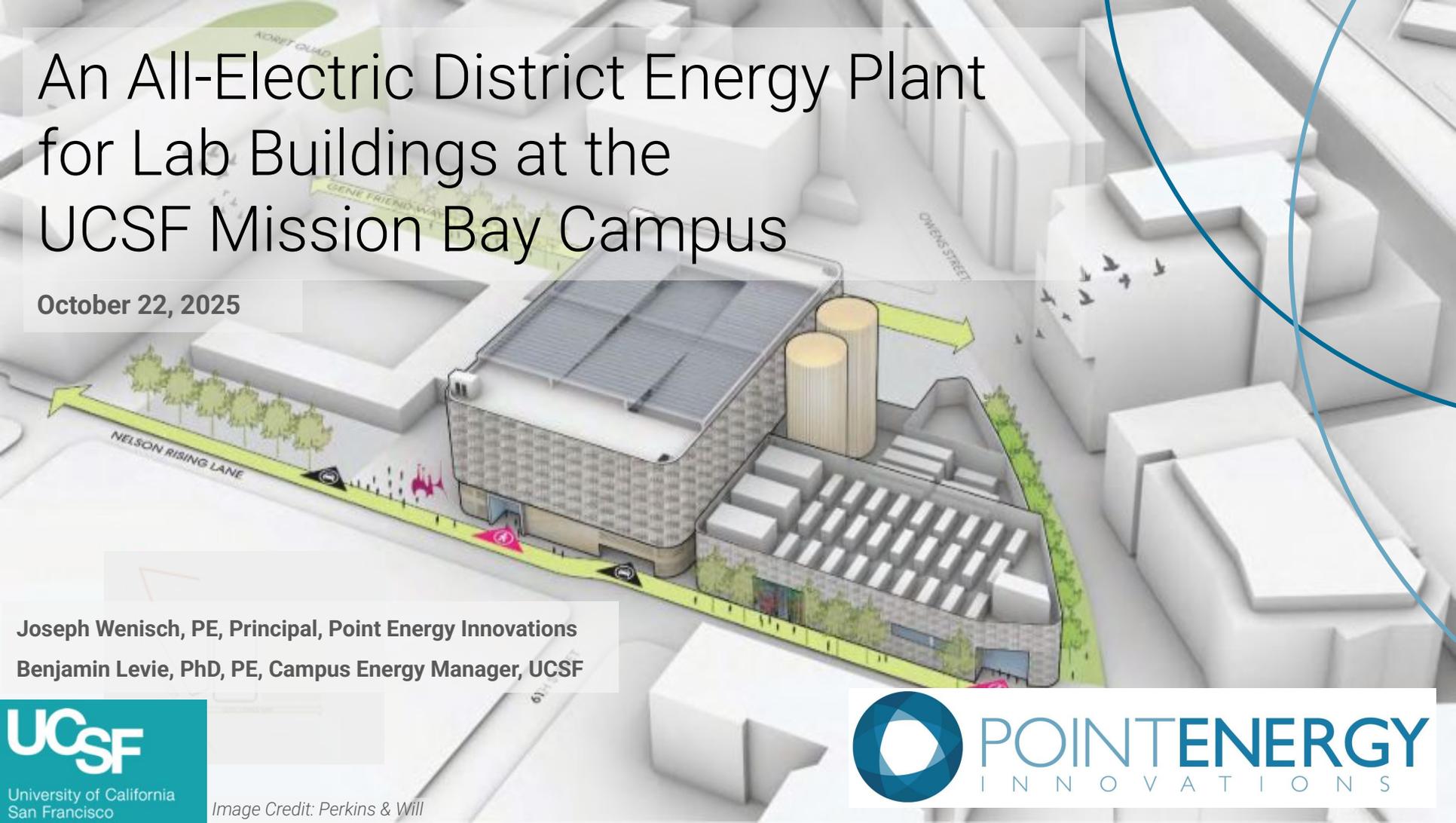


An All-Electric District Energy Plant for Lab Buildings at the UCSF Mission Bay Campus

October 22, 2025



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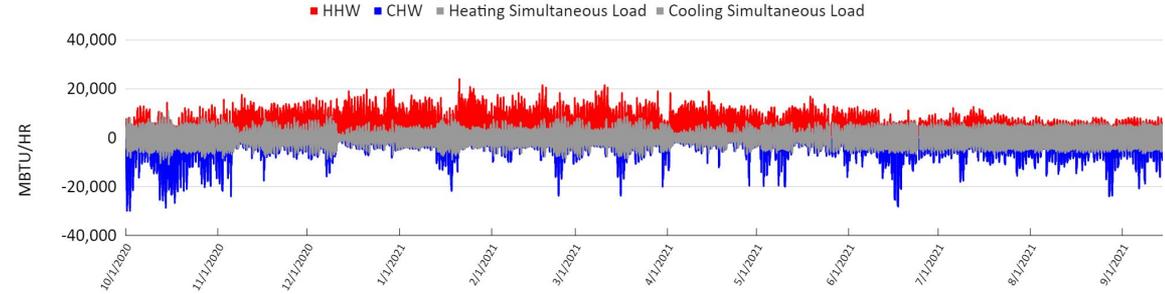
Learning Objectives

1. Use historical load data to right-size a district all-electric plant.
2. Select appropriate hot water temperatures to maximize heat recovery and heat pump performance.
3. Optimize Thermal Energy Storage (TES) to balance first and operating cost savings.
4. Provide lessons learned to decarbonize other lab district heating and cooling plants.

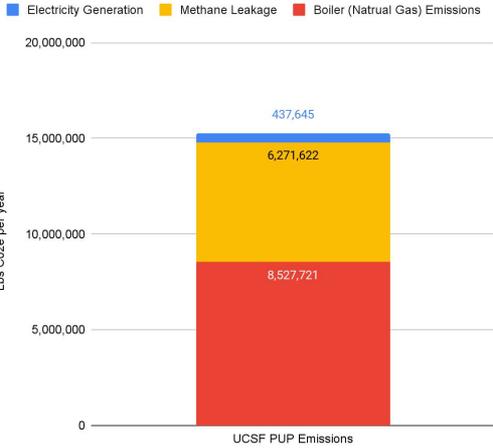
Existing Plant Overview



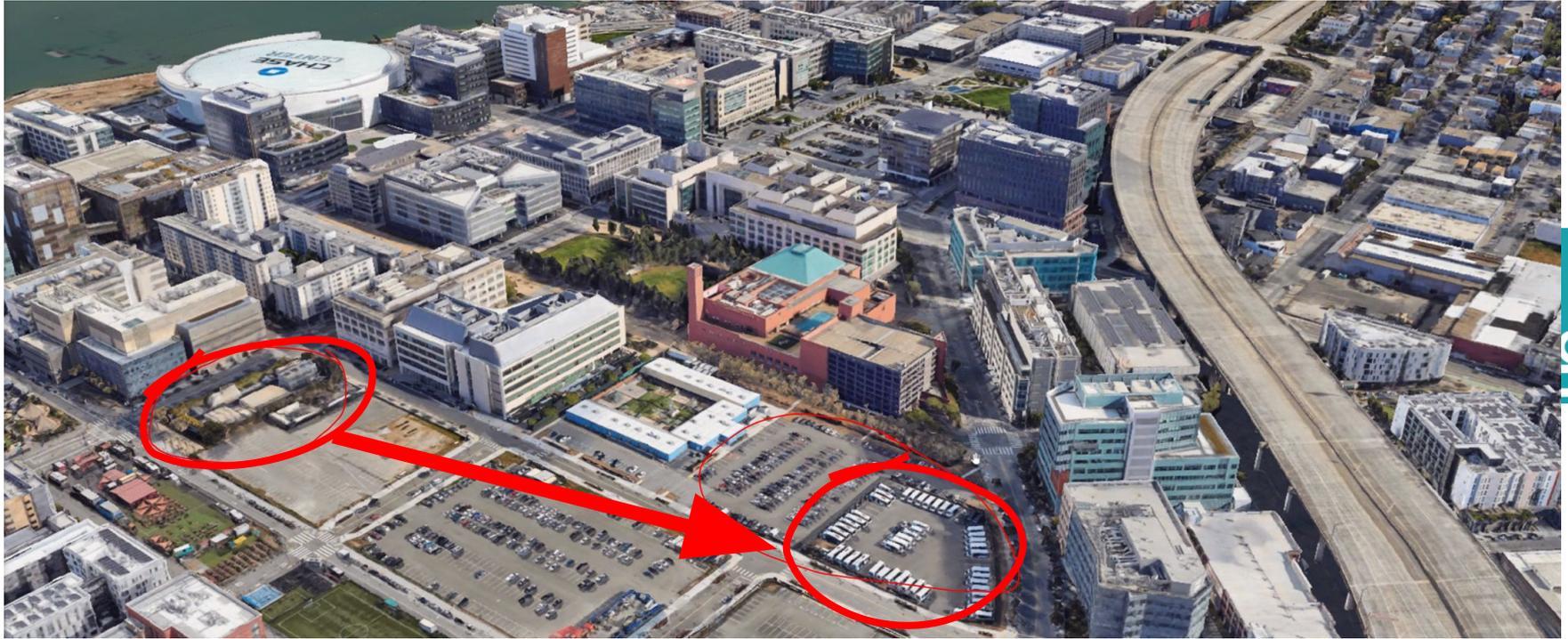
	Installed Capacity	Est. Design Load	Bldg Area Served (GDF)	Design Clg/Htg Density	Avg. Chiller/Boiler Efficiency
Cooling	3,575 tons	2,550 tons	1,006,500	395 SF/ton	0.542 kW/ton 0.415 NPLV
Heating	48,900 MBH	32,600 MBH	804,105*	41 BTUH/SF	85%



UCSF PUP
September 2020 - August 2021 CO2e Emissions
(15,237,000 lbs CO2e)



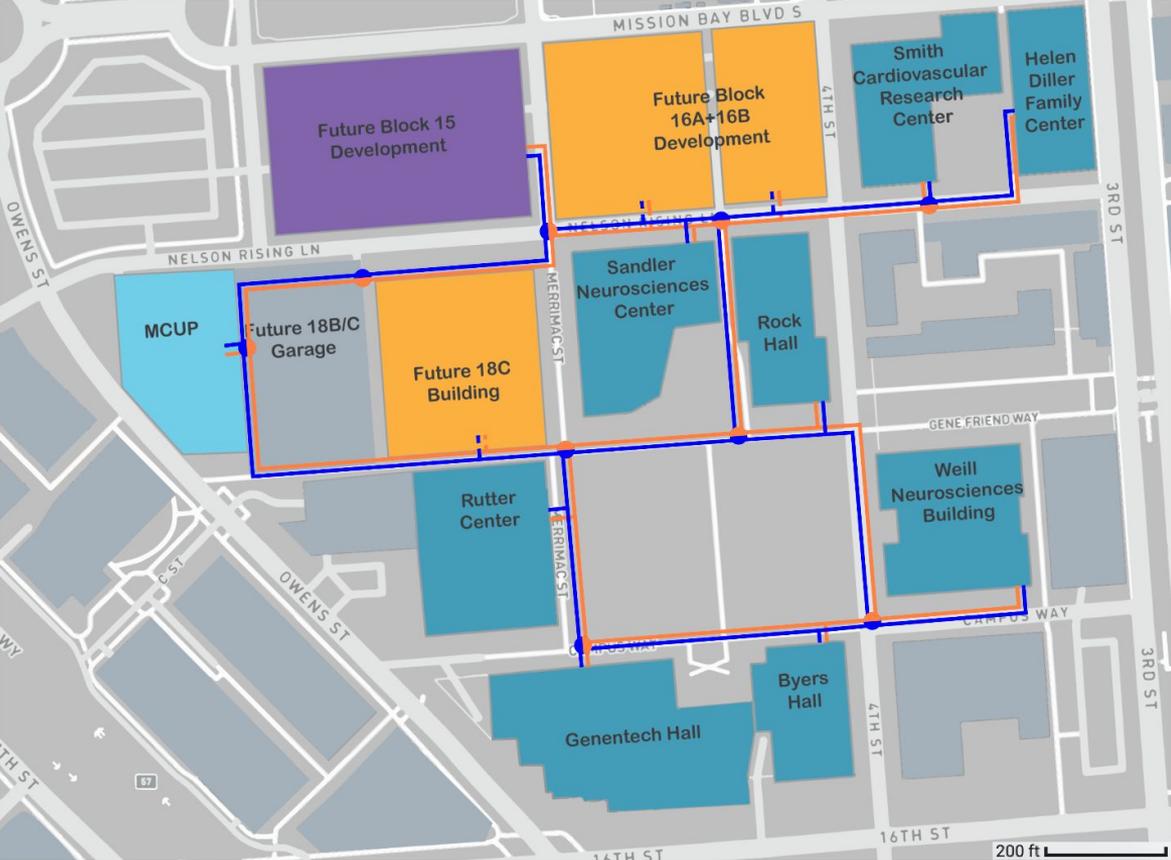
Site Overview



UCSF Goals

- Relocate existing District Chilled and Hot Water plant to make room for new real estate development.
- Replace with all-electric plant to eliminate on-site natural gas use and reduce carbon emissions by 32.5 million lbs of CO₂e/year.
- Expand new plant to serve existing and future buildings in 25 yr plan.
- Meet decarbonization goals without increasing operating costs.

Mission Bay North District - 25 Year Buildout PPlan

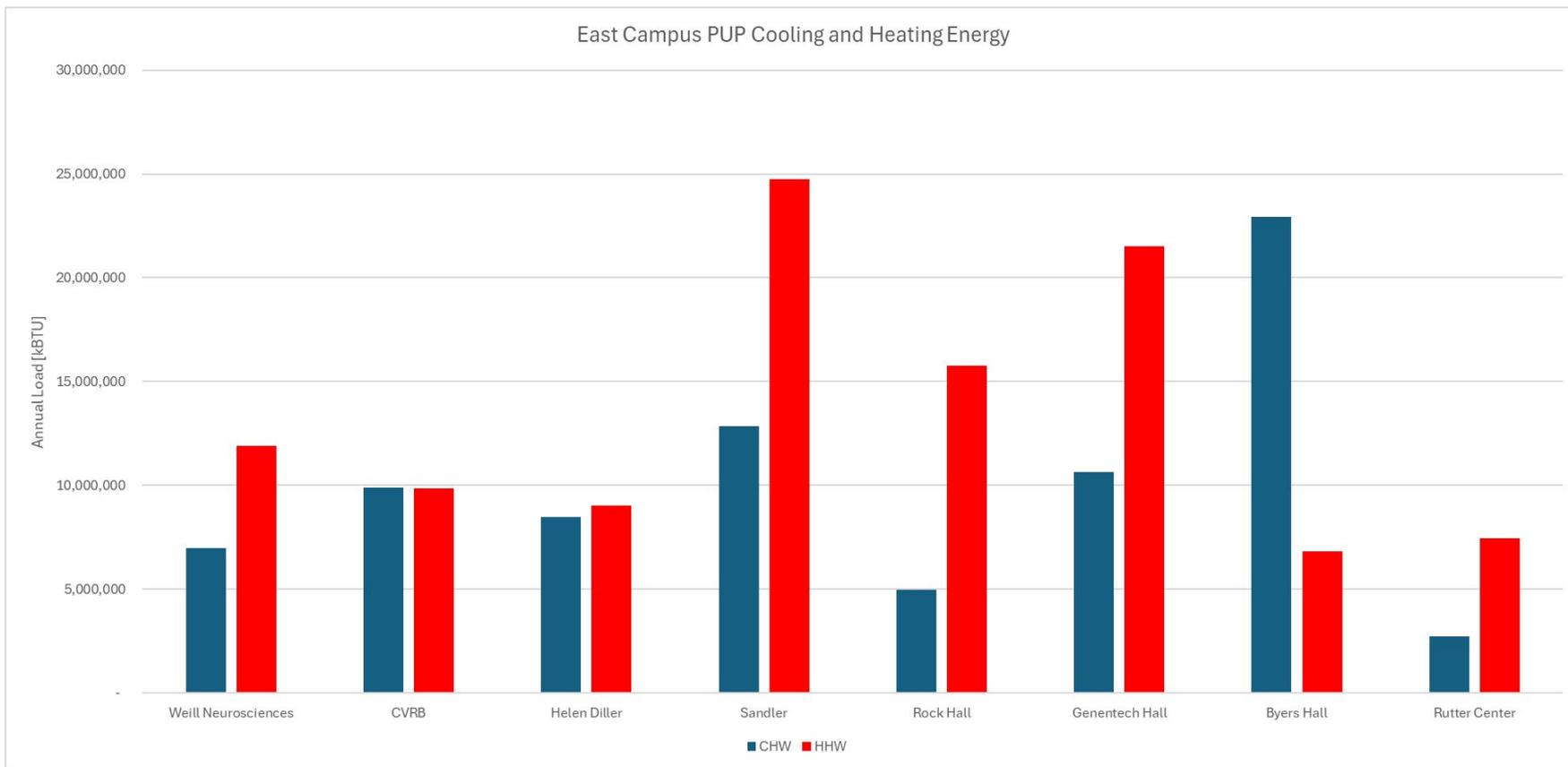


- MCUP
- EXISTING BUILDING
- NEW BUILDING (10 YR BUILDOUT)
- NEW BUILDING (25 YR BUILDOUT)
- EXISTING (E) CHW PIPING
- EXISTING (E) HHW PIPING
- NEW (N) CHW PIPING
- NEW (N) HHW PIPING

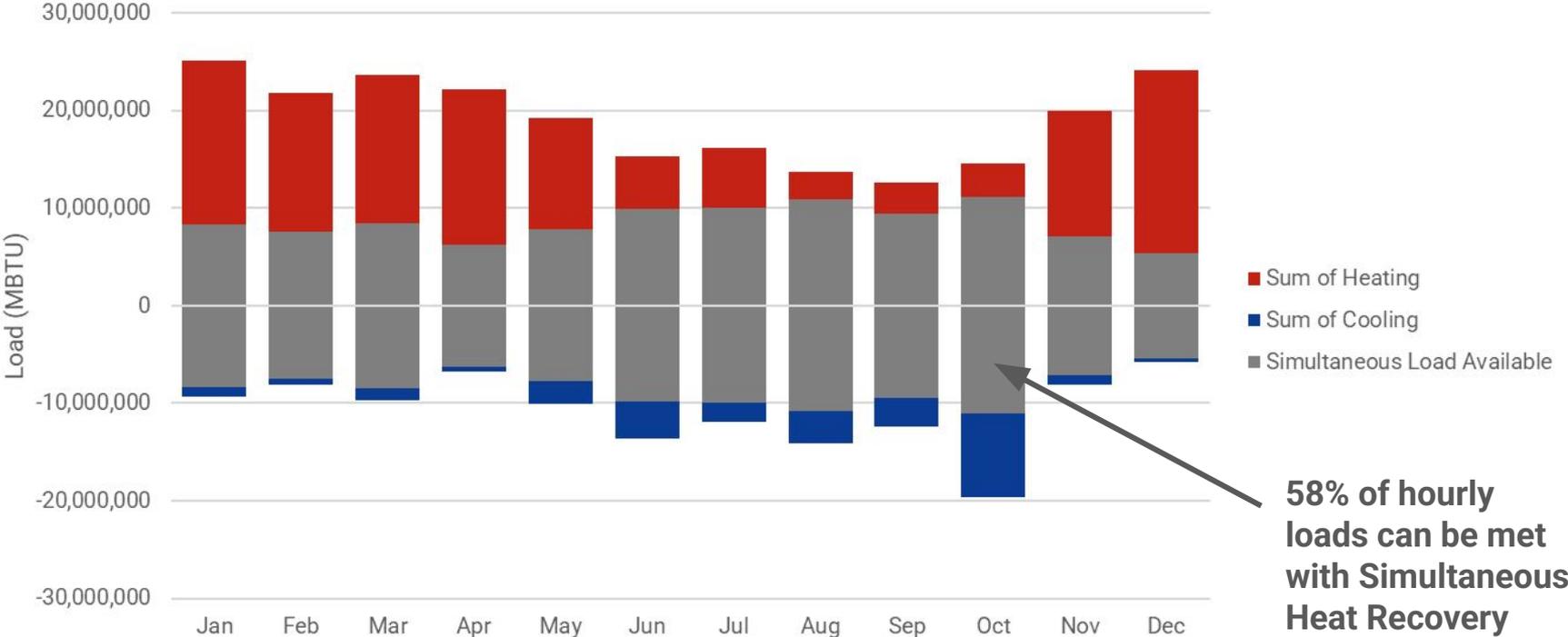
Understanding Future Loads

Building (# / Name)	End Use	Area (GSF)	Year Built	Existing Plant	New - 10 Year Buildout	New - 25 Year Buildout
Rock Hall	Health Science	170,565	2003	x	x	x
19A / Sandler Neuro	Health Science	237,000	2012	x	x	x
Helen Diller	Health Science	160,540	2008	x	x	x
Smith Cardio	Health Science	236,000	2010	x	x	x
23A / Weil Neuro	Health Science	202,361	2020	x	x	x
Byers Hall	Health Science	154,434	2003		x	x
Genentech Hall	Health Science	384,879	2002		x	x
Rutter Center	Community Bldg	158,605	2003		x	x
15	Health Science	415,000	Future		x	x
16A	Health Science	247,500	Future			x
16B	Health Science	149,000	Future			x
18C	Health Science	250,000	Future			x
Area Totals (GSF)				1,006,466	2,119,384	2,765,884
Additional Area Served (%)				0%	211%	275%
Peak Cooling Load (tons) @ 400 SF/ton				2,500	5,300	6,900
Peak Heating Load (MBH) @ 25 BTUH/SF				25,200	53,000	69,200
NOTES:						
1. Genentech Hall and Rutter Center should be connected to the MCUP.						
2. Byers Hall and Weil Neurosciences currently receive only chilled water from the PUP.						
3. Excludes Mission Hall and MB Housing, currently no plans to connect to MCUP for CHW and HHW						

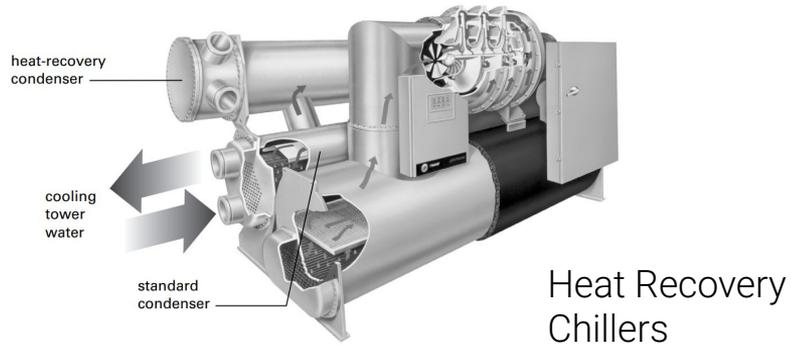
Existing Building Annual Energy Use



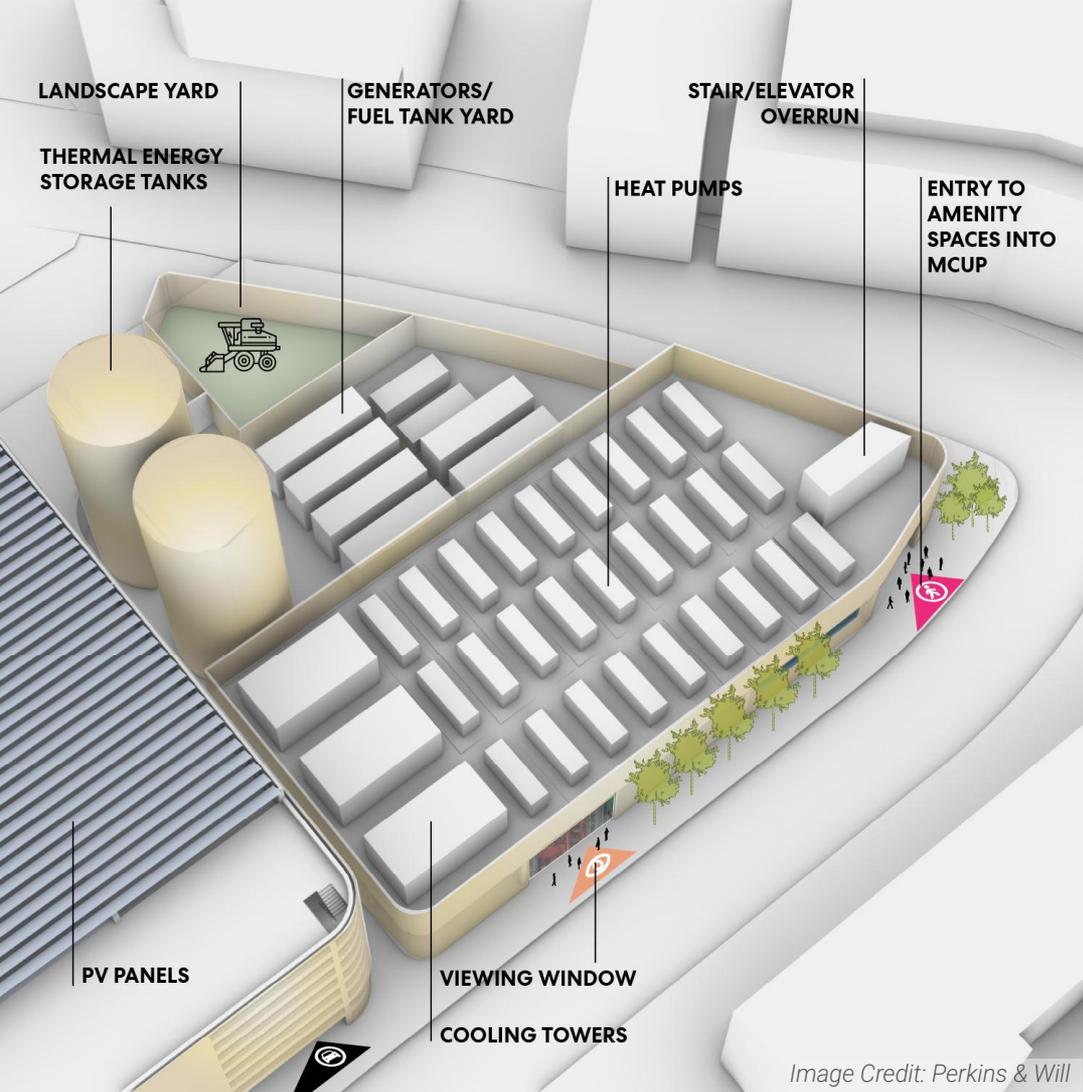
Combined District Loads and Potential for Heat Recovery



Key Electrification Strategies



Hot and Chilled Water Thermal Energy Storage



Equipment Layout

- Two-story CUP to maximize use of available site; ASHP's and Cooling towers on roof; chillers and electrical indoors

- 42 ft Diam x 96 ft High TES ; maximum height allowance, minimum footprint

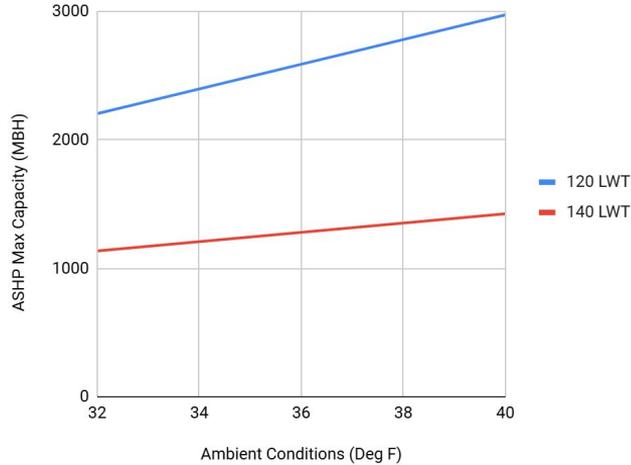
- Backup generators and fuel storage take up significant space; future options for reductions by accounting for TES, batteries...

- Windows to make plant equipment visible to tell sustainability story

Image Credit: Perkins & Will

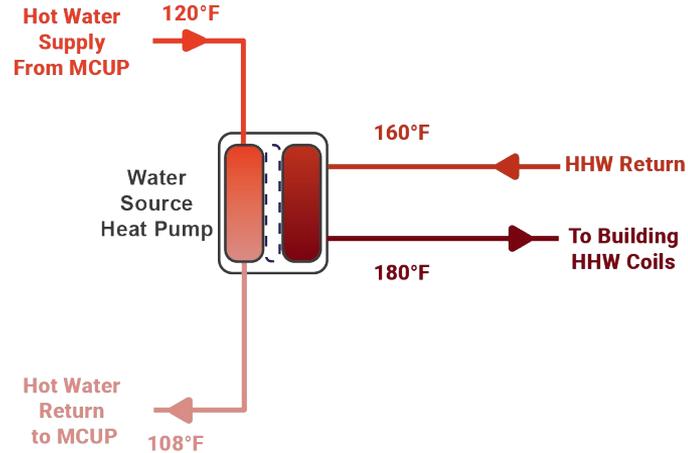


Hot Water Design Considerations



ASHP performance and capacity decreased by outdoor design temperatures

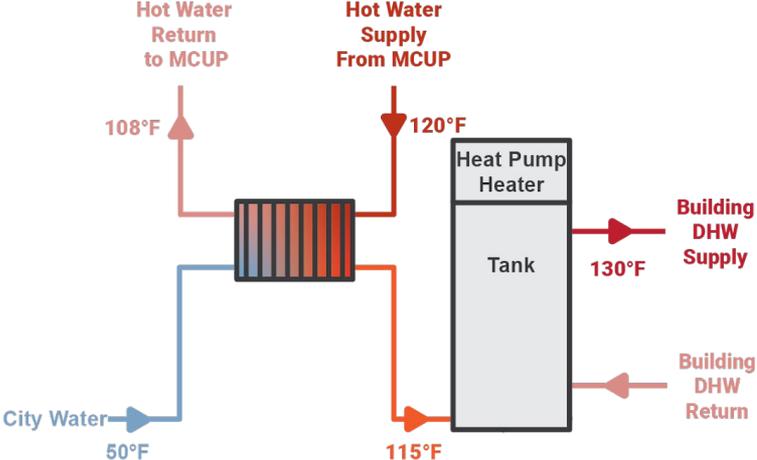
TES shifts runtime to warmer temps



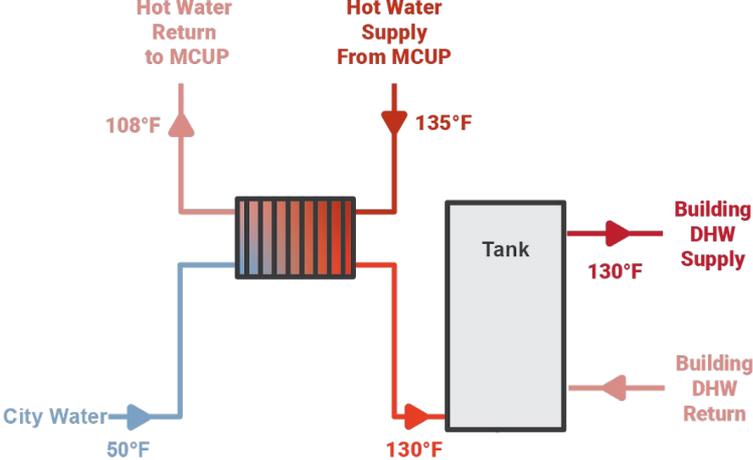
Include supplemental heat pumps for existing buildings with higher temp demands

First 'stress test' existing buildings at lower temps, many buildings were oversized

Domestic Hot Water Design Options



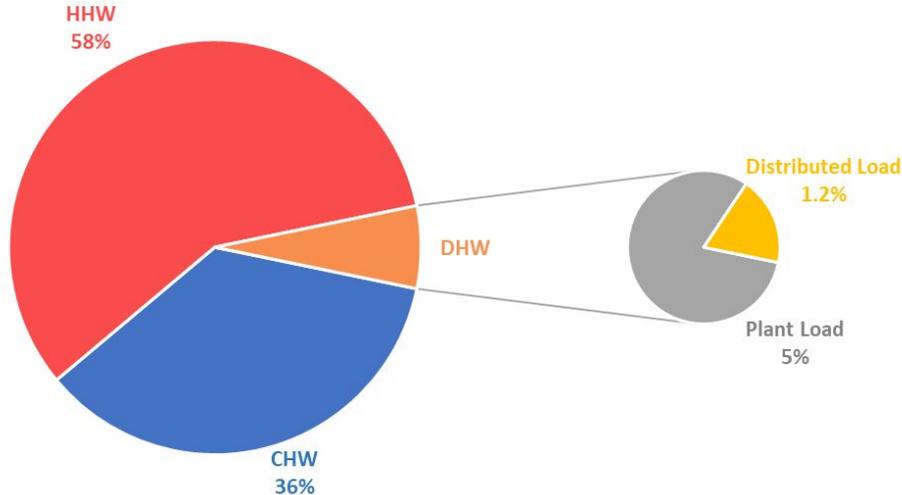
Low Temperature Plant



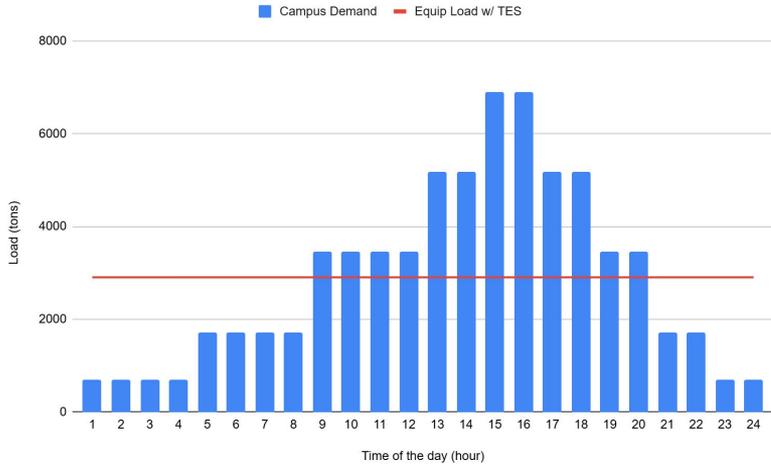
Medium Temperature Plant

Focus on Combined Plant Efficiency

	Standard Natural Gas Plant	Electric Resistance + Chiller Plant	Low Temperature Plant	Medium Temperature Plant
Plant Heating Efficiency (COP)	0.80	0.92	4.5	3.7
Plant Cooling Efficiency (COP)	8.6	8.6	7.8	6.5
Combined Plant Efficiency (COP)	1.3	1.6	5.5	4.5



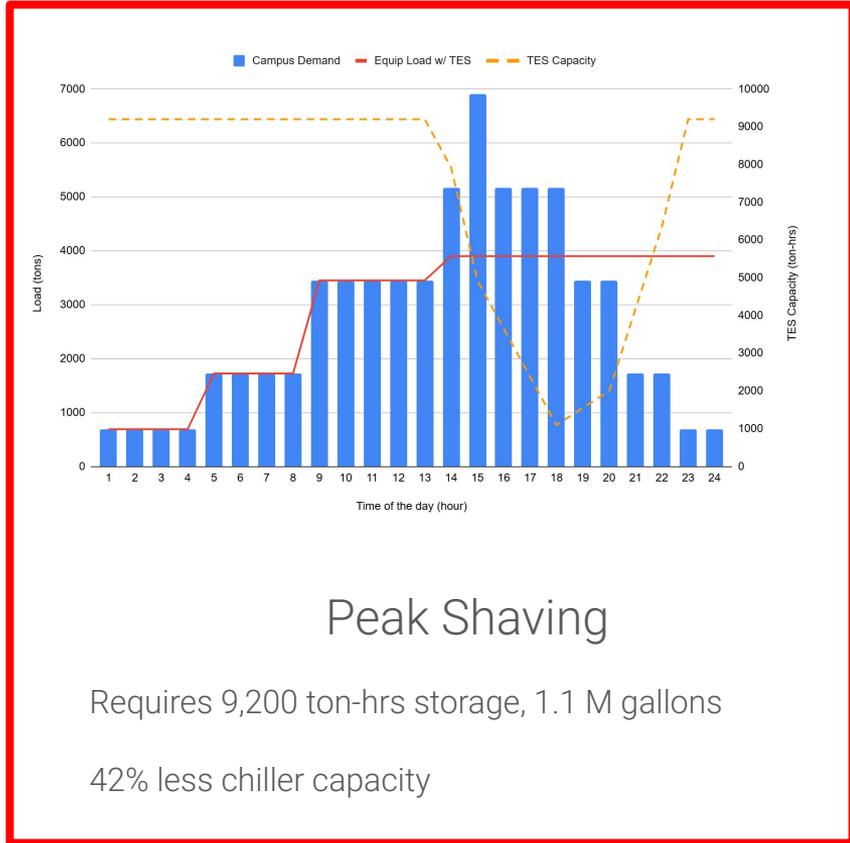
TES for Chilled Water - Peak Shaving vs Load Leveling



Load Leveling

Requires 20,000 ton-hrs storage, 2.4 M gallons

58% less chiller capacity required

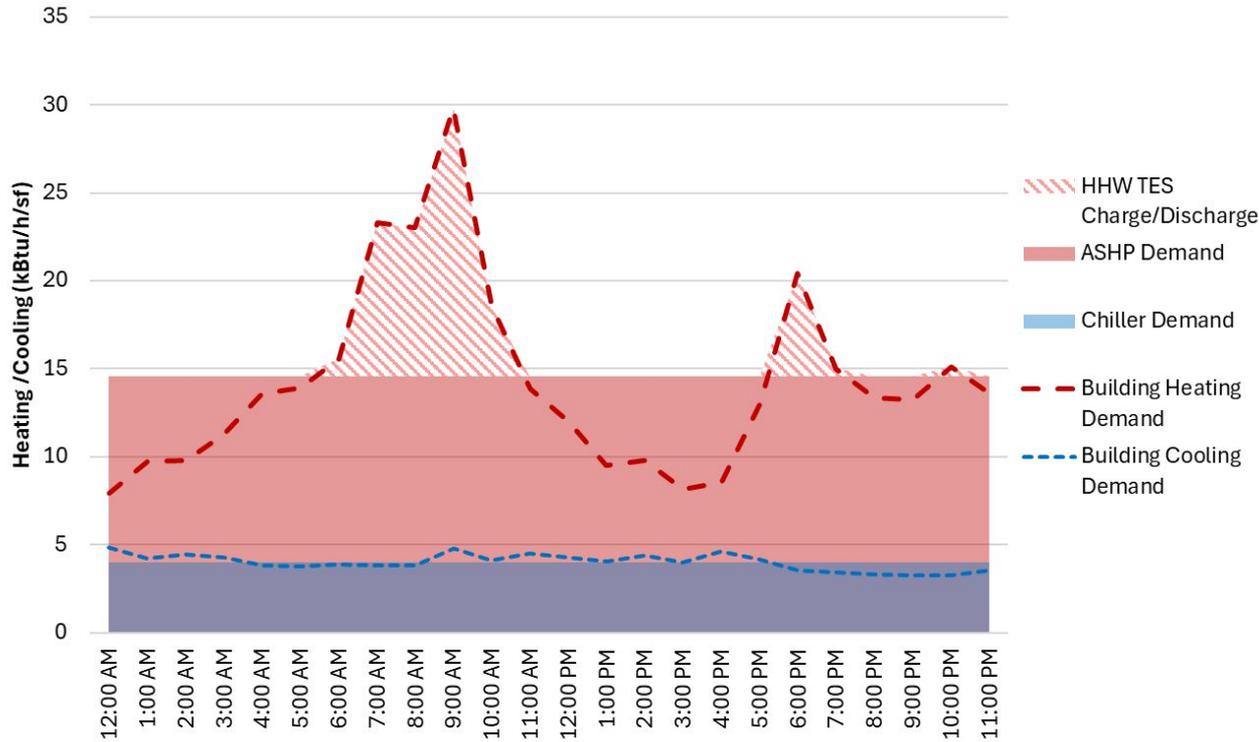


Peak Shaving

Requires 9,200 ton-hrs storage, 1.1 M gallons

42% less chiller capacity

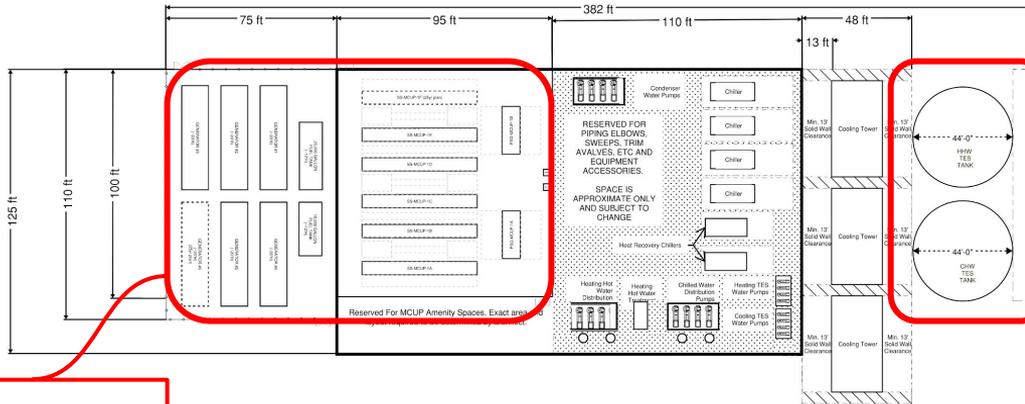
TES for Hot Water - Peak Shaving



Benefits

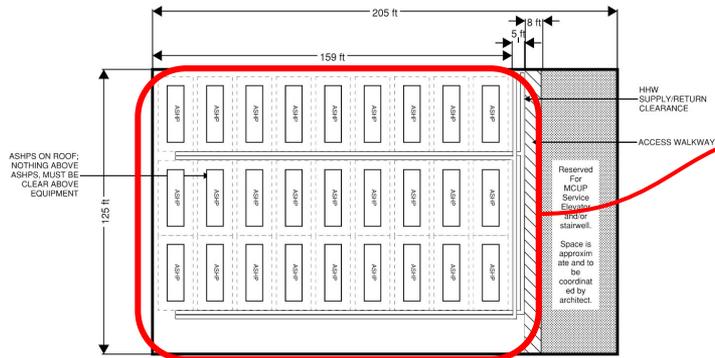
- 50% fewer ASHP's running on peak days
- Heat pumps run when ambient temps are higher, increasing efficiency
- TES stores recovered waste heat from chillers for later use

TES - Space & Cost Considerations



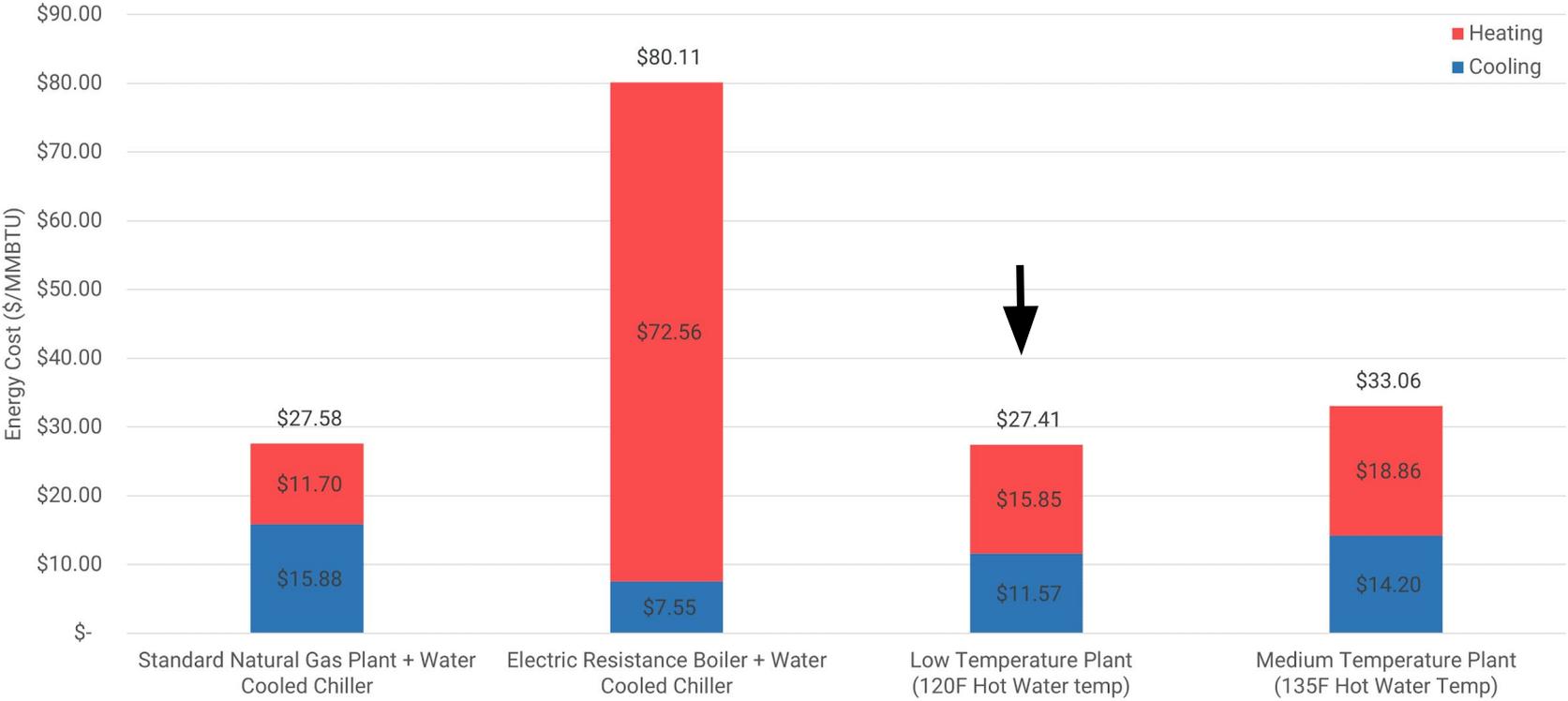
2 x 1.1M gallon TES tanks
44 ft Diam x 96 ft H

Electrical equipment space reduced with 20-25% less Chiller and ASHP demand

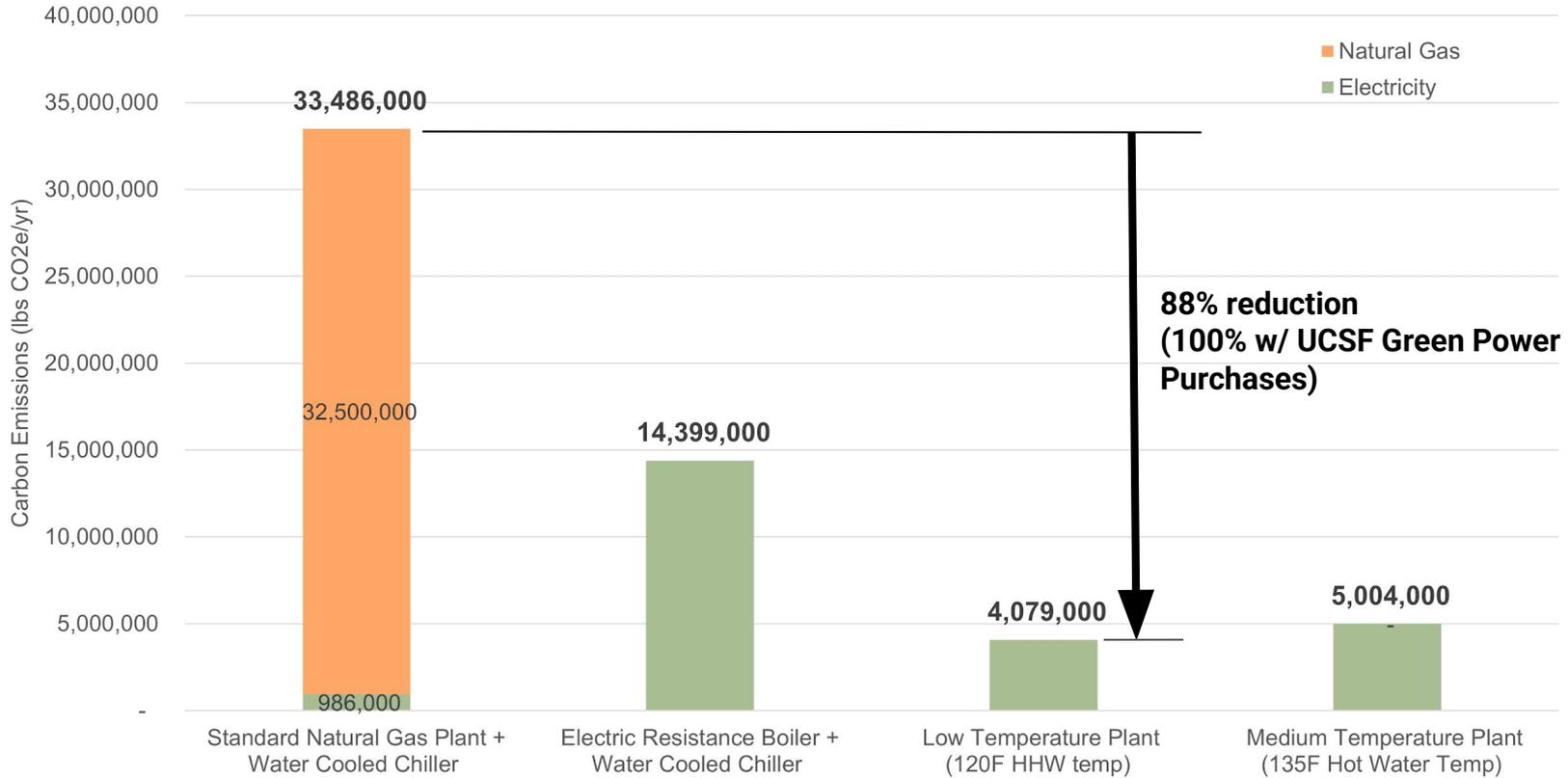


27 ASHP's needed to fit on roof (vs 36 without TES)

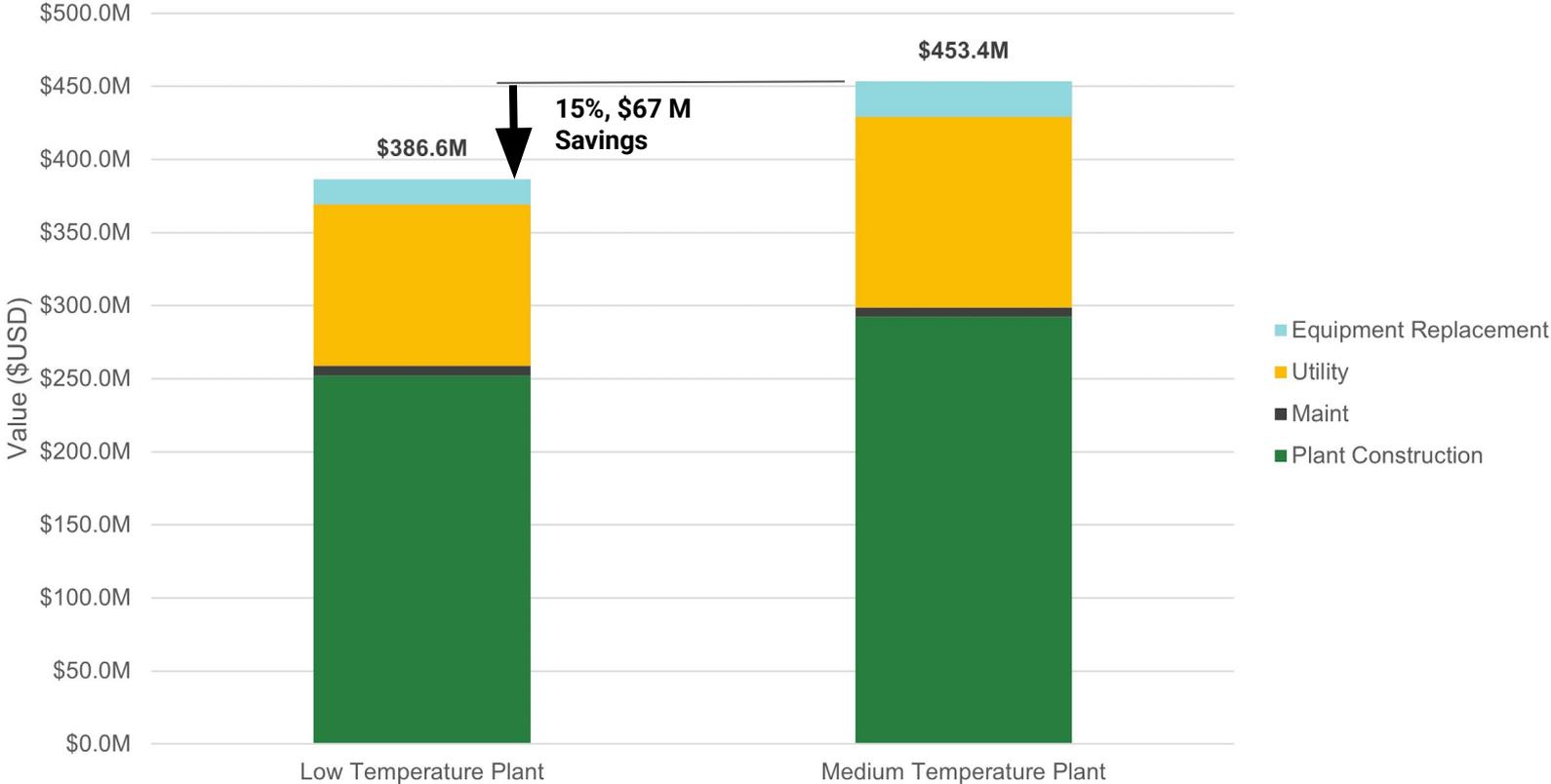
Cost Per Unit Energy Delivered



Annual Carbon Emissions Comparison



Life Cycle Cost Comparison



Summary Conclusions

1. Use historical loads to help **'right-size'** plant and identify heat recovery potential.
2. Select **'low'** 120°F hot water design temperatures to maximize heat recovery chiller and air source heat pump performance.
3. Use Hot Water **AND** Chilled Water TES and optimally size to balance space constraints, first cost, and operating cost savings.
4. ***All-electric district plant CAN operate as cheaply as natural gas plant AND achieve decarbonization goals***

Questions?



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