
CampusEnergy2021
BRIDGE TO THE FUTURE
Feb. 16-18 | CONNECTING VIRTUALLY
WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

UNIVERSITY of DENVER

Now Comes the Hard Part of De-carbonization!

Electrified Campus Heating Systems

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Affiliated Engineers

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Q&A Will Not Be Answered Live

Please submit questions in the Q&A box.
The presenters will respond to questions off-line.

Campus Overview

- Founded in 1864 as Colorado Seminary in the Colorado Territory
- Great Private University dedicated to the Public Good
- 3.8 million square feet over 125 acres in the City of Denver
- 11,500 students & 3,800 staff/faculty
- Campus is a working Arboretum
- 18 of 88 Buildings on chilled water distribution system
- 12 of 88 Buildings on low pressure (10psig) steam distribution system

University Hall: 1892

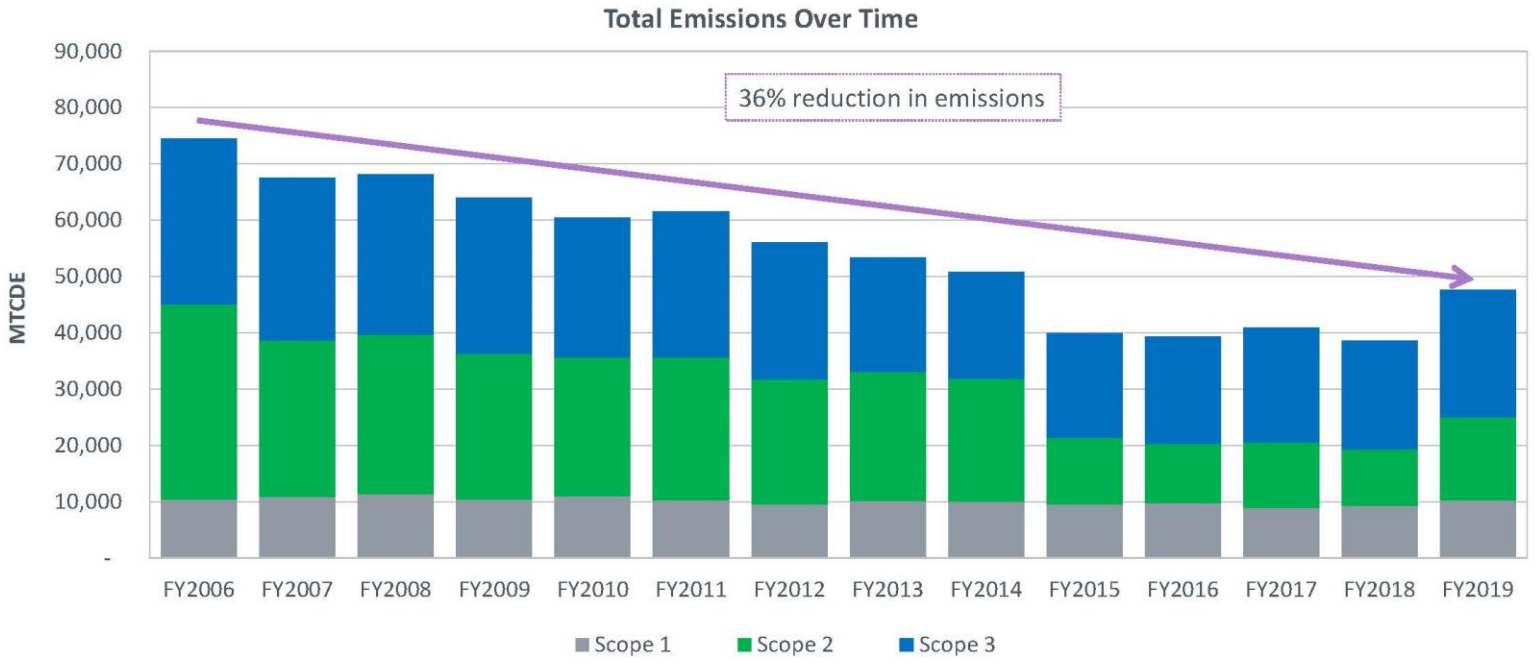
Burwell Center for Career Achievement: 2020

Study Objectives

1. Sustainability Goals & Results
2. Steam to Hot Water Conversion Feasibility
3. System Comparisons
4. Findings
5. Next Steps

Sustainability Goals & Results

- Carbon Neutrality by 2050
  - 24% reduction by 2020
  - 45% reduction by 2025
  - Baseline year 2006
- 5% on-site renewable by 2025
- Energy conservation projects with 5-yr payback
- Reduction of 500,000kWh annually



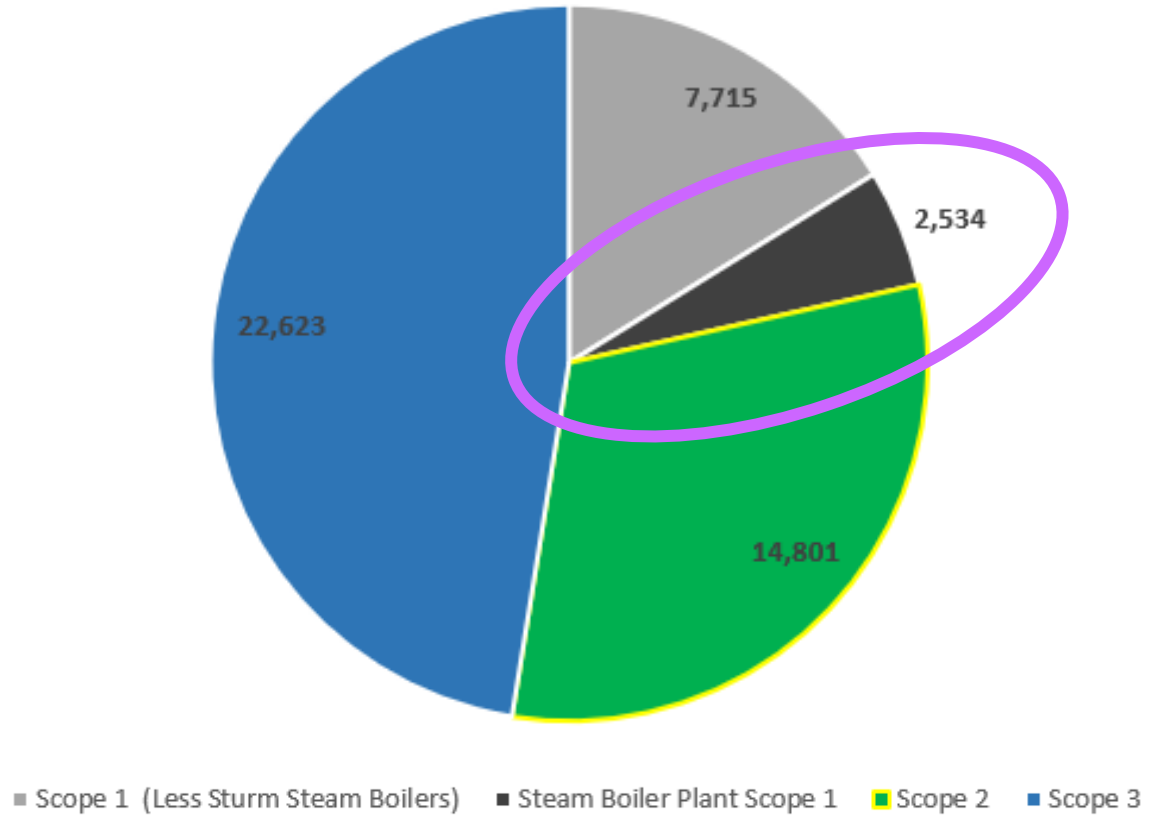
36% reduction in emissions
Below 2020 goal by 12%
Above 2025 goal by 9%

Campus Steam Plant Carbon Emissions and Study Goals

Feasibility study converting existing low pressure steam boiler system to hot water with hot water generators as the primary source.

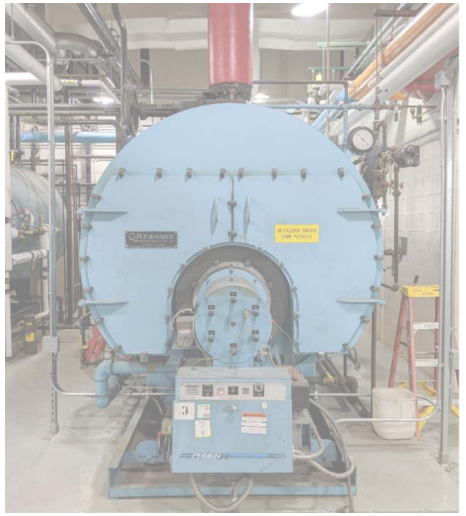
Effort aimed to:

1. Improve energy efficiency
2. Reduce Scope 1 emissions
3. Future planning



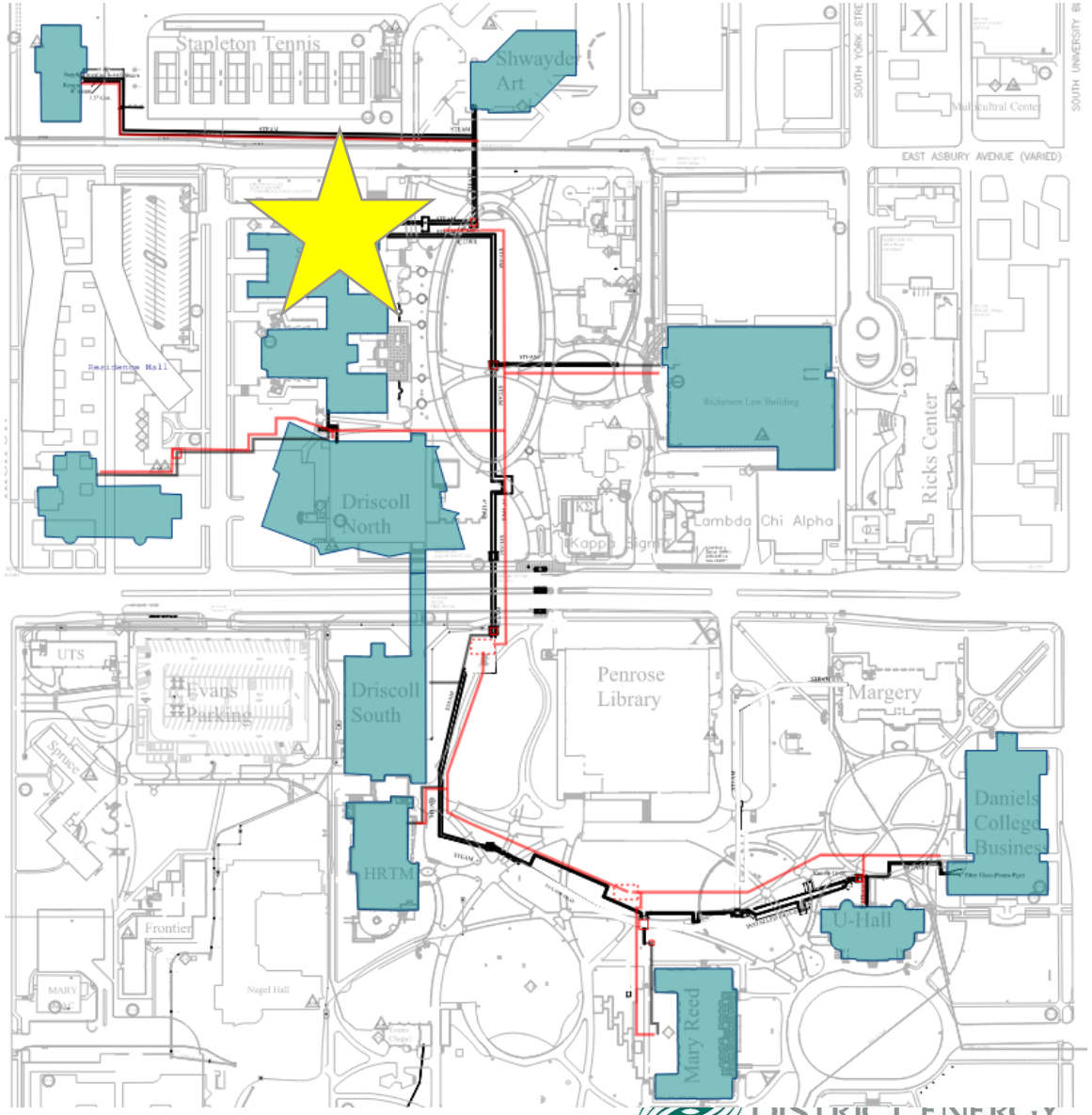
Conversion Feasibility

1. The Distribution
2. The Buildings
3. The Plant

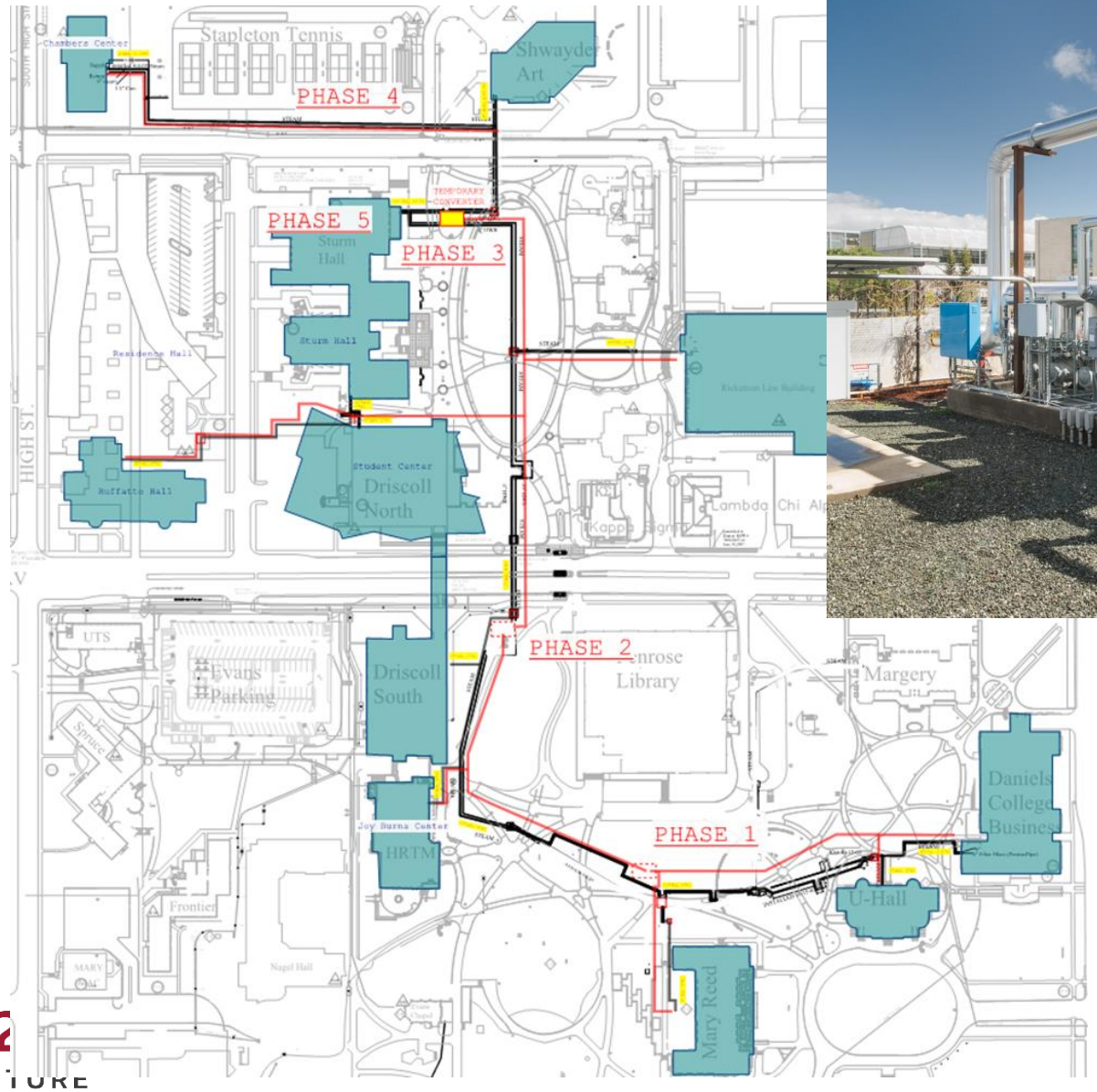


Campus System Overview

- Low pressure steam boiler plant serves 12 Buildings or 20% of DU's Building Stock with a Firm Capacity of 1200HP
- Approx. 15,000ft of direct buried steam piping with buried isolation valves in some locations and most shutoff valves within buildings.
- New Distribution installed late 90s and early 2000s

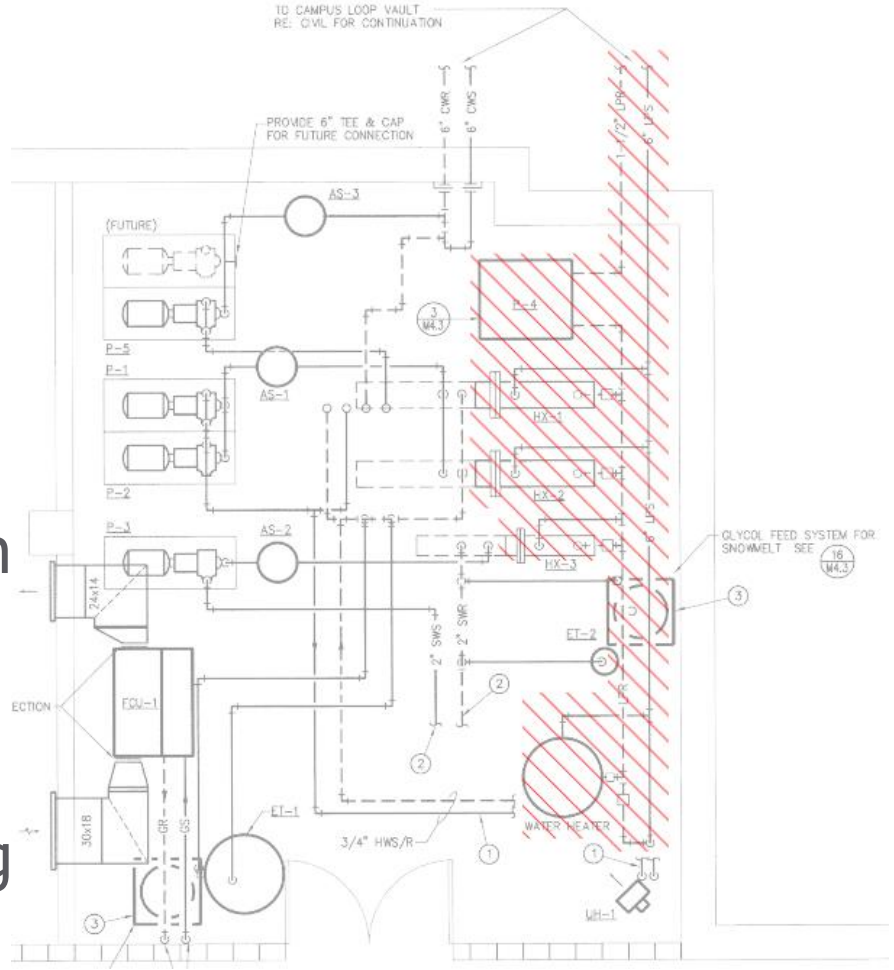


Distribution Conversion



Building Conversion Example

- Replace converters w/ plate & frame heat exchangers
- Replace steam heated domestic water heater with water heated domestic water heater
- Demolish existing steam lines to building and install new HW



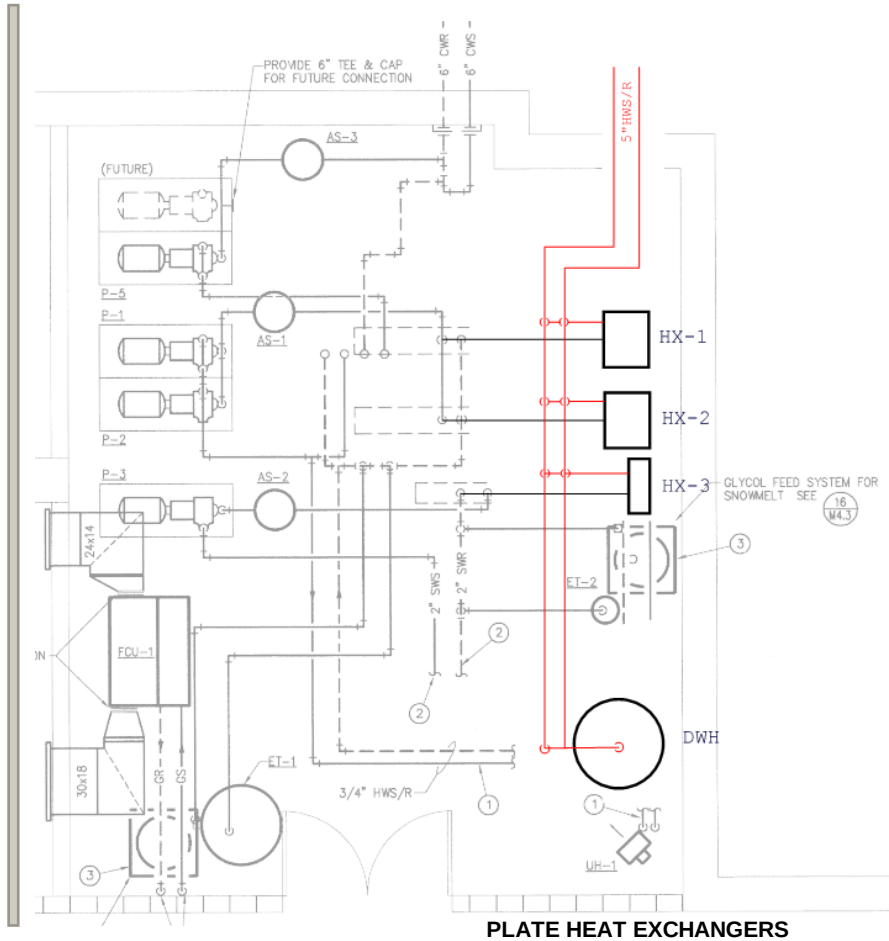
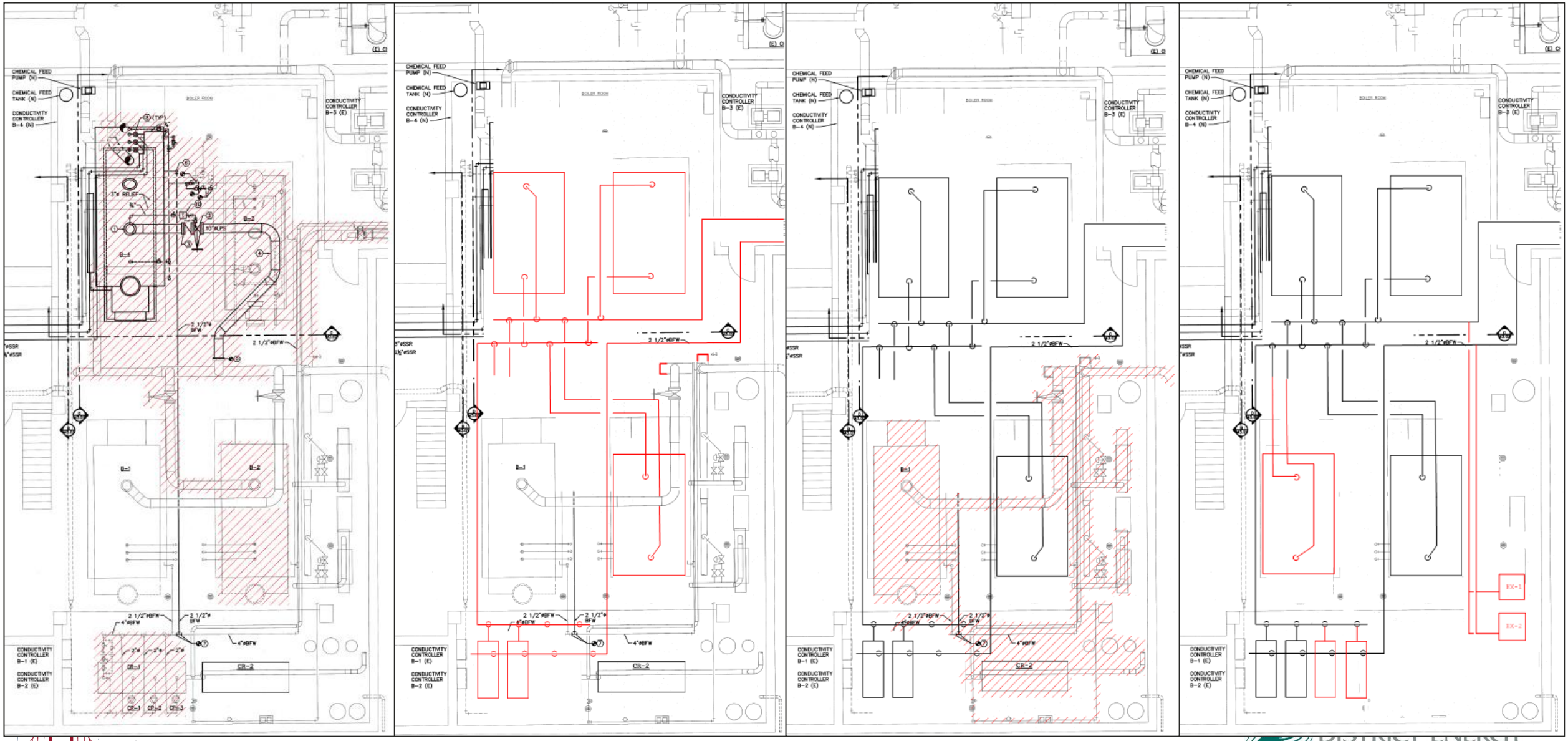


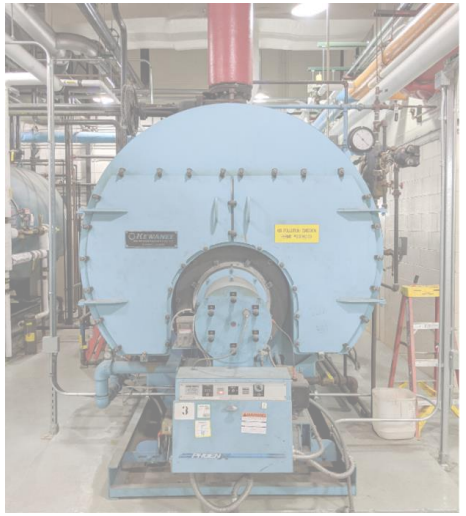
PLATE HEAT EXCHANGERS

MARK (HX)	LOCATION	TYPE	TOTAL CAPACITY (MBH)	DESIGN DUTY HEAT TRANS. AREA MIN. (FT²)	ADD'L PLATES FACTOR FOR FOULING (%) (1)	FRAME FUTURE PLATE CAP. (2)	HOT SIDE						COLD SIDE						UNIT DIMENSIONS			REMARKS
							FLUID	FLOW (GPM)	EWT (°F)	LWT (°F)	PD (FT)	DESIGN PRESSURE (PSIG)	FLUID	FLOW (GPM)	EWT (°F)	LWT (°F)	PD (FT)	DESIGN PRESSURE (PSIG)	WIDTH MAX. (FT)	HEIGHT MAX. (FT)	LENGTH MAX. (FT)	
	DANIELS	PLATE & FRAME	1500					150					30% GLY.	150	180	200	3					HEATING
	DANIELS	PLATE & FRAME	1500					150					30% GLY.	150	180	200	3					HEATING
	DANIELS	PLATE & FRAME	340					32					30% GLY.	32	180	200	1.2					SNOWMELT

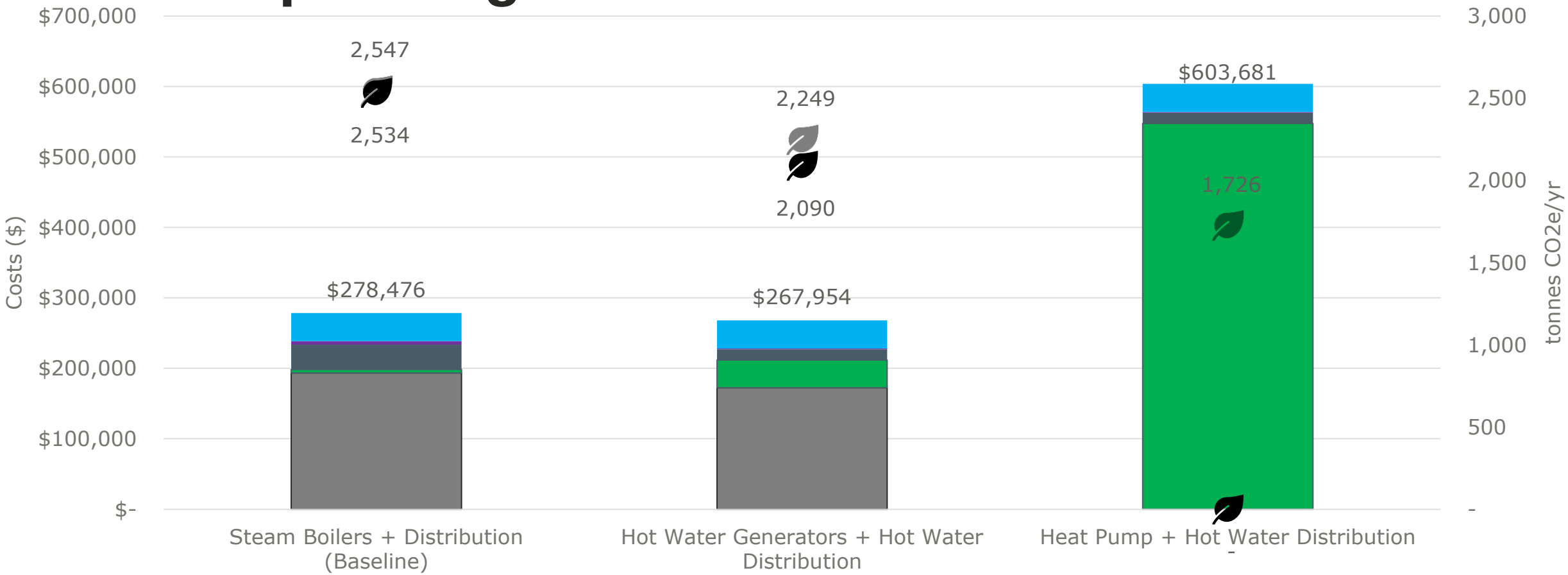
Plant Conversion



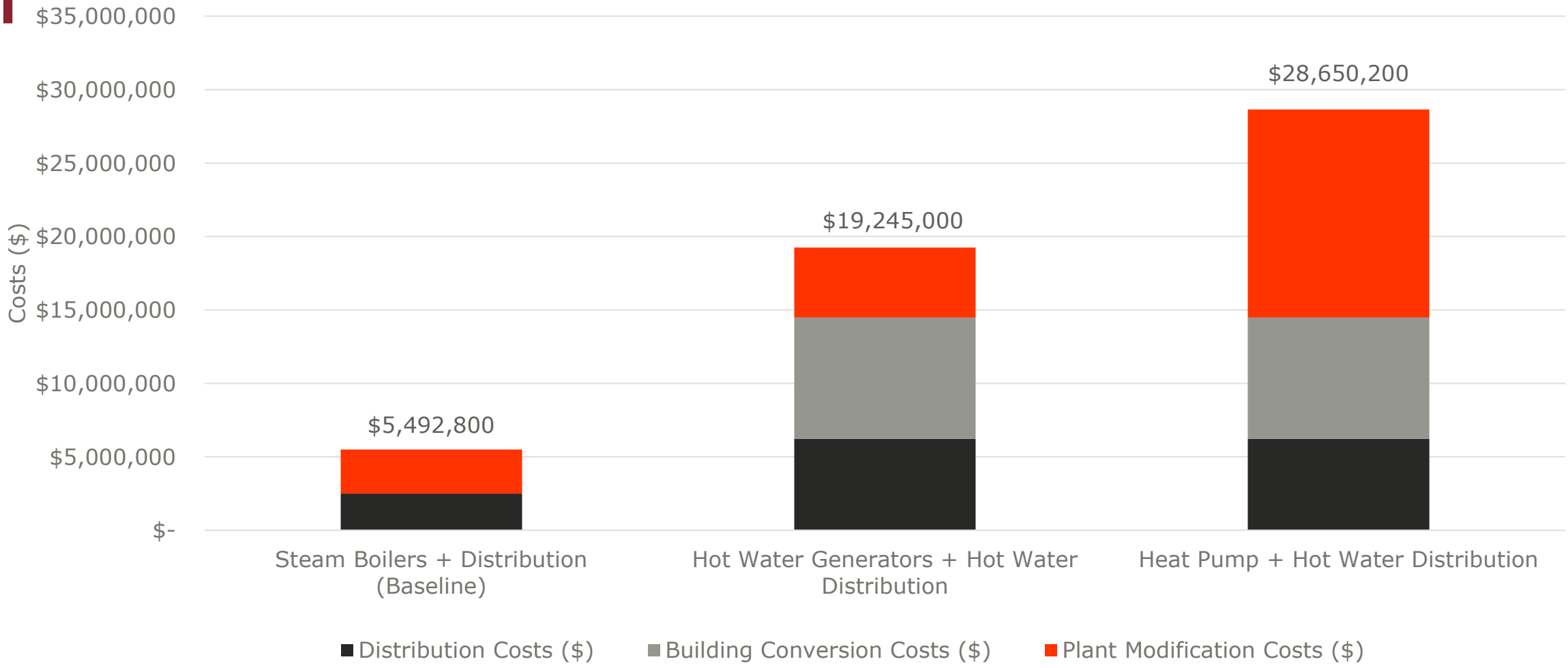
System Comparisons



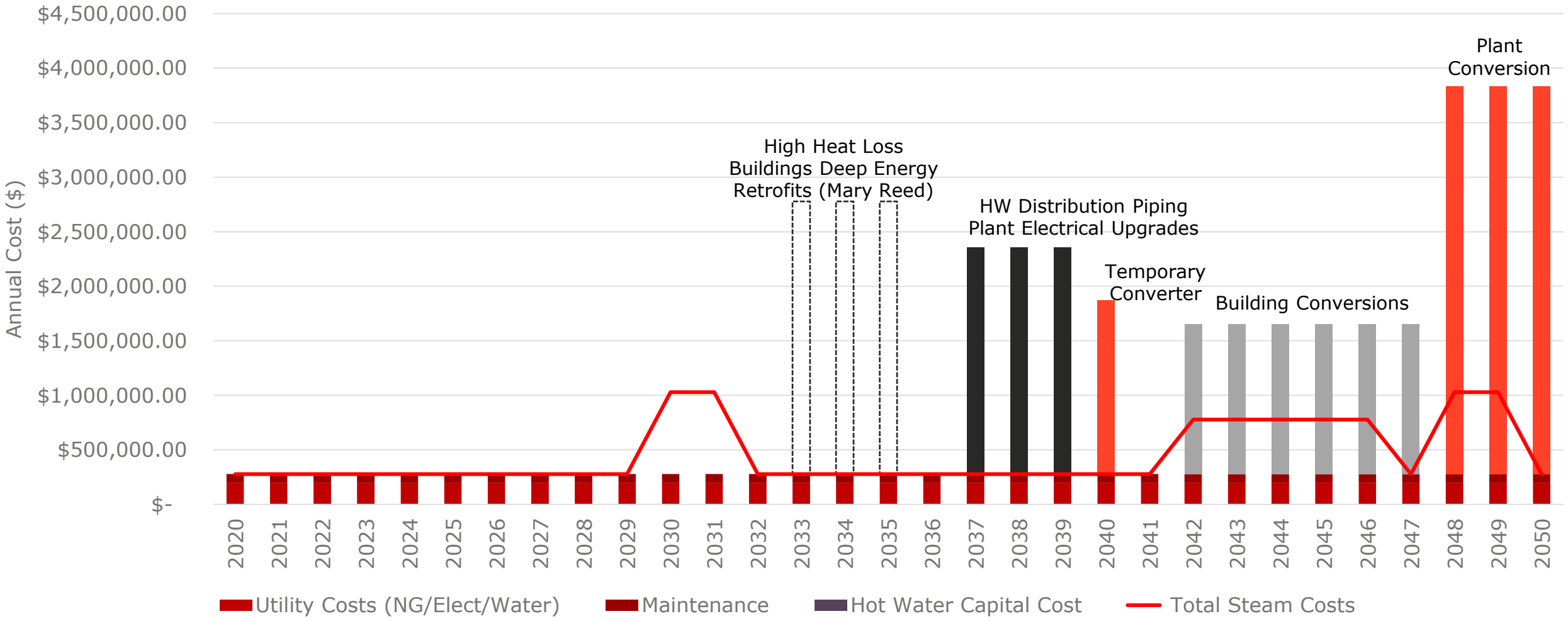
Annual Operating Costs



Conversion Capital Estimate



Conversion Cost Estimates



Study Findings

Hot Water Generator

1. No return on investment in comparison to BAU
2. $998/MTCDE Net present cost

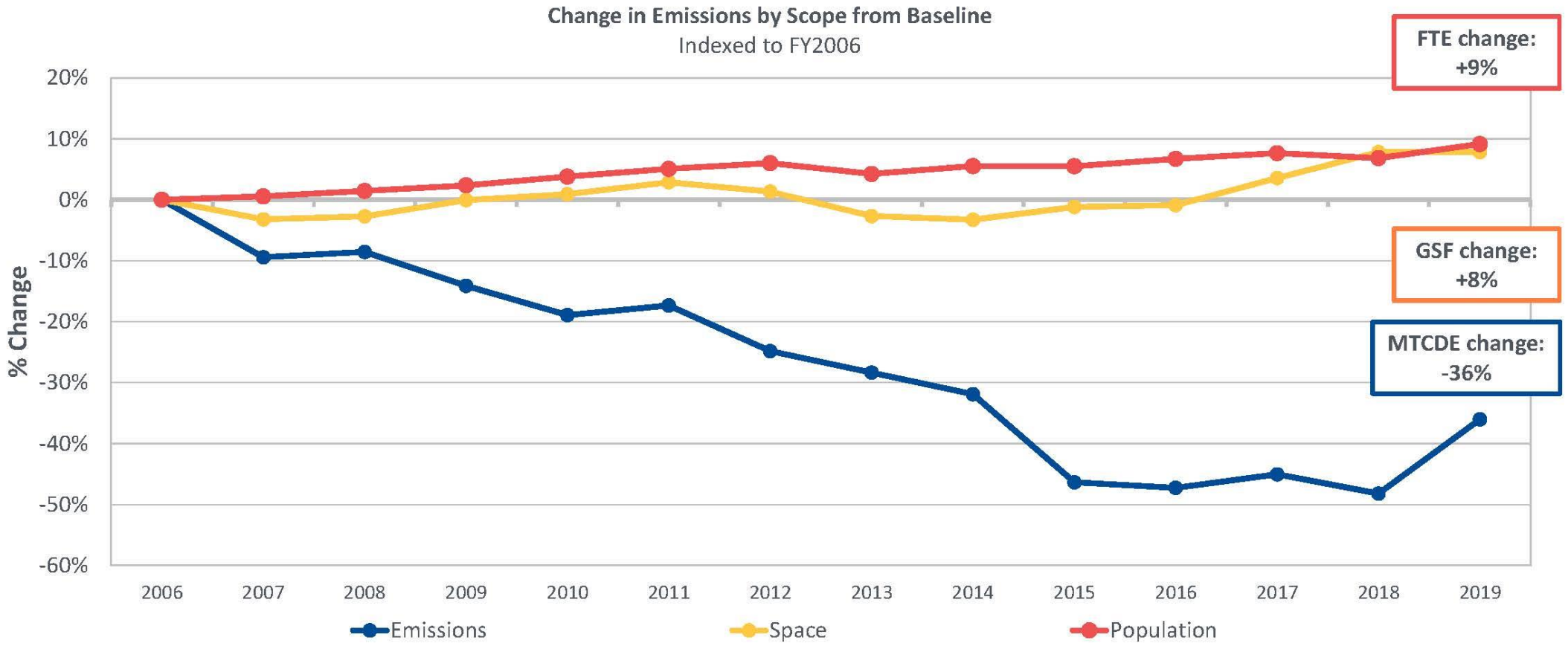
Heat Pump

1. Return on investment possible when paired with campus chilled water production and need for steam system deferred maintenance
2. $372/MTCDE Net present cost

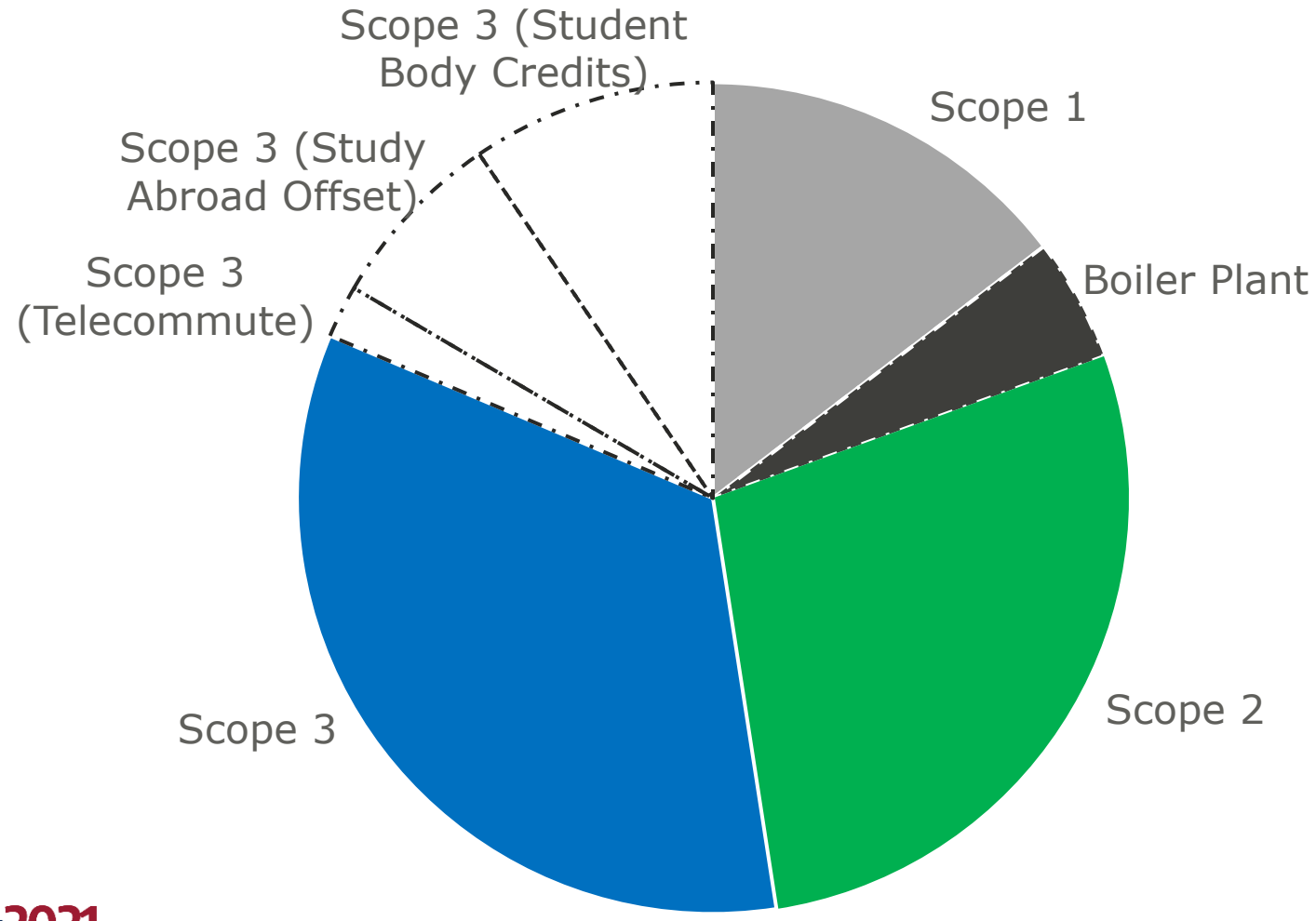
Study Recommendations

1. **Continue funding excellent steam system maintenance**
2. Inventory Building Loads and Install Building Meters
3. Building Energy Audits
4. Develop action plan for low carbon emissions campus heating solutions
5. Develop campus design standards to support electrified utilities
6. Pursue study to electrify campus thermal utilities
7. Investigate potential heat sources

Change in Emissions & Campus Size



Projected 2021 Campus Carbon Emissions



Next Steps

- File for REC ownership for completed Solar PPA 2.2mW project.
- Not pursuing off-site PPA – Xcel Energy commitment to carbon neutrality by 2050
- Address Scope 1 and 3 emissions
  - Natural gas consumption
  - Travel
  - Commuting
- Campus Growth: 3 new buildings (285,000 GSF) coming online in FY21
- Energy Master Plan for pathway to carbon neutrality
  - Student Government just passed a resolution for neutrality by 2030

Thank You

Lynn Bailey

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AEI Affiliated Engineers