Converting The University of Virginia District Steam & MTHW to a LTHW Heat Recovery System

Track 3A: Steam to Hot Water Conversion

February 27, 2019

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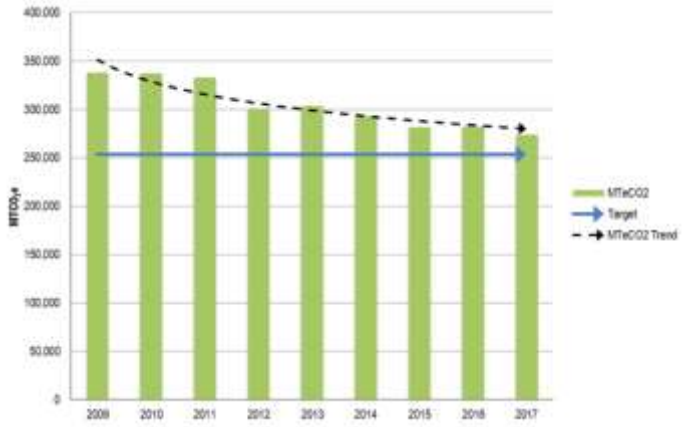
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Background

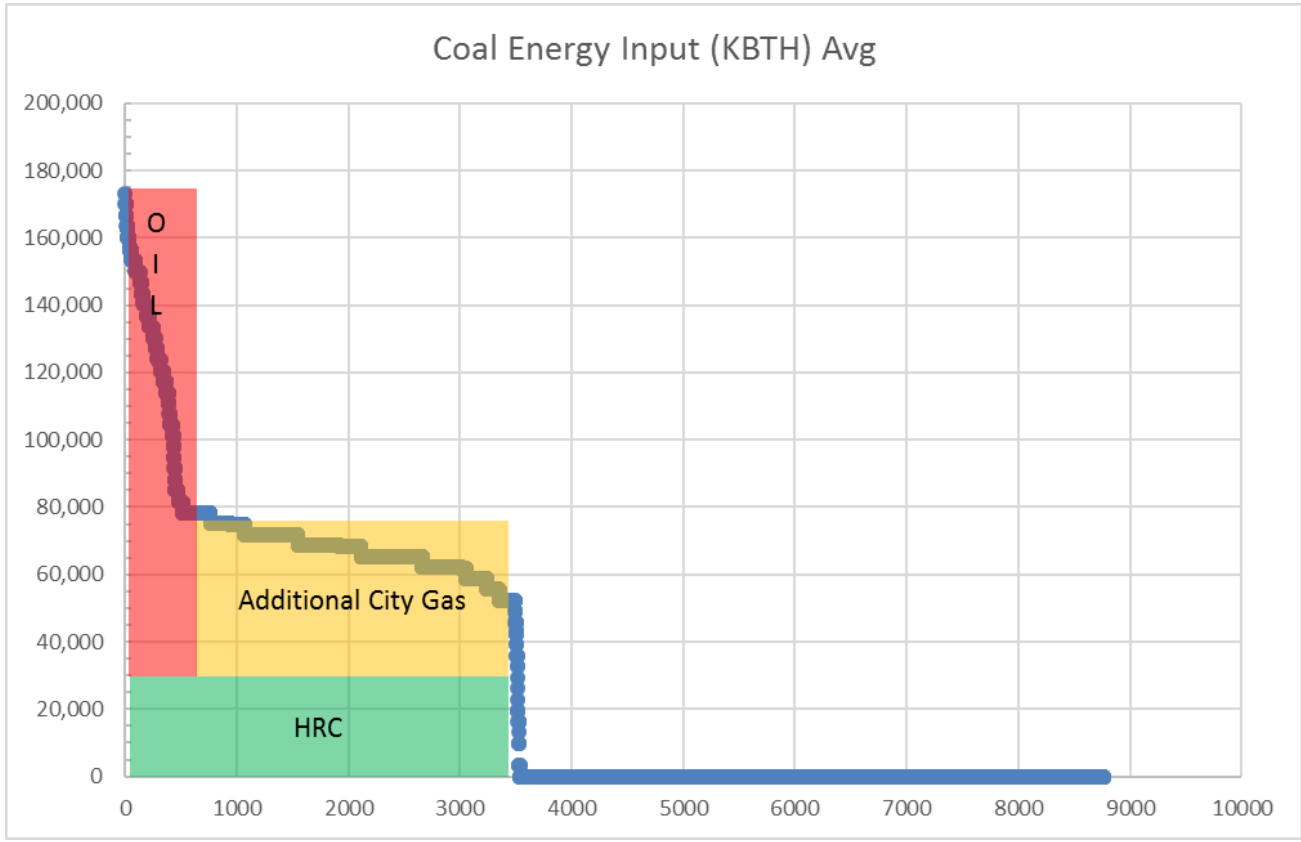


- 2010 Sustainability commitments
- 2015 Demonstration of LTHW and HRC at NGMP
- 2015 E&U Master Plan
- 2016 Engineering Study – LTHW feasible
- 2018 LTHW Project

✓ LTHW

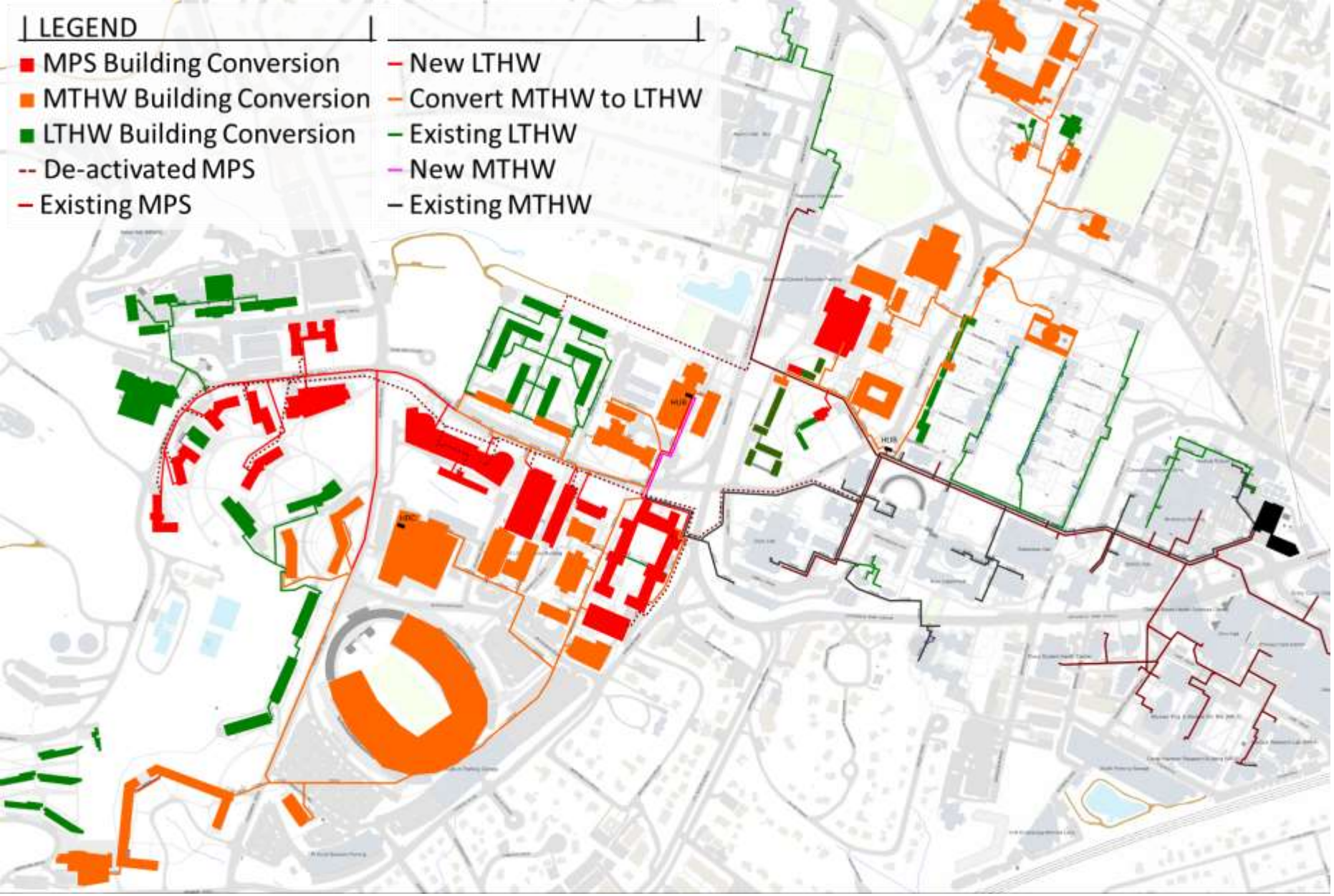
Conceptual Displacement of Coal Heat Input

- Today
  - Coal and Natural Gas
  - Steam
- Tomorrow
  - Natural Gas, Electricity, Oil
  - Steam and Hot Water
- Future
  - Electricity and _____
  - Hot Water



Agenda

- **Scope Map**
- Combined Heating and Cooling System
- Building Conversions



Original Scope

HUB Concept

Annual Savings:	-
Savings PV:	-
Project Cost:	$5.4M

Convert MPS Bldgs. to LTHWS

Annual Savings:	$185k/yr
Savings PV:	$4.1M
Project Cost:	$4.5M

Convert MTHW Bldgs. to LTHWS

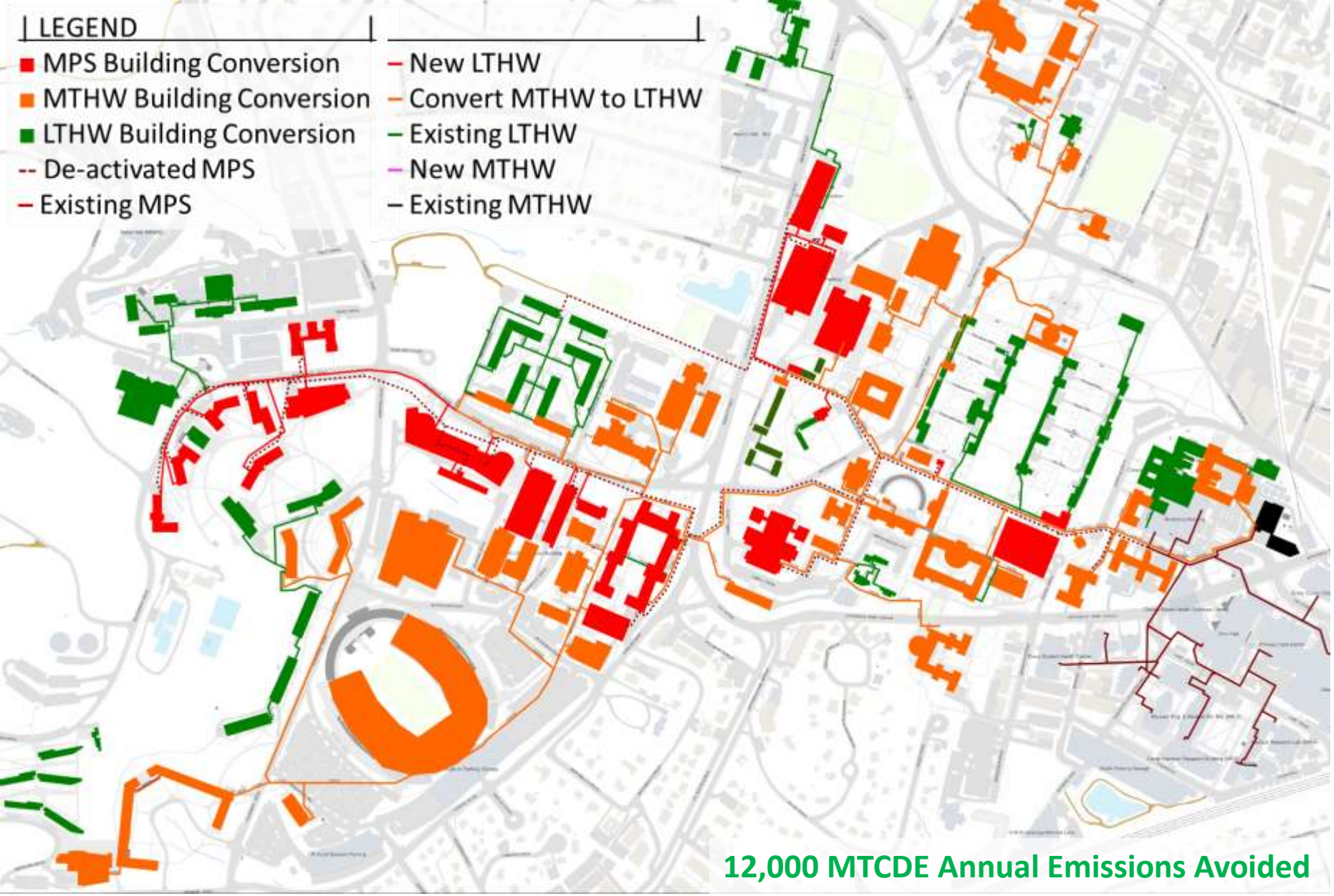
Annual Savings:	-
Savings PV:	-
Project Cost:	$7.2M

Combined Heating and Cooling

Annual Savings:	$210k/yr
Savings PV:	$3.9M
Project Cost:	$2.8M

Affiliated Engineers

University of Virginia



Original Scope

~~HUB Concept~~
Eliminate HUBS
Save $5.4M Project Cost

Convert MPS Bldgs. to LTHWS

Annual Savings:	$290k/yr
Savings PV:	$6.4M
Project Cost:	$5-10M

Convert MTHW Bldgs. to LTHWS

Annual Savings:	-
Savings PV:	-
Project Cost:	$10.9M

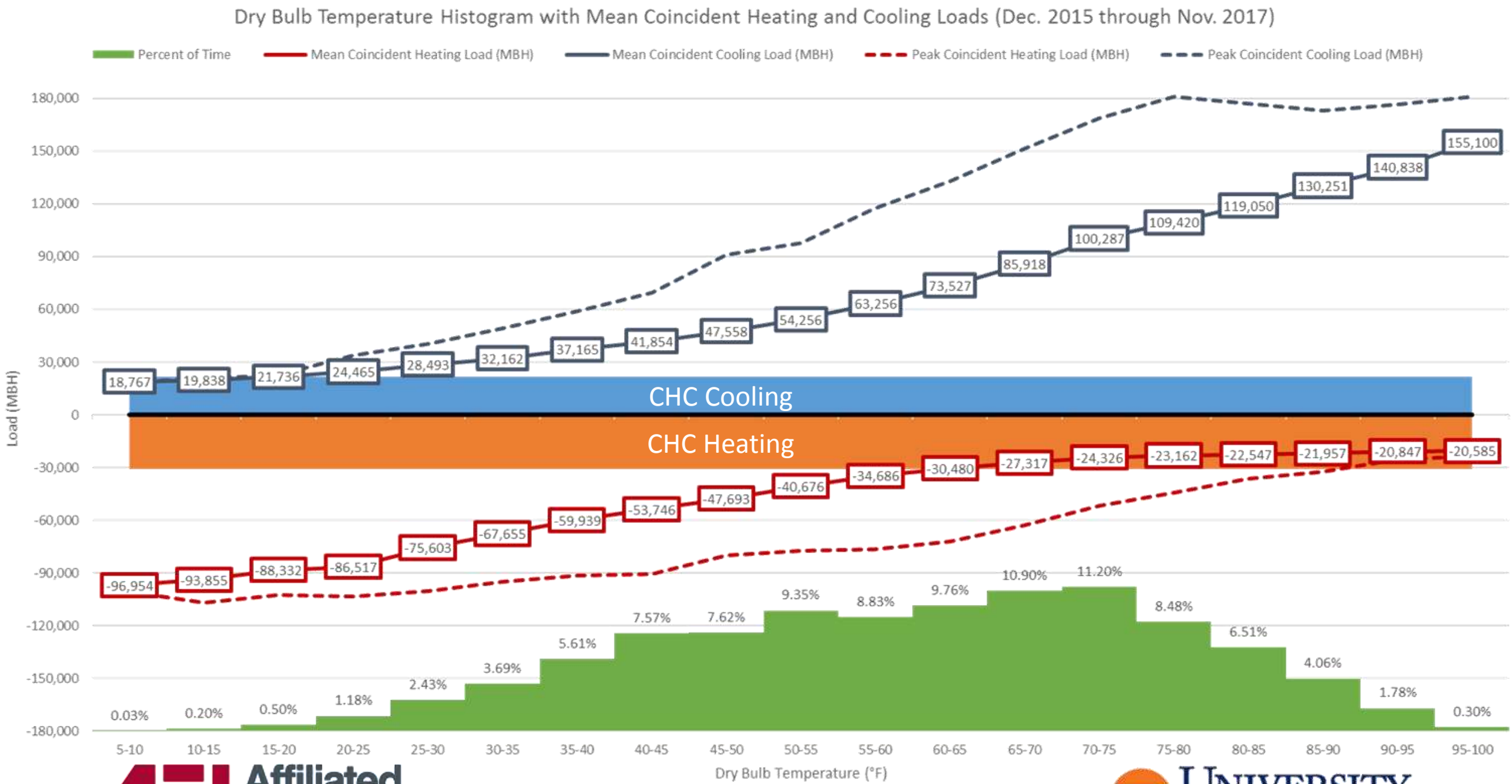
Combined Heating and Cooling

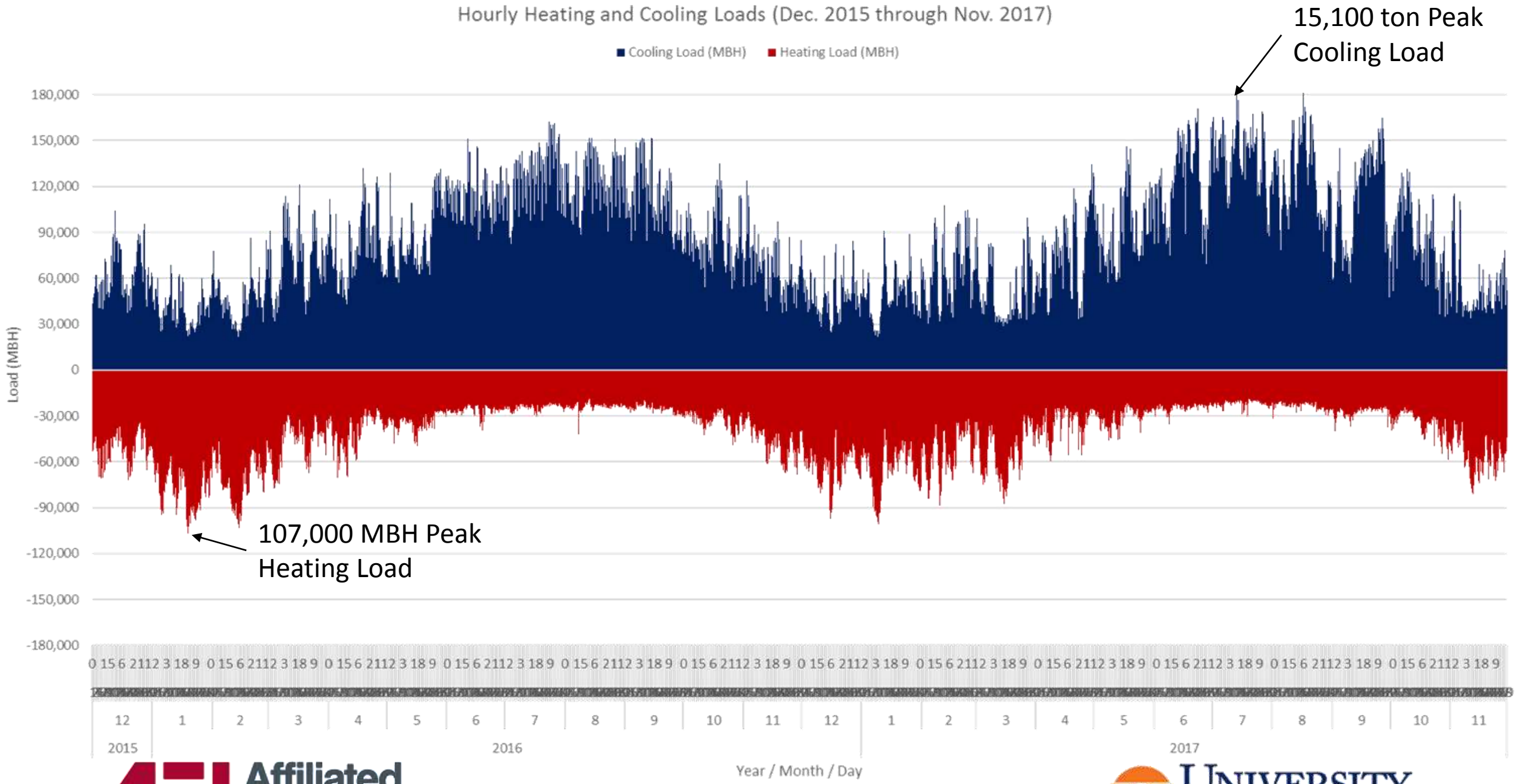
Annual Savings:	$950k/yr
Savings PV:	**$24.6M**
Project Cost:	$9.0M

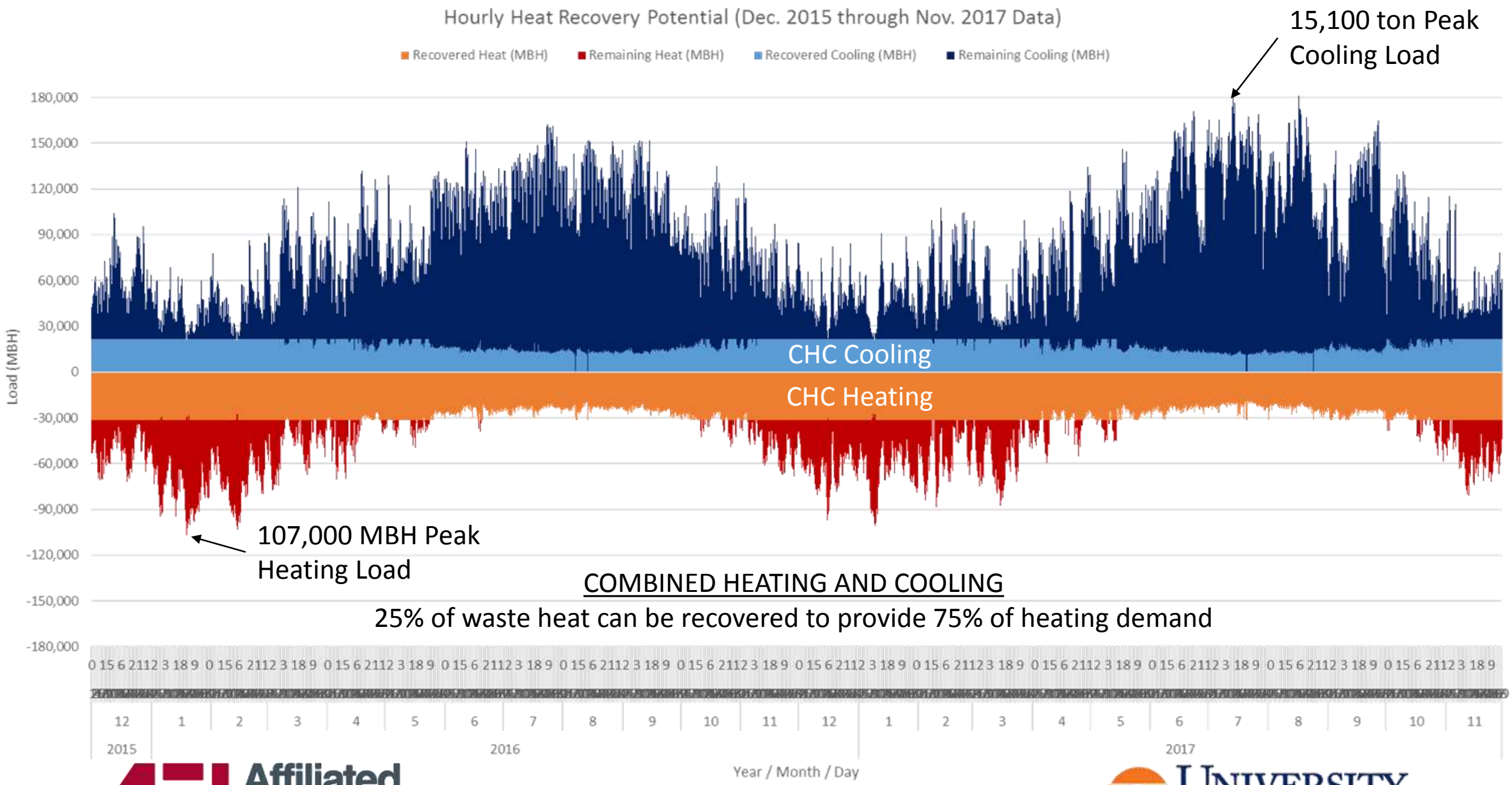
12,000 MTCDE Annual Emissions Avoided

Agenda

- Scope Map
- **Combined Heating and Cooling System**
- Building Conversions

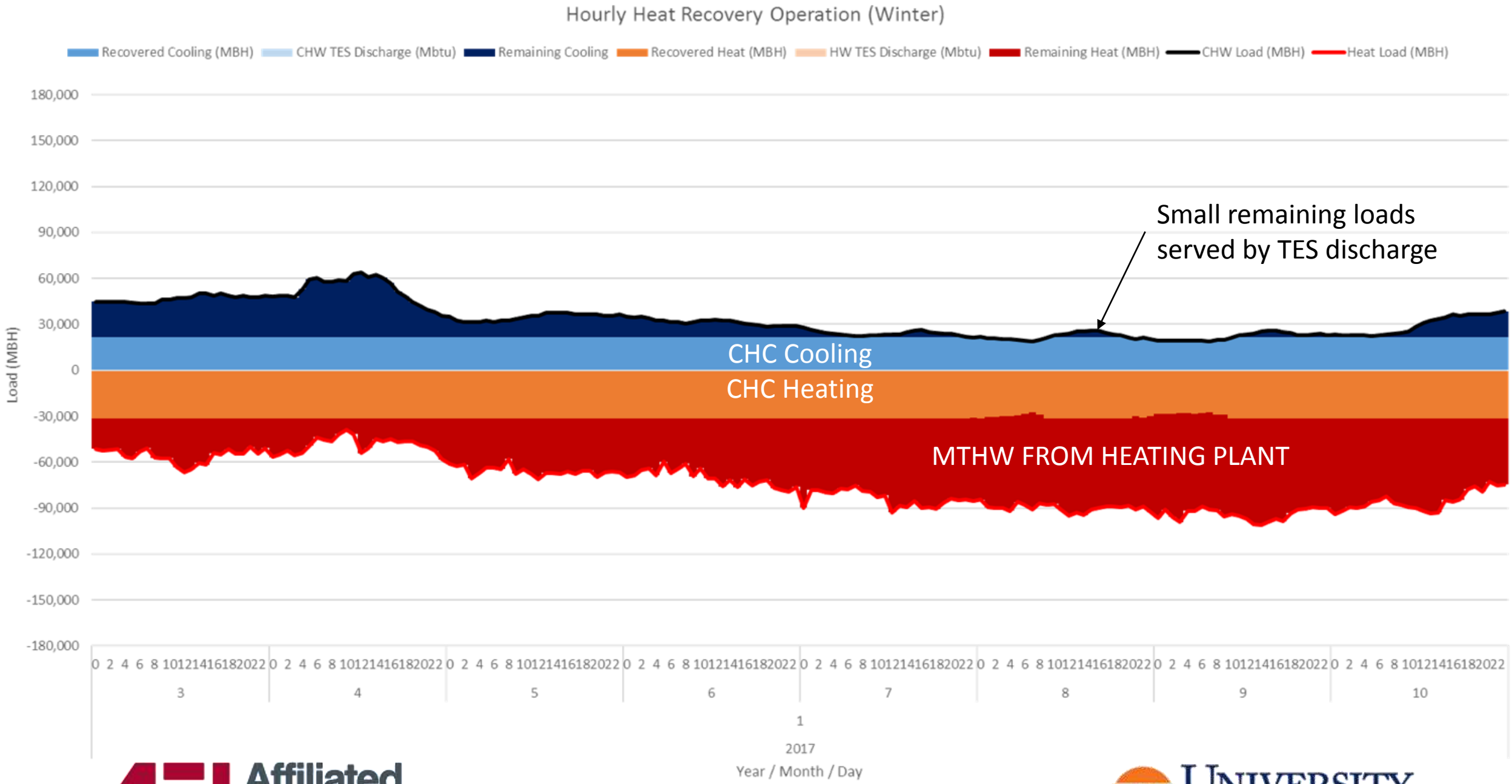

Dry Bulb Temperature Histogram with Mean Coincident Heating and Cooling Loads (Dec. 2015 through Nov. 2017)
Percent of Time
Mean Coincident Heating Load (MBH)
Mean Coincident Cooling Load (MBH)
Peak Coincident Heating Load (MBH)
Peak Coincident Cooling Load (MBH)
Load (MBH)
180,000
150,000
120,000
90,000
60,000
30,000
0
-30,000
-60,000
-90,000
-120,000
-150,000
-180,000
CHC Cooling
CHC Heating
18,767
19,838
21,736
24,465
28,493
32,162
37,165
41,854
47,558
54,256
63,256
73,527
85,918
100,287
109,420
119,050
130,251
140,838
155,100
-96,954
-93,855
-88,332
-86,517
-75,603
-67,655
-59,939
-53,746
-47,693
-40,676
-34,686
-30,480
-27,317
-24,326
-23,162
-22,547
-21,957
-20,847
-20,585
0.03%
0.20%
0.50%
1.18%
2.43%
3.69%
5.61%
7.57%
7.62%
9.35%
8.83%
9.76%
10.90%
11.20%
8.48%
6.51%
4.06%
1.78%
0.30%
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65-70
70-75
75-80
80-85
85-90
90-95
95-100
Dry Bulb Temperature (°F)

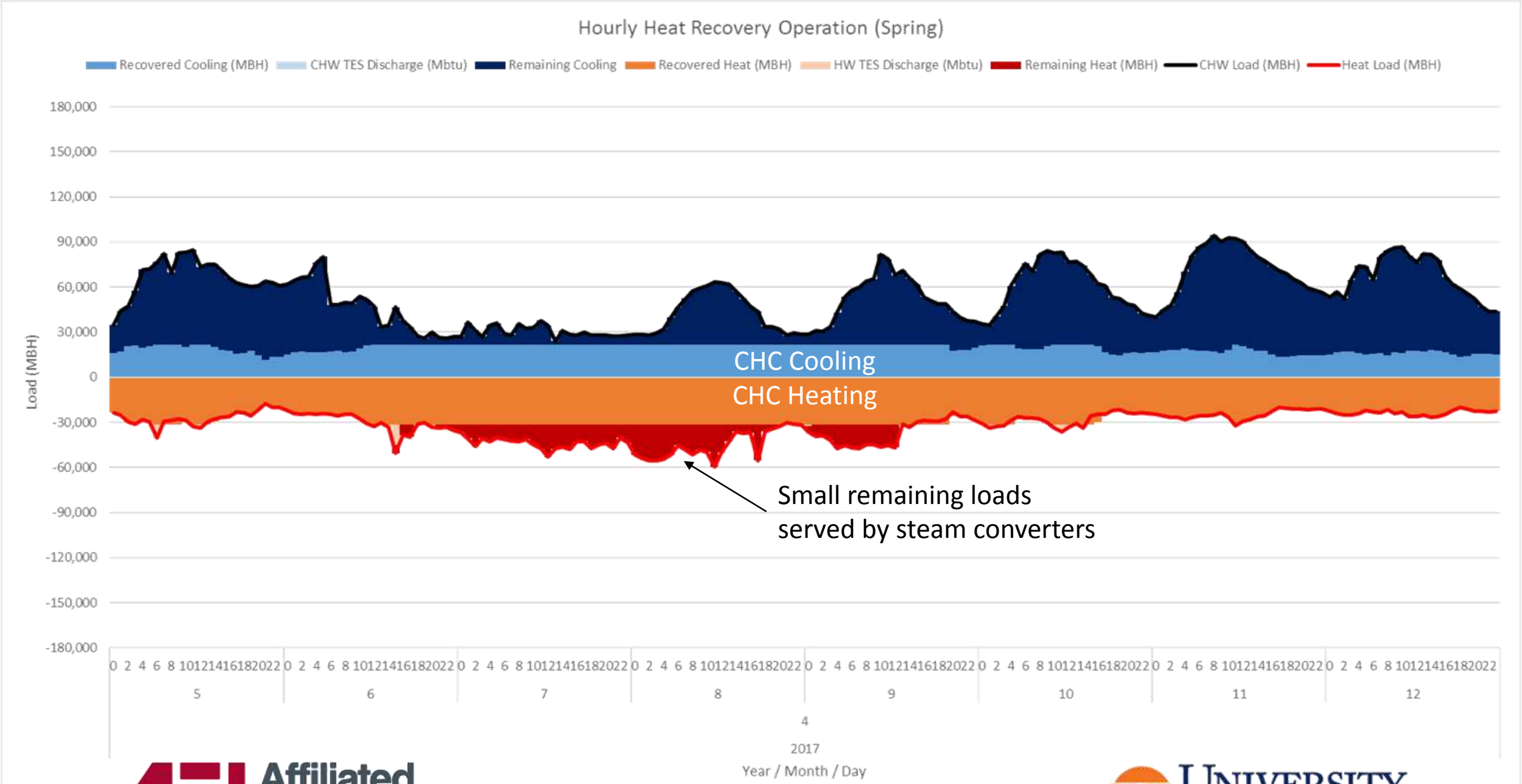

Hourly Heating and Cooling Loads (Dec. 2015 through Nov. 2017)
Cooling Load (MBH)
Heating Load (MBH)
15,100 ton Peak Cooling Load
107,000 MBH Peak Heating Load
Load (MBH)
180,000
150,000
120,000
90,000
60,000
30,000
0
-30,000
-60,000
-90,000
-120,000
-150,000
-180,000
2015
2016
2017
Year / Month / Day

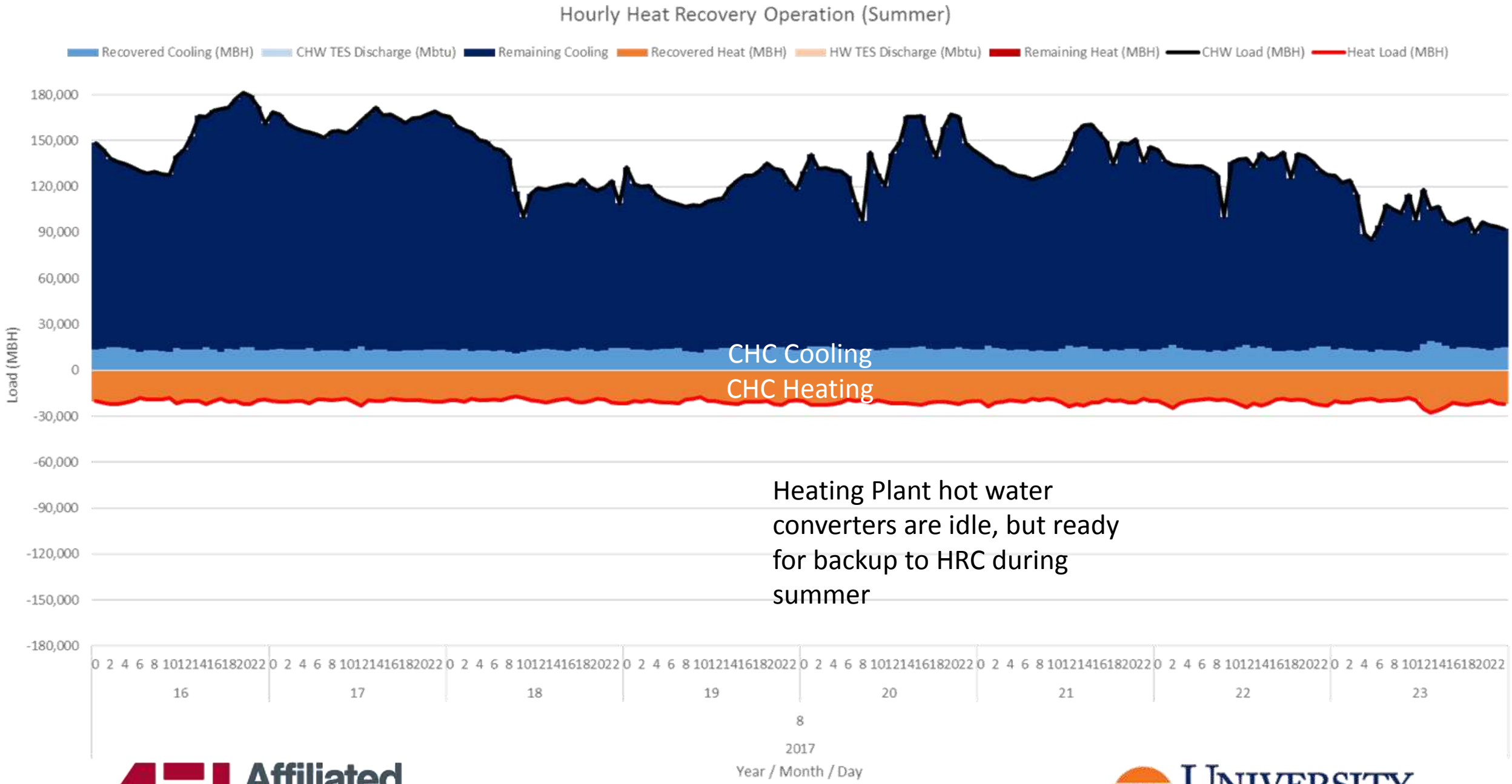


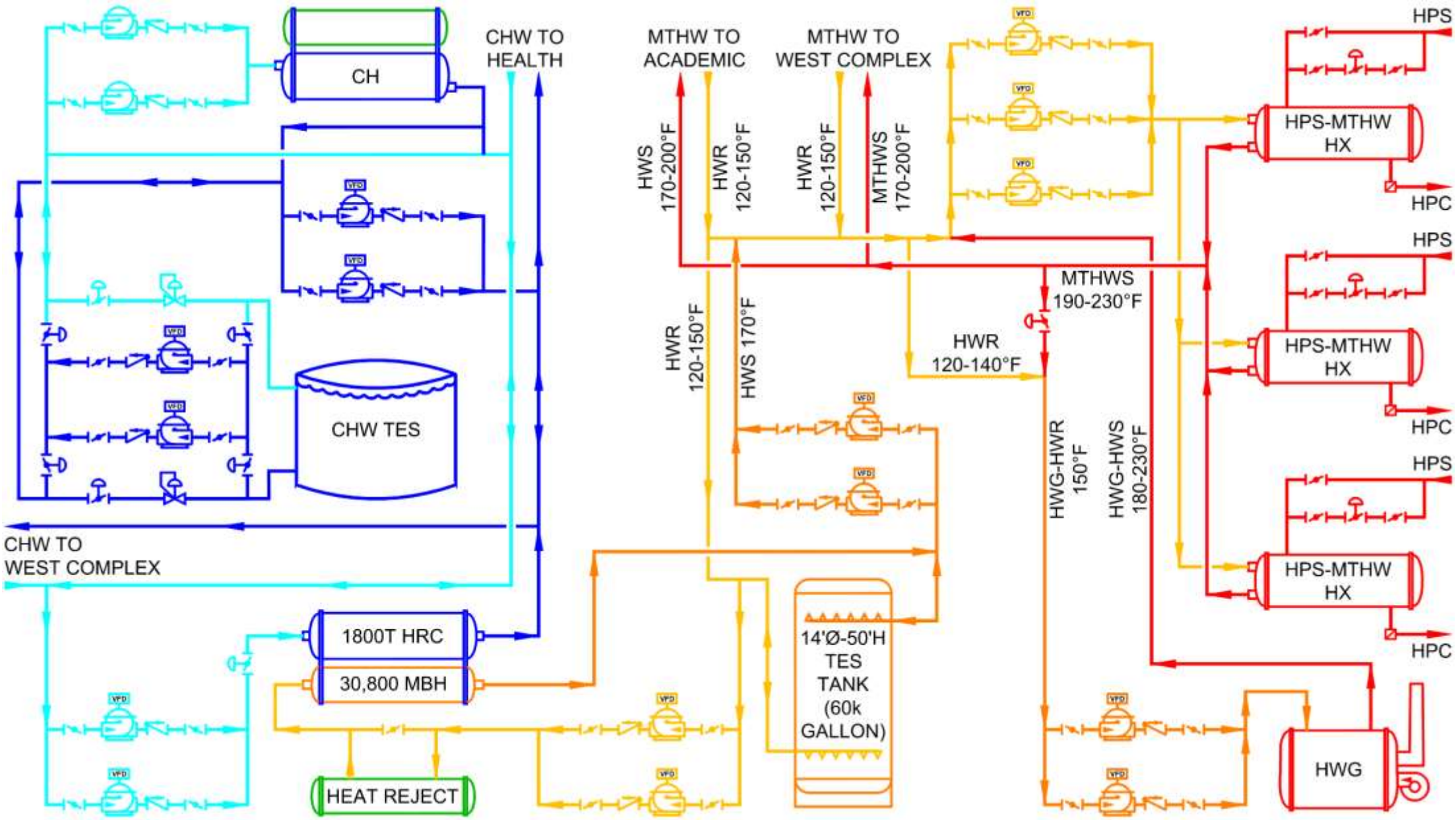
COMBINED HEATING AND COOLING

25% of waste heat can be recovered to provide 75% of heating demand

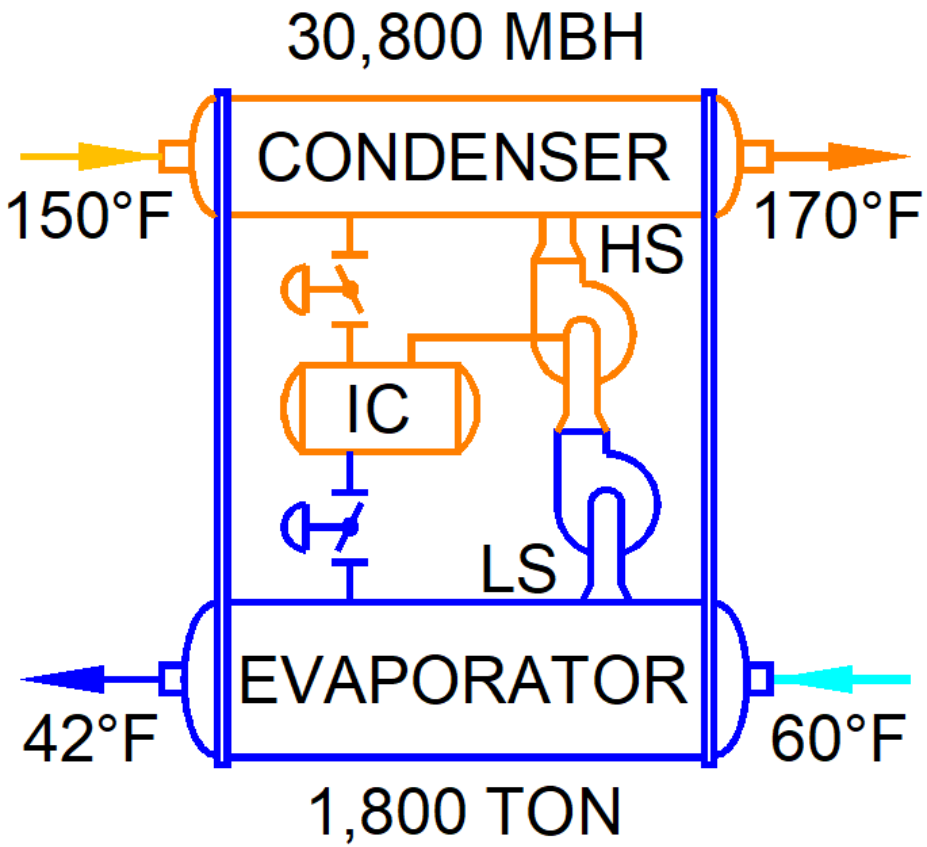

Hourly Heat Recovery Operation (Winter)
Recovered Cooling (MBH)
CHW TES Discharge (Mbtu)
Remaining Cooling
Recovered Heat (MBH)
HW TES Discharge (Mbtu)
Remaining Heat (MBH)
CHW Load (MBH)
Heat Load (MBH)
Load (MBH)
180,000
150,000
120,000
90,000
60,000
30,000
0
-30,000
-60,000
-90,000
-120,000
-150,000
-180,000
Small remaining loads
served by TES discharge
CHC Cooling
CHC Heating
MTHW FROM HEATING PLANT
0 2 4 6 8 10 12 14 16 18 20 22
3
4
5
6
7
8
9
10
1
2017
Year / Month / Day

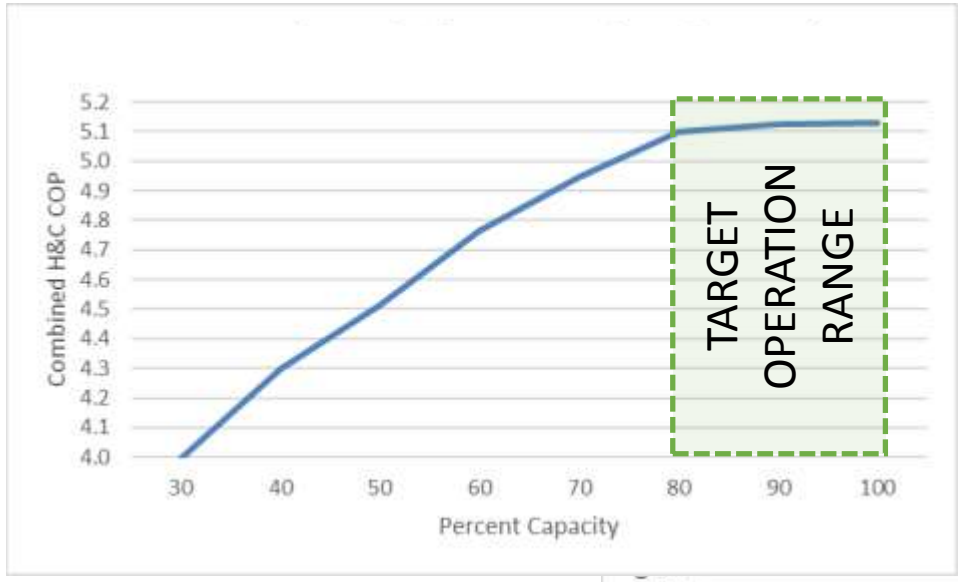

Hourly Heat Recovery Operation (Spring)
Recovered Cooling (MBH)
CHW TES Discharge (Mbtu)
Remaining Cooling
Recovered Heat (MBH)
HW TES Discharge (Mbtu)
Remaining Heat (MBH)
CHW Load (MBH)
Heat Load (MBH)
Load (MBH)
180,000
150,000
120,000
90,000
60,000
30,000
0
-30,000
-60,000
-90,000
-120,000
-150,000
-180,000
CHC Cooling
CHC Heating
Small remaining loads
served by steam converters
5
6
7
8
9
10
11
12
4
2017
Year / Month / Day

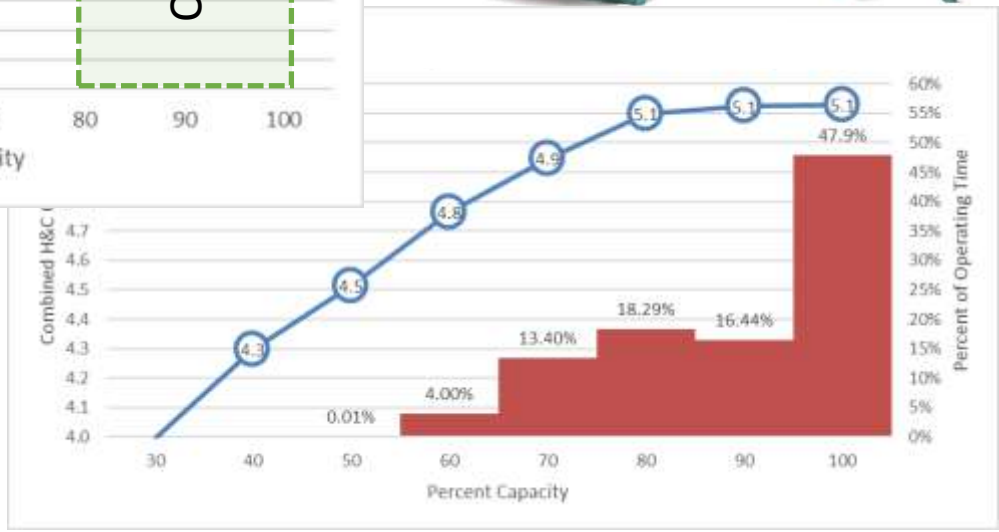

Hourly Heat Recovery Operation (Summer)
Recovered Cooling (MBH)
CHW TES Discharge (Mbtu)
Remaining Cooling
Recovered Heat (MBH)
HW TES Discharge (Mbtu)
Remaining Heat (MBH)
CHW Load (MBH)
Heat Load (MBH)
Load (MBH)
180,000
150,000
120,000
90,000
60,000
30,000
0
-30,000
-60,000
-90,000
-120,000
-150,000
-180,000
CHC Cooling
CHC Heating
Heating Plant hot water converters are idle, but ready for backup to HRC during summer
16
17
18
19
20
21
22
23
8
2017
Year / Month / Day


CH
CHW TO HEALTH
CHW TES
CHW TO WEST COMPLEX
1800T HRC
30,800 MBH
HEAT REJECT
MTHW TO ACADEMIC
MTHW TO WEST COMPLEX
HWS 170-200°F
HWR 120-150°F
HWR 120-150°F
MTHWS 170-200°F
HWR 120-150°F
HWS 170°F
MTHWS 190-230°F
HWR 120-140°F
HWG-HWR 150°F
HWG-HWS 180-230°F
14'Ø-50'H TES TANK (60k GALLON)
HPS
HPS-MTHW HX
HPC
HPS
HPS-MTHW HX
HPC
HPS
HPS-MTHW HX
HPC
HWG

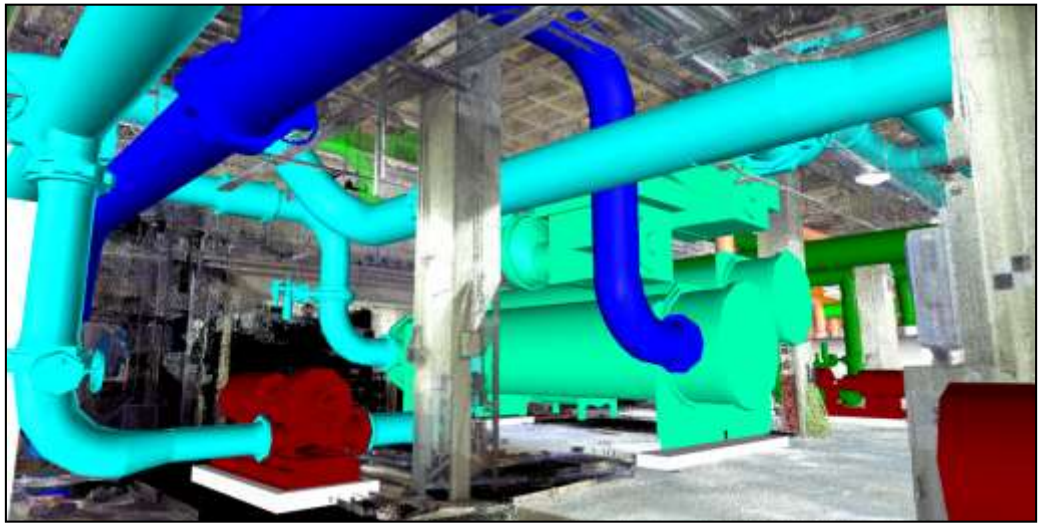
Compound Centrifugal Heat Pump







North Chiller Plant Renovation



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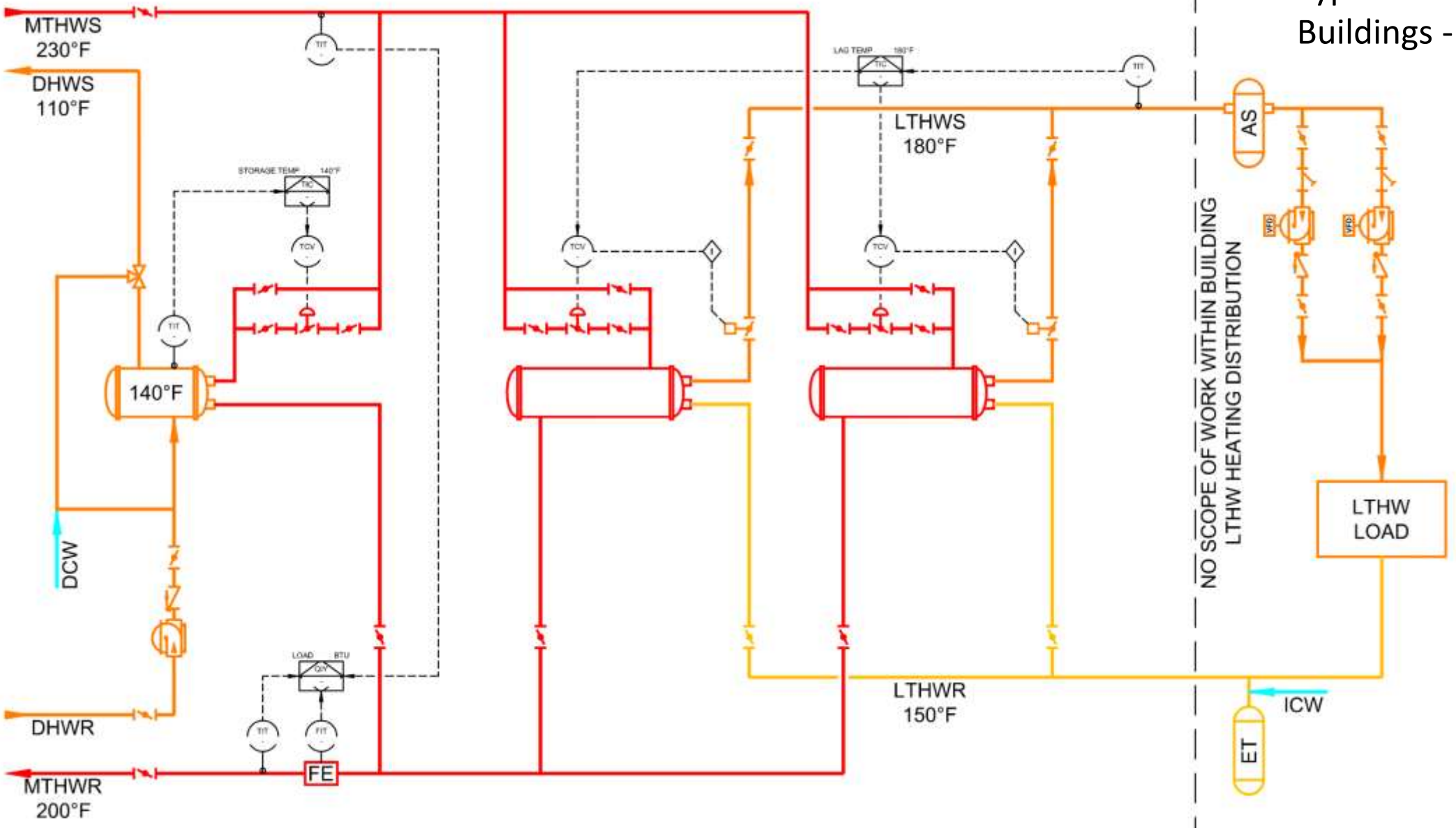
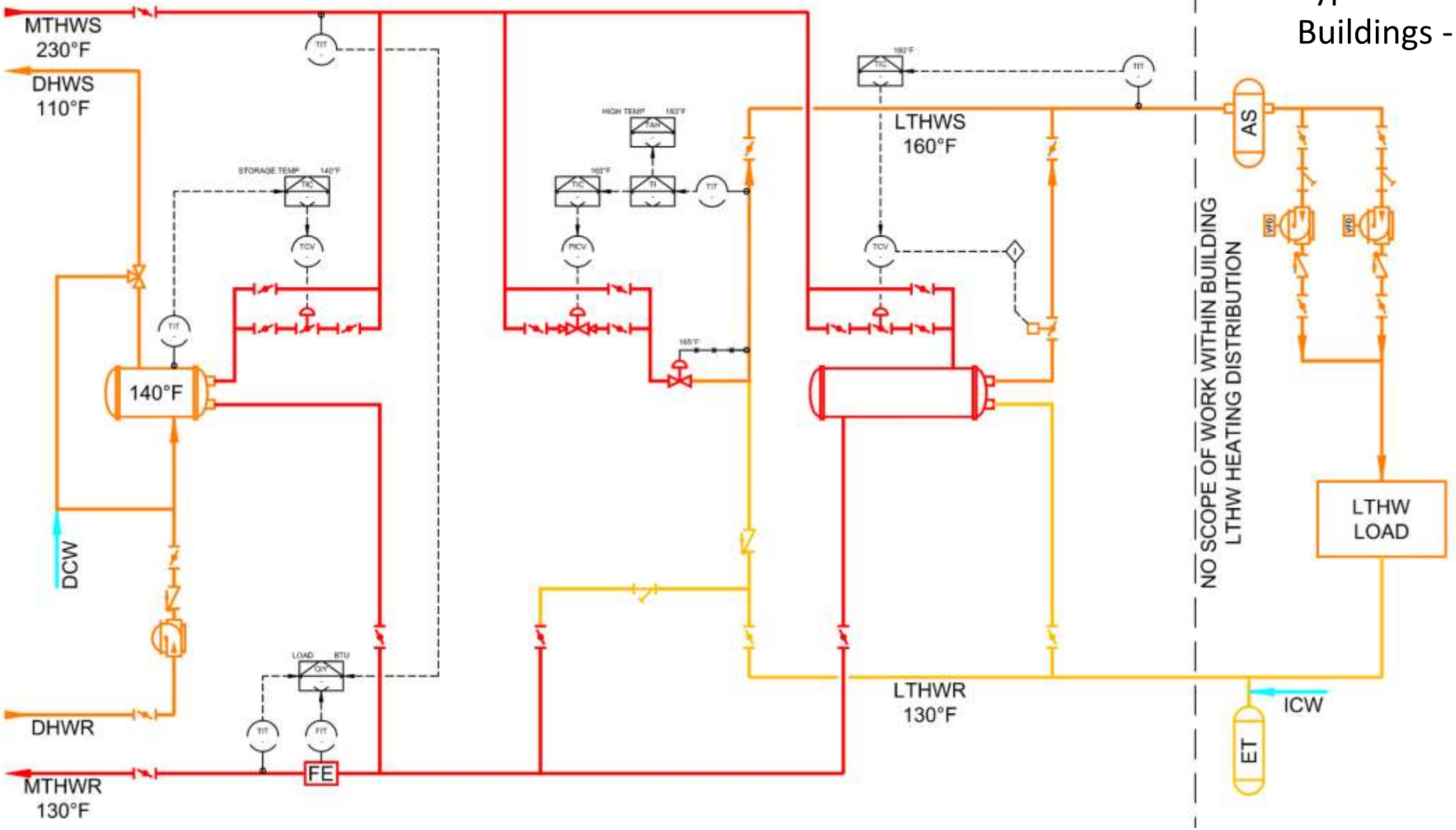
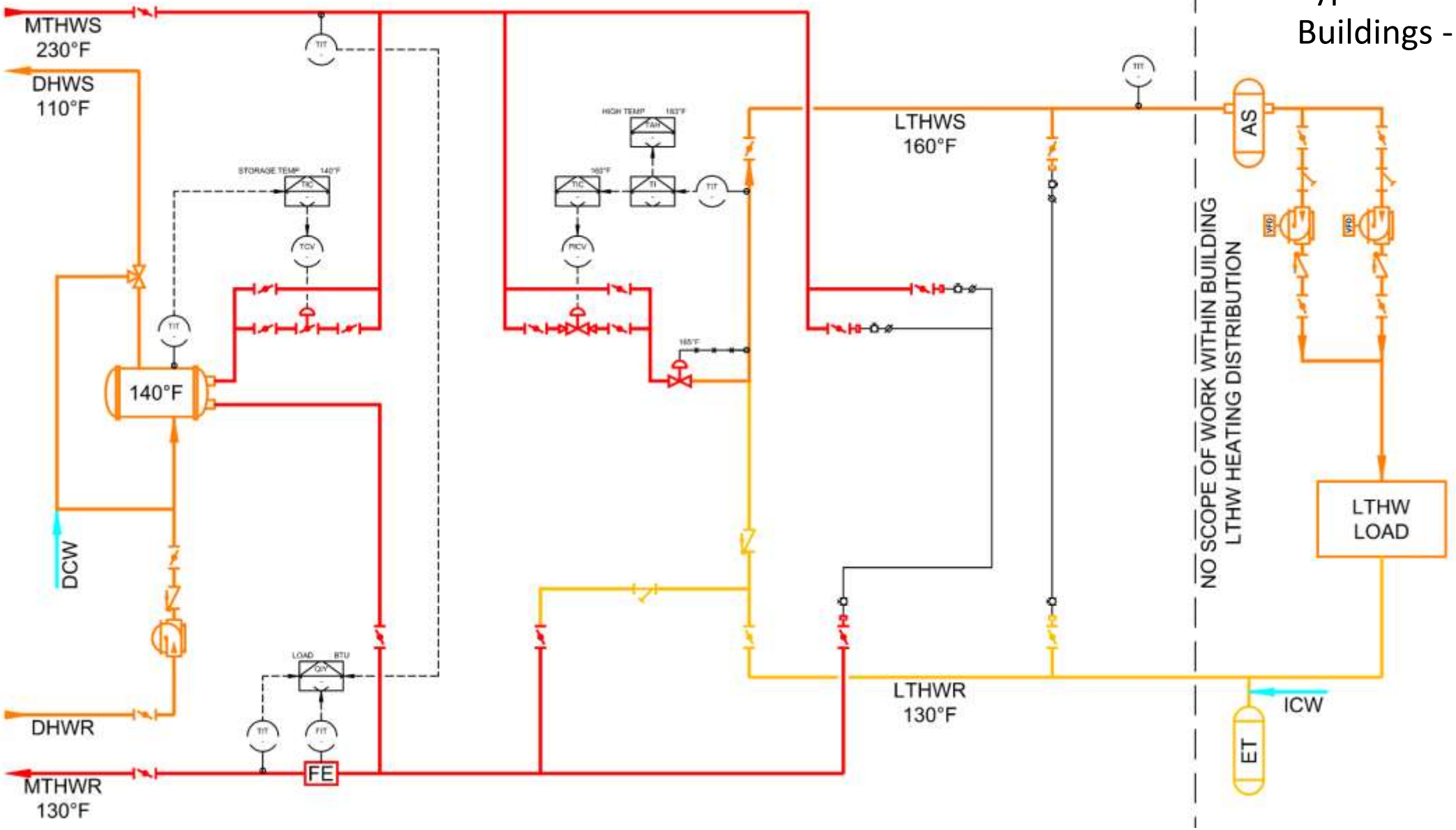
Typical MTHW Buildings - BEFORE



Typical MTHW Buildings - PHASED

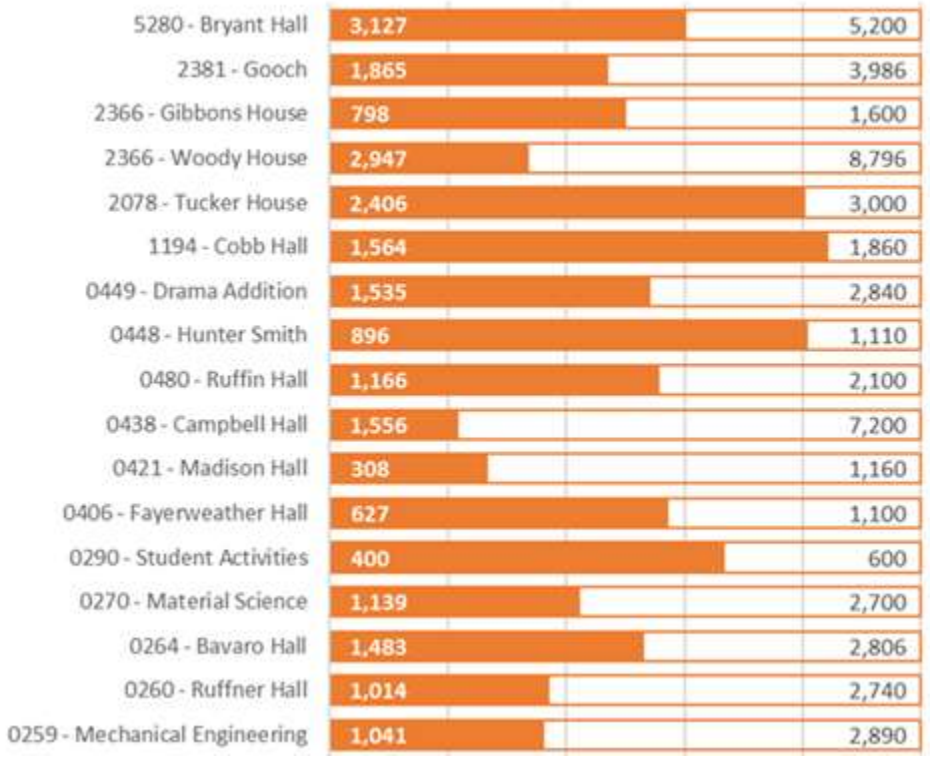


Typical MTHW Buildings - FINAL



Lessons Learned

- Test and gather data
- Compare design to actual load
- Improve Delta T
  - 3-way valves
  - Hydraulic bridges
  - Series preheat w/ reheat
  - Standardize



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