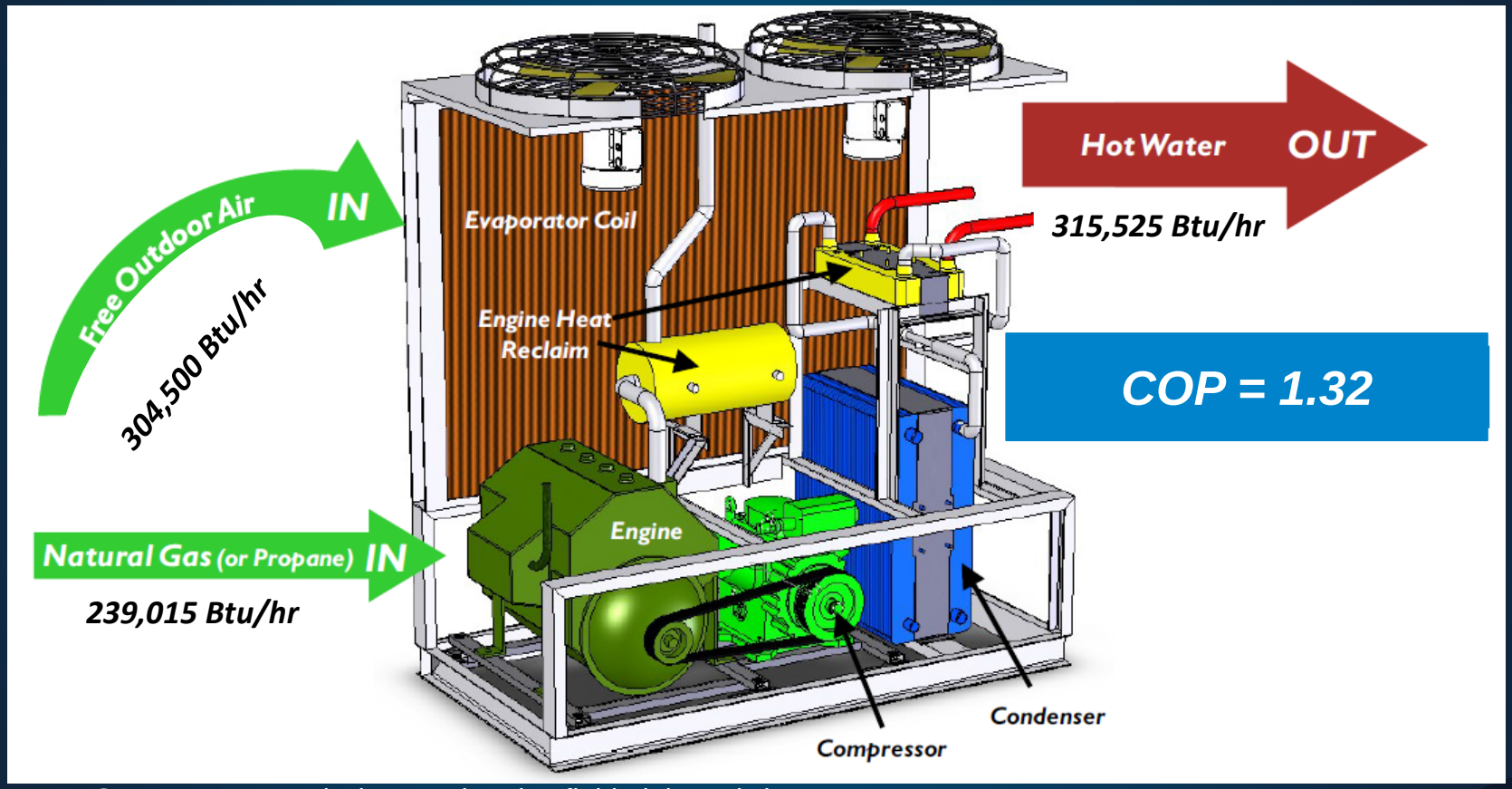
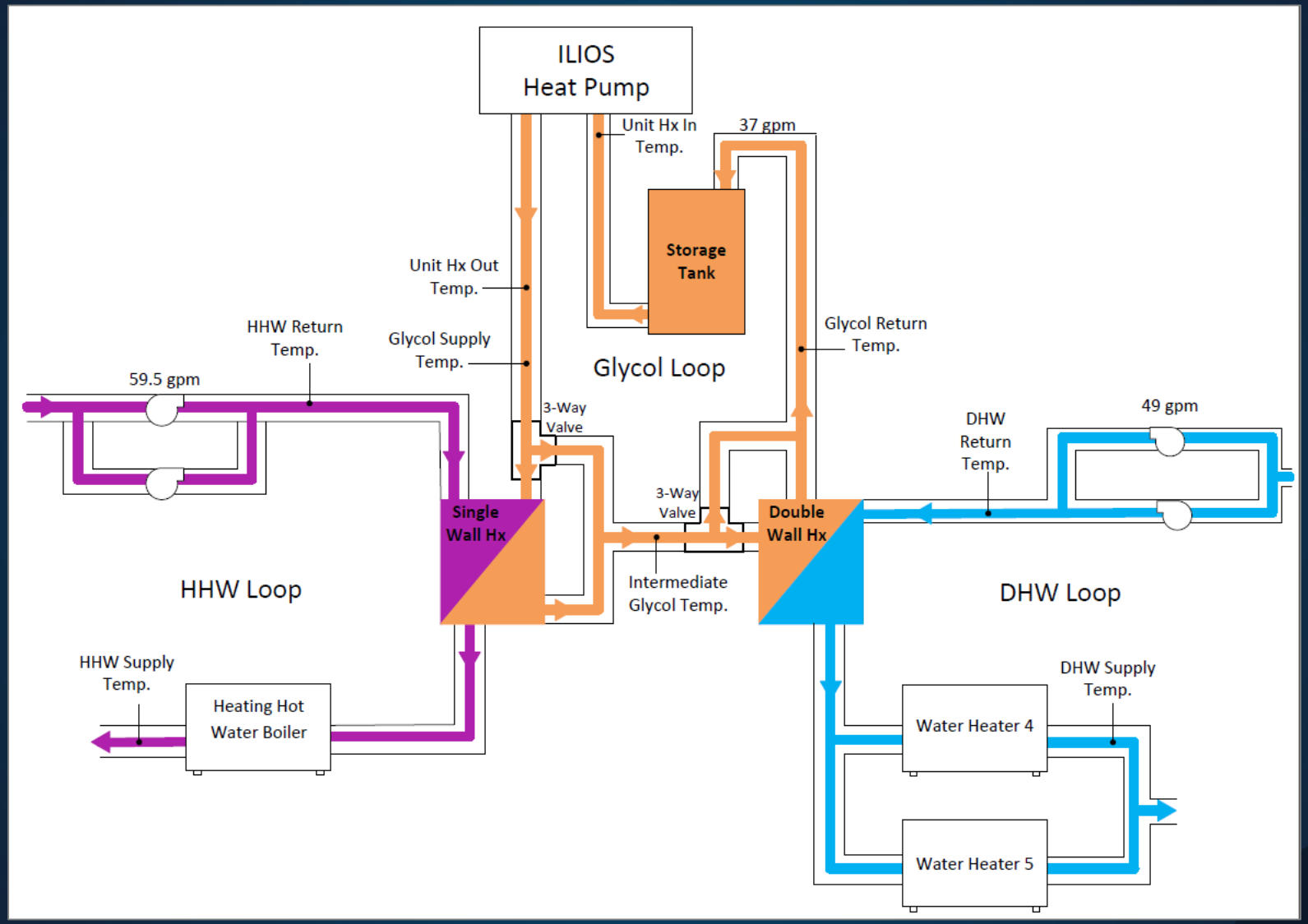


Image Source: Tecogen (values updated to field trial results)

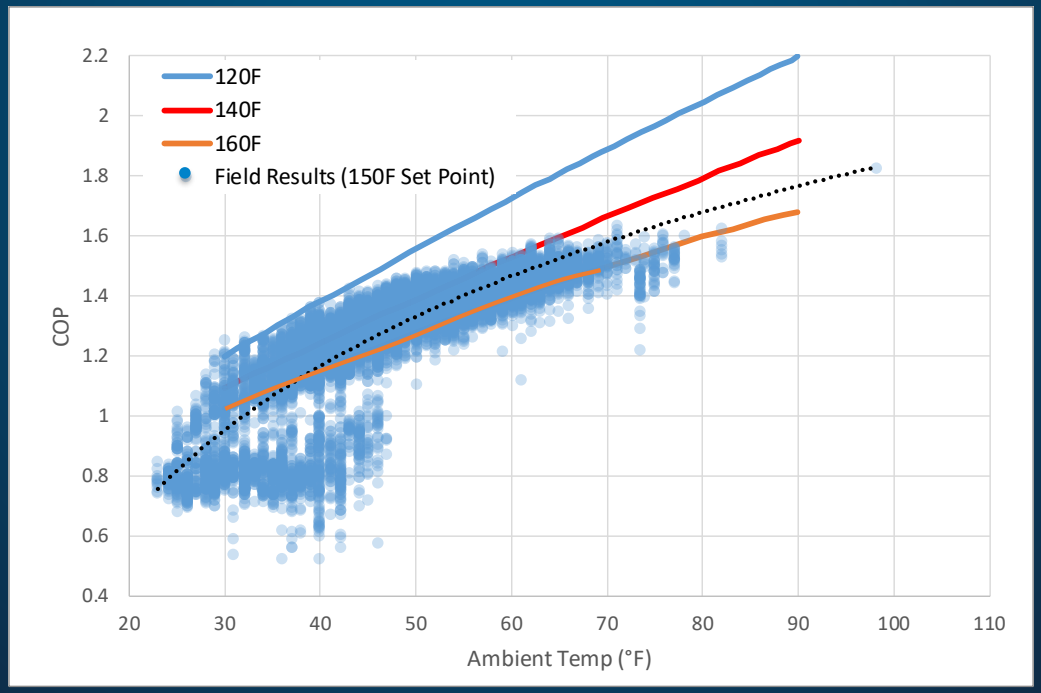
AS-BUILT SCHEMATIC



INSTALLATION

PERFORMANCE RESULTS

Overall COP	Average Capacity (Btu/hr)	COP @ 40°F Ambient	COP @ 75°F Ambient	Capacity @ 40°F Ambient (Btu/hr)	Capacity @ 75°F Ambient (Btu/hr)
1.34	315,525	1.01	1.50	220,535	401,519



ECONOMIC RESULTS

NWN Schedule:	32CSF	
Energy Cost:	$0.5712 /therm	
Baseline Annual Gas Consumption (Therms)	**Performance Gas Consumption (Therms)**	**Annual Gas Savings (Therms)**
28,759	17,409	11,350

ILIOS FAILURE

Contained Fire

No Safety Issues

Forensic Investigation

Unit Unrecoverable

REPLACEMENT HEAT PUMP

- DHW and HHW
- Efficiency > 120%
- Fit Existing Pad
- Utilize Existing Heat Exchanger System

Image Source:
www.sierrafas.com

Image Source:
www.roburcorp.com

Image Source:
www.yanmar-es.com/

GAS FIRED ABSORPTION HEAT PUMP

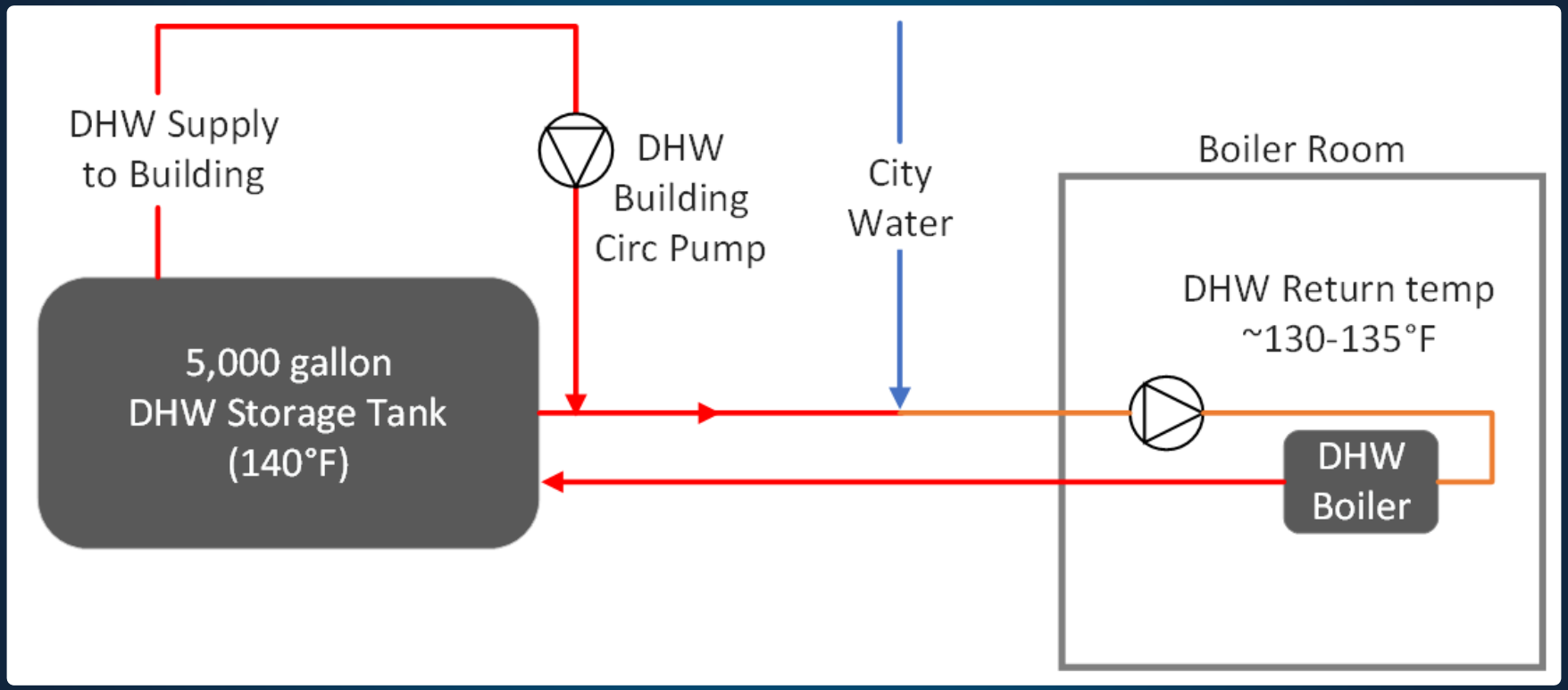
- **HW up to 140°F**
- **Efficiency up to 129%**
- **Nominal Heat Output: 123,500 Btu/hr**
- **Modular and Scalable**

Image Source: www.roburcorp.com

CHALLENGES TO OVERCOME

- **Robur: max return temperature of 122°F**
- **Max hot water supply temperature 140°F**

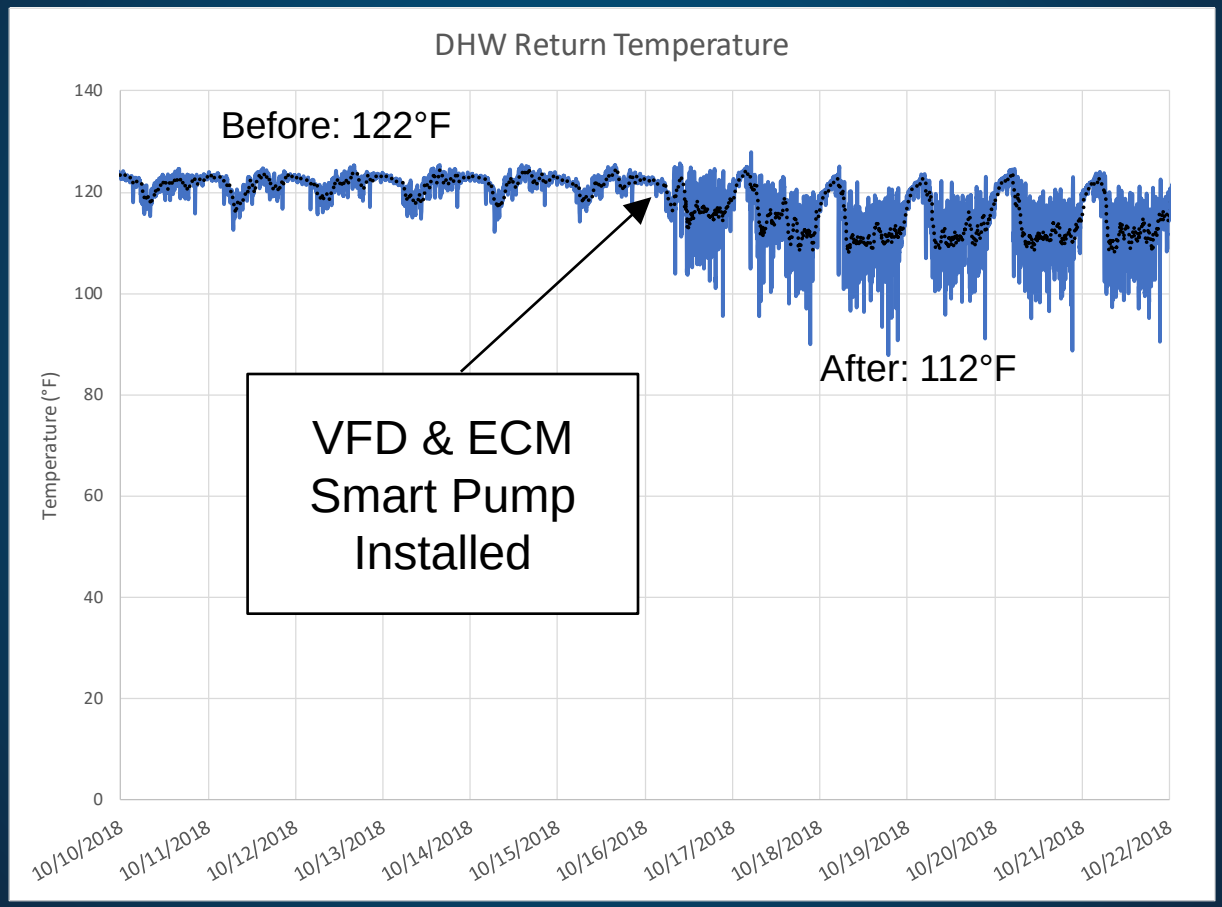
DOMESTIC HW LOOP



MINIMIZING RETURN TEMPERATURE TO GAHPS

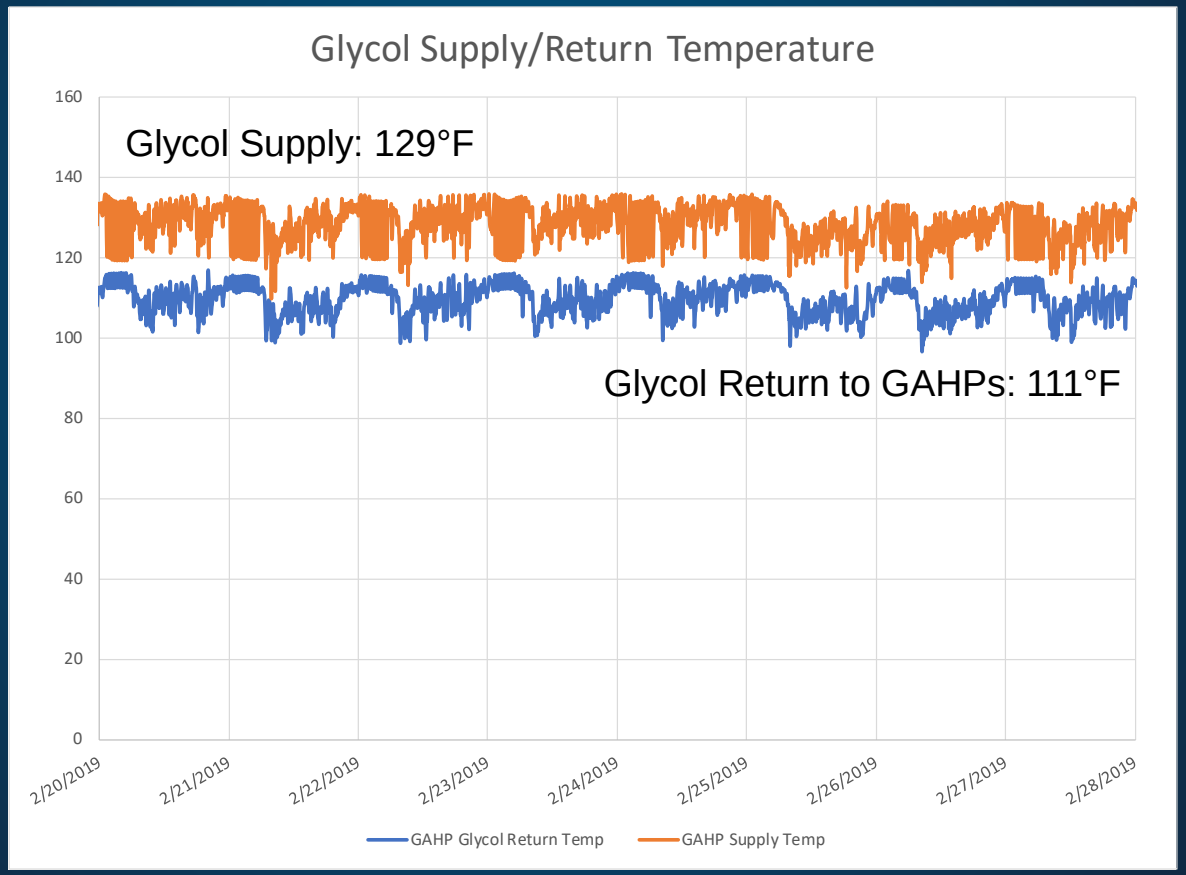
- **Installed VFDs on DHW loop pumps**
- **Replaced DHW circ pump with ECM**
- **Aggressively lowered HHW reset Temp**

DHW RETURN TEMPERATURE WAS SIGNIFICANTLY REDUCED



INSTALLED AND COMMISSIONED

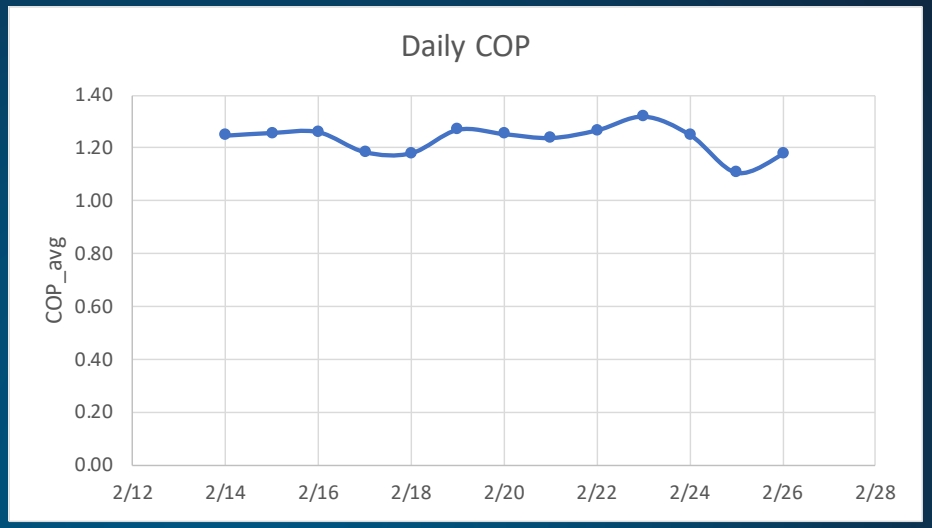
GAHP RETURN TEMPERATURE HAS HELD COMFORTABLY BELOW 122°F

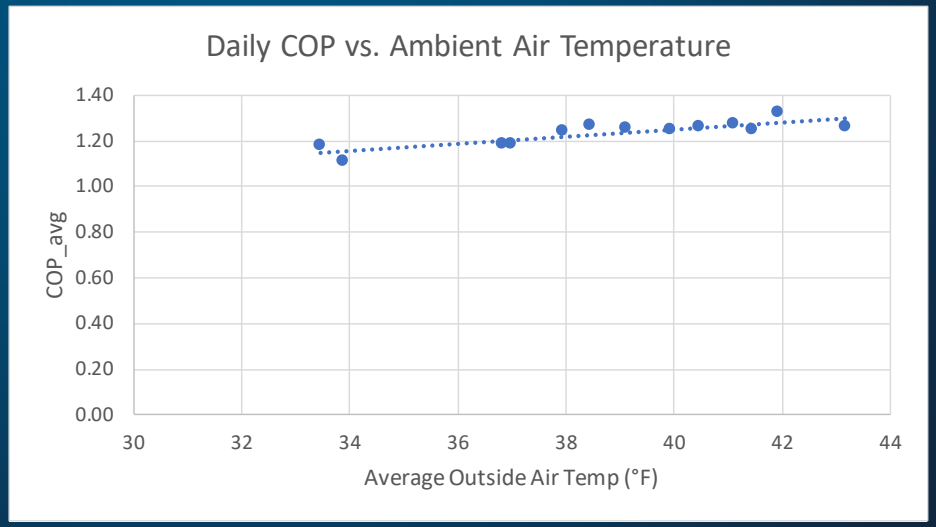


PRELIMINARY PERFORMANCE

GUE = 1.27
(Gas Input Only)

COP = 1.23
(Includes GAHP Electric Input)





NEXT STEPS

- **Monitor** GAHP performance through end of 2019
- **Analyze** annual performance
- **Report** performance results along with economic findings

THANK YOU !

Questions?

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APPENDIX

Gas Absorption Cycle

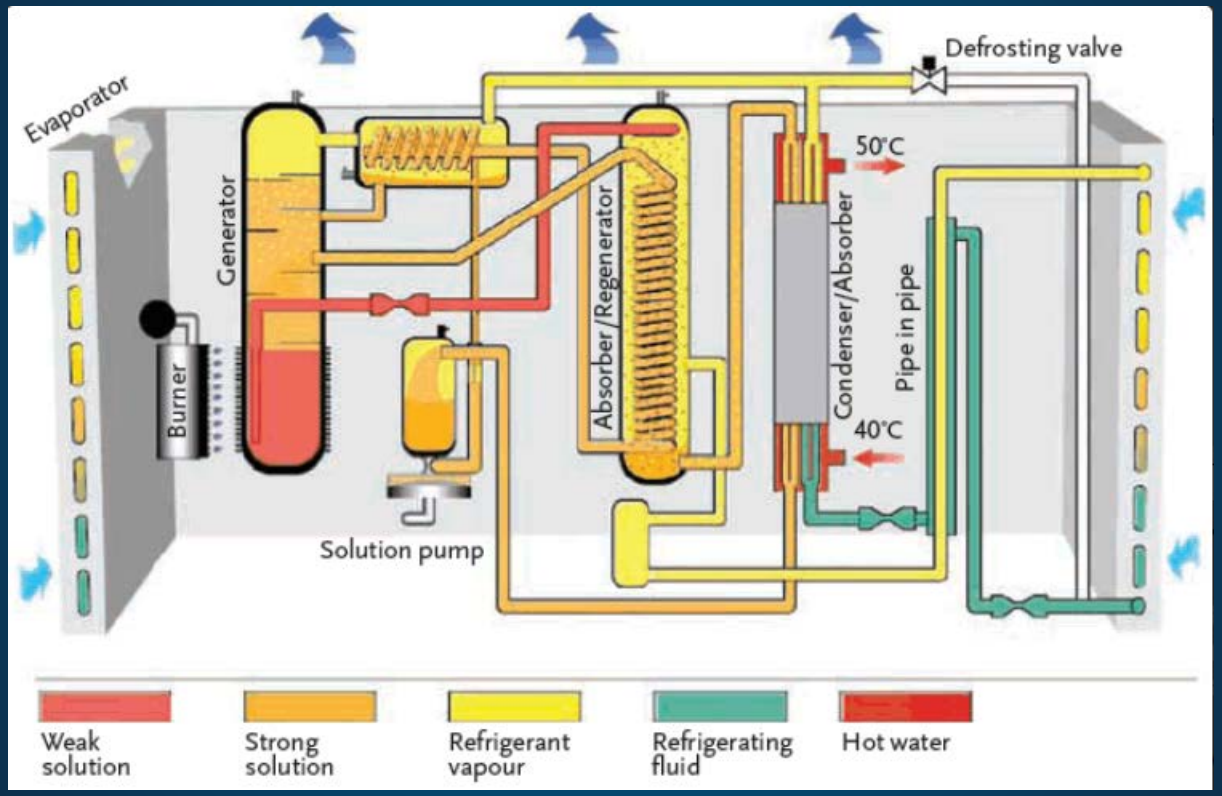
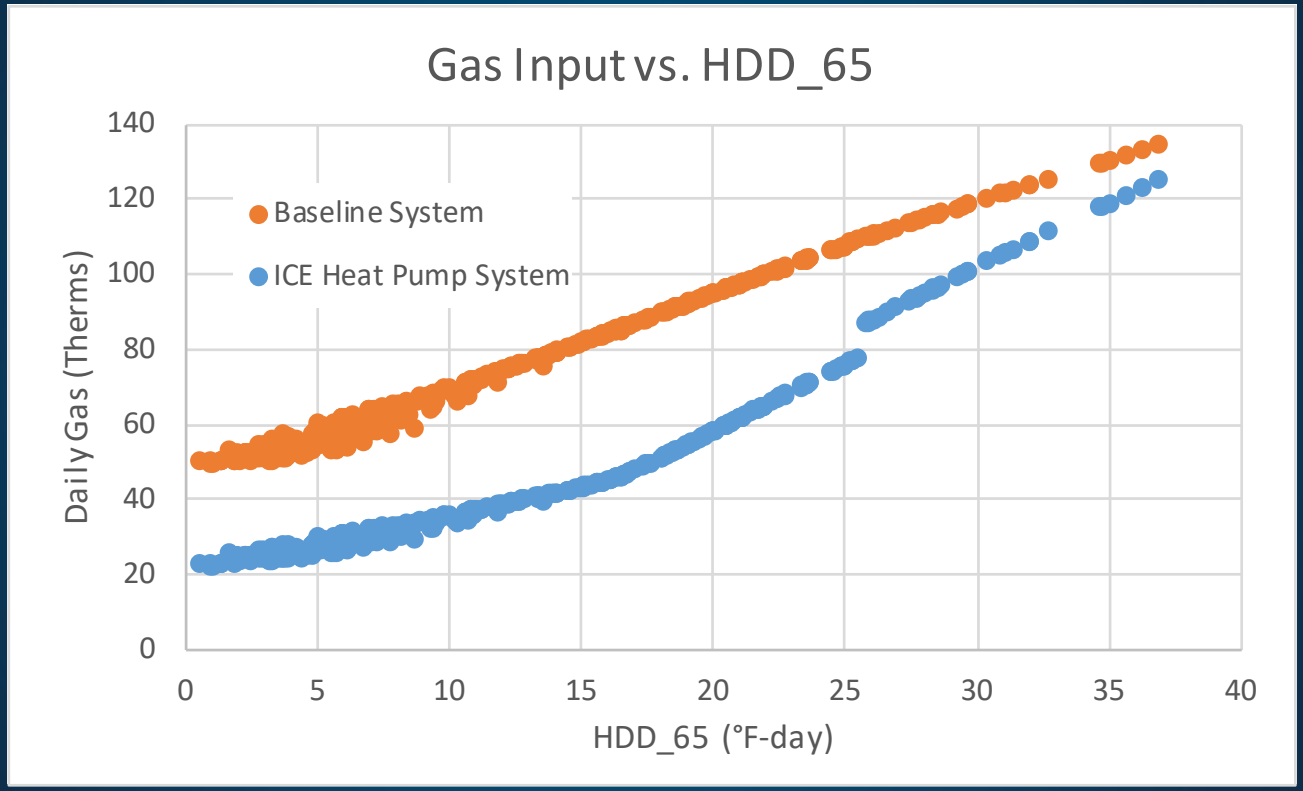


Image Source: www.roburcorp.com

ICE HEAT PUMP SYSTEM PERFORMANCE



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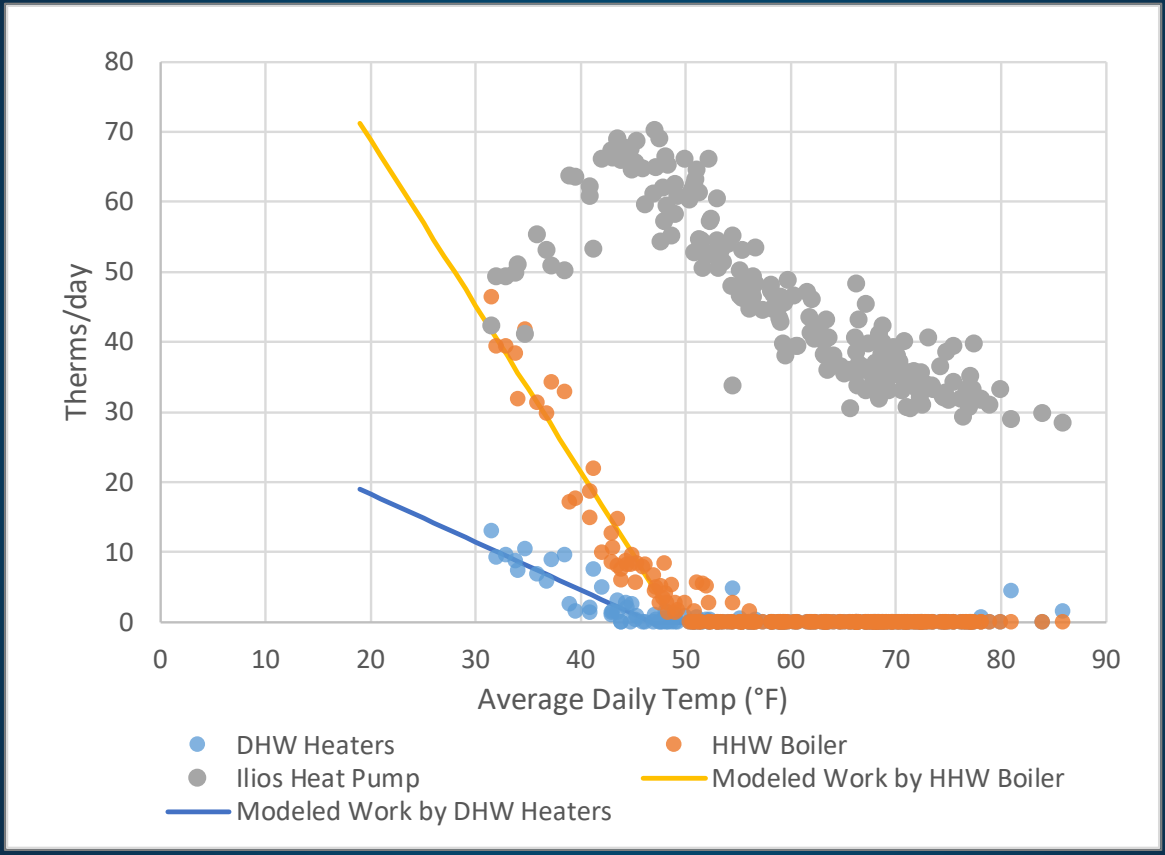
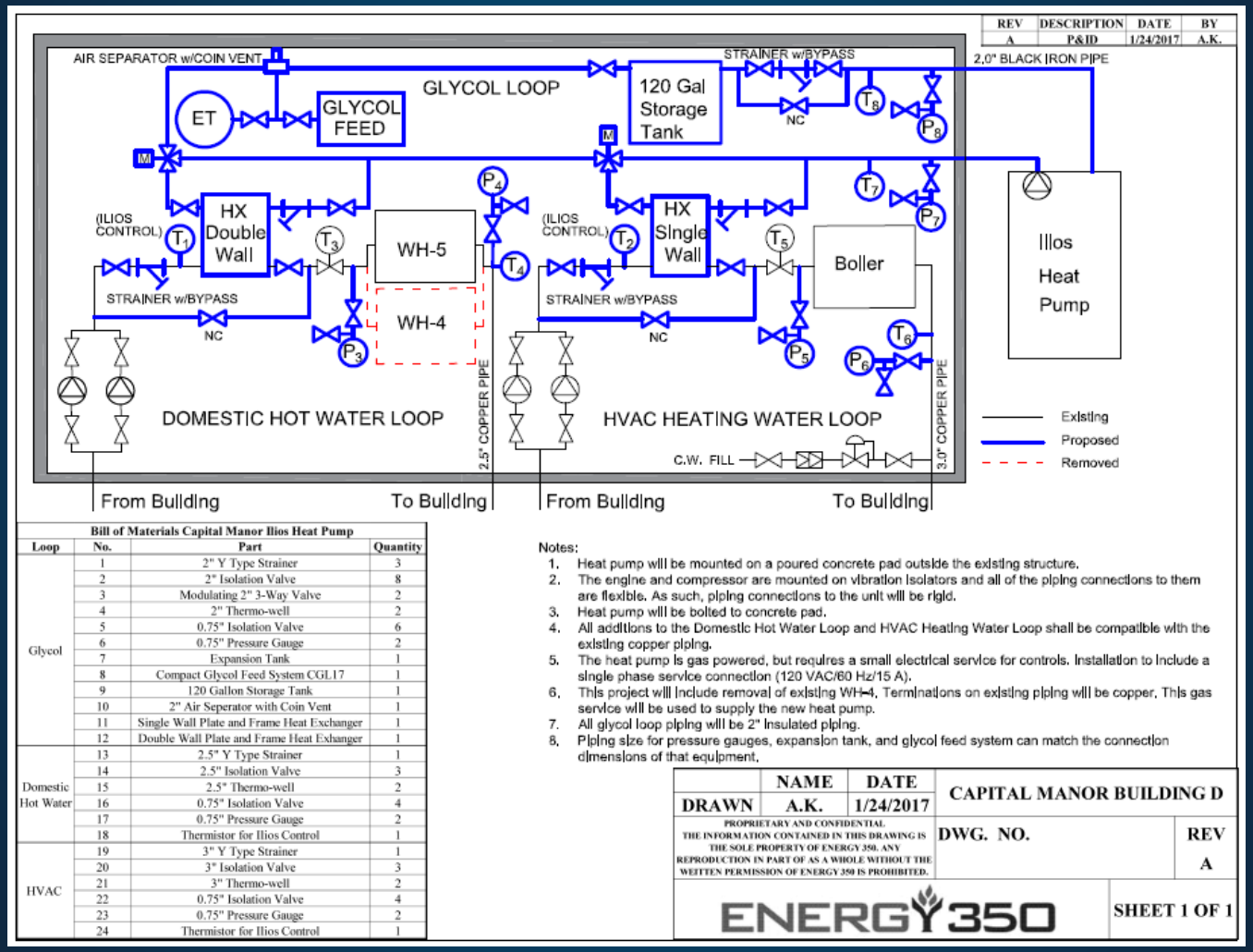


DESIGN SCHEMATIC



Bill of Materials Capital Manor Ilios Heat Pump

Loop	No.	Part	Quantity
Glycol	1	2" Y Type Strainer	3
	2	2" Isolation Valve	8
	3	Modulating 2" 3-Way Valve	2
	4	2" Thermo-well	2
	5	0.75" Isolation Valve	6
	6	0.75" Pressure Gauge	2
	7	Expansion Tank	1
	8	Compact Glycol Feed System CGL17	1
	9	120 Gallon Storage Tank	1
	10	2" Air Seperator with Coin Vent	1
	11	Single Wall Plate and Frame Heat Exchanger	1
	12	Double Wall Plate and Frame Heat Exhanger	1
Domestic Hot Water	13	2.5" Y Type Strainer	1
	14	2.5" Isolation Valve	3
	15	2.5" Thermo-well	2
	16	0.75" Isolation Valve	4
	17	0.75" Pressure Gauge	2
	18	Thermistor for Ilios Control	1
HVAC	19	3" Y Type Strainer	1
	20	3" Isolation Valve	3
	21	3" Thermo-well	2
	22	0.75" Isolation Valve	4
	23	0.75" Pressure Gauge	2
	24	Thermistor for Ilios Control	1

Notes:

1. Heat pump will be mounted on a poured concrete pad outside the existing structure.
2. The engine and compressor are mounted on vibration isolators and all of the piping connections to them are flexible. As such, piping connections to the unit will be rigid.
3. Heat pump will be bolted to concrete pad.
4. All additions to the Domestic Hot Water Loop and HVAC Heating Water Loop shall be compatible with the existing copper piping.
5. The heat pump is gas powered, but requires a small electrical service for controls. Installation to include a single phase service connection (120 VAC/60 Hz/15 A).
6. This project will include removal of existing WH-4. Terminations on existing piping will be copper. This gas service will be used to supply the new heat pump.
7. All glycol loop piping will be 2" insulated piping.
8. Piping size for pressure gauges, expansion tank, and glycol feed system can match the connection dimensions of that equipment.

	NAME	DATE	CAPITAL MANOR BUILDING D
DRAWN	A.K.	1/24/2017	

DWG. NO. | REV A

ENERGY 350 | SHEET 1 OF 1

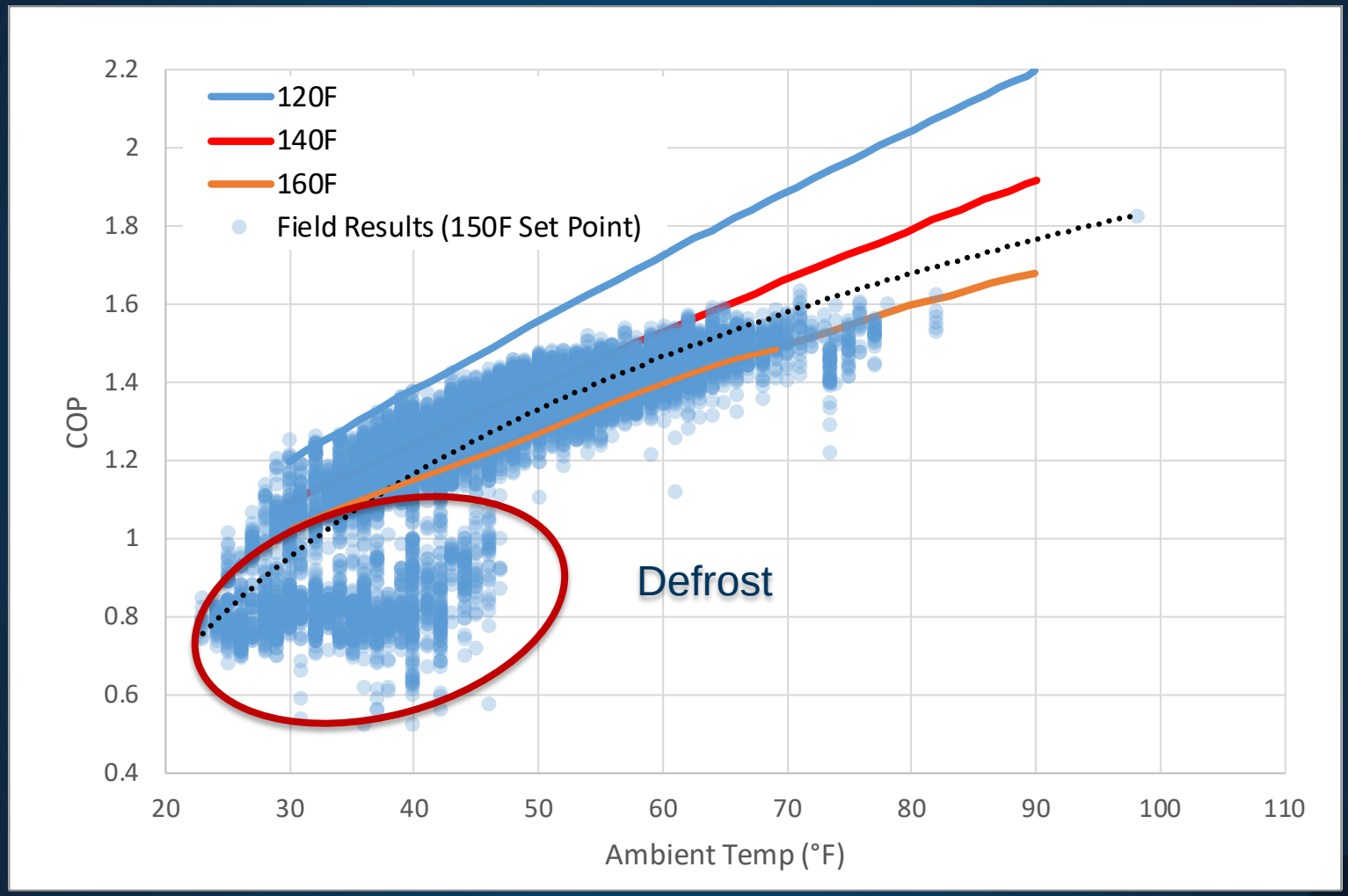
ECONOMIC RESULTS

NWN Schedule:	32CSF
Energy Cost:	$0.5712 /therm

Baseline Annual Gas Consumption (Therms)	Performance Gas Consumption (Therms)	Annual Gas Savings (Therms)	Annual Gas Savings ($)	Annual Maintenance Costs ($)	Total Project Costs	Simple Payback (Years)
28,759	17,409	11,350	$6,483	$2,167	$138,927	32.2

Simple Payback (Years)	Maintenance Excluded Payback (Years)	Low Gas Price Payback (Years)	Medium Gas Price Payback (Years)	High Gas Price Payback (Years)	Optimal Scenario Payback (Years)
32.2	21.4	26.5	19.2	15.4	9.8

PERFORMANCE RESULTS



ADDED VFD TO DHW PUMPS & REPLACED CIRCULATOR PUMP WITH ECM SMART PUMP