

LEADING THE WAY **CampusEnergy**2022

Feb. 15-18 | Westin Boston Seaport District Hotel | Boston, Mass.





Amherst College – Decarbonization Plan

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Decarbonization Goals

➤ **Carbon Neutrality** by 2030

- Minimize **onsite** created emissions
- Maximize **renewable** electricity usage
- Minimize reliance on **Carbon Offsets** to achieve zero effective carbon emissions
- Implement **cost-effective** and **forward-looking** technologies
- Replace **aging, archaic** infrastructure with **modern, efficient, and flexible** systems

A tall, illuminated cable-stayed bridge at night, with its lights reflecting in the water below. The bridge features a central pylon and numerous stay cables, all brightly lit against the dark sky. The reflection of the bridge is clearly visible in the calm water in the foreground.

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- The map illustrates the layout of the University of North Carolina at Chapel Hill campus. It features a central area with the Student Center and Old Well, surrounded by numerous academic and administrative buildings. The campus is characterized by its extensive green spaces and tree-lined streets. Key streets shown include College Street and South Pleasant Street. The map also indicates the locations of various sports fields, including Hitchcock Field, and other facilities like the Tennis Court and Merrill Apts.

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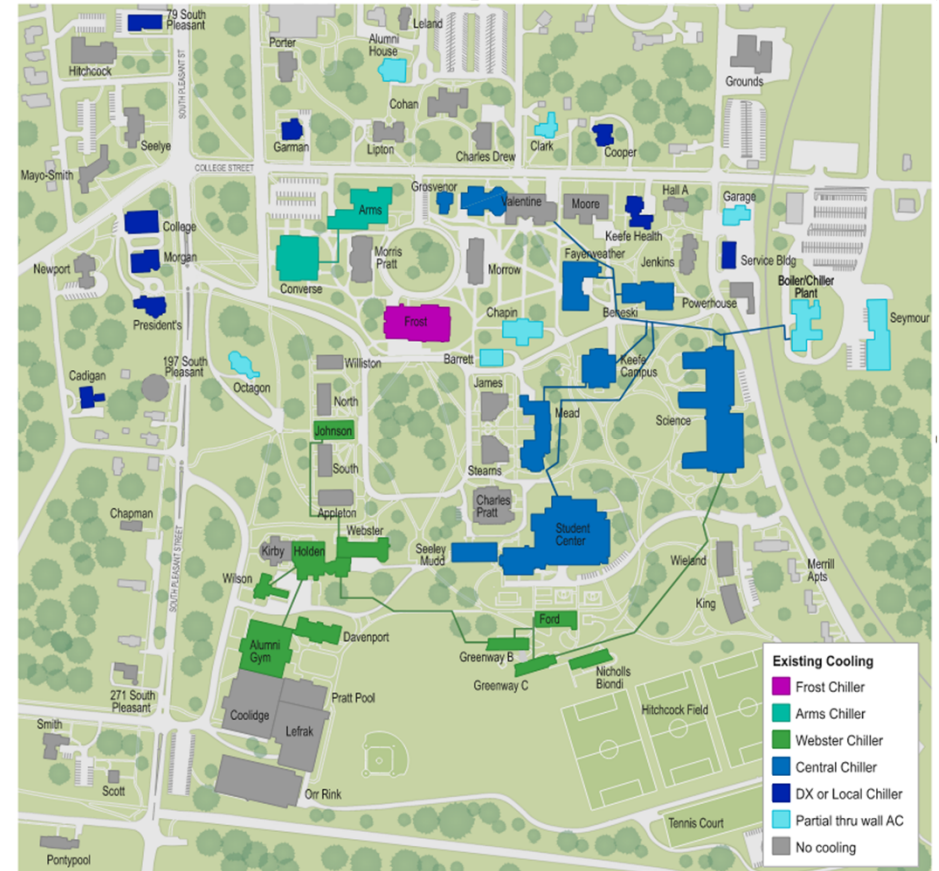


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A tall, illuminated cable-stayed bridge at night, with its lights reflecting in the water below. The bridge features a central pylon with numerous stay cables fanning out to the deck. The pylon is topped with a red light. The bridge deck and its reflection are brightly lit, creating a vibrant contrast against the dark night sky and water.

Cooling Systems

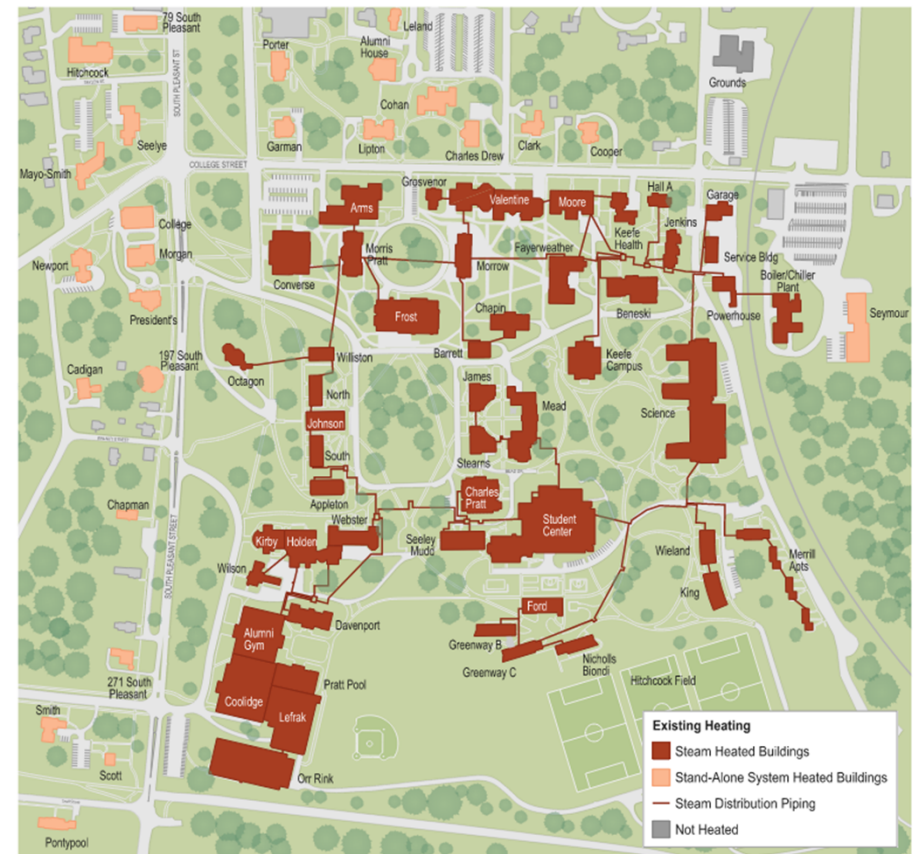
- Central Chiller Plant
 - Outdated Refrigerant
 - 8 buildings (529k GSF)
- Steam Absorption Chillers (Arms, Webster, Frost)
 - Extremely inefficient technology
 - 13 Buildings (505k GSF)
- Standalone Cooling (DX, local chillers, window units)
 - Outdated refrigerant
 - 27 Buildings (364k GSF)
- No Cooling
 - 34 Buildings (686k GSF)



Existing Heating Systems

Heating Systems

- Steam Heating Network (Boiler Plant)
 - Steam network dates to 1927
 - 50 Buildings (1.6 million GSF)
- Standalone Heating (local boilers and furnaces)
 - 32 Buildings (430k GSF)







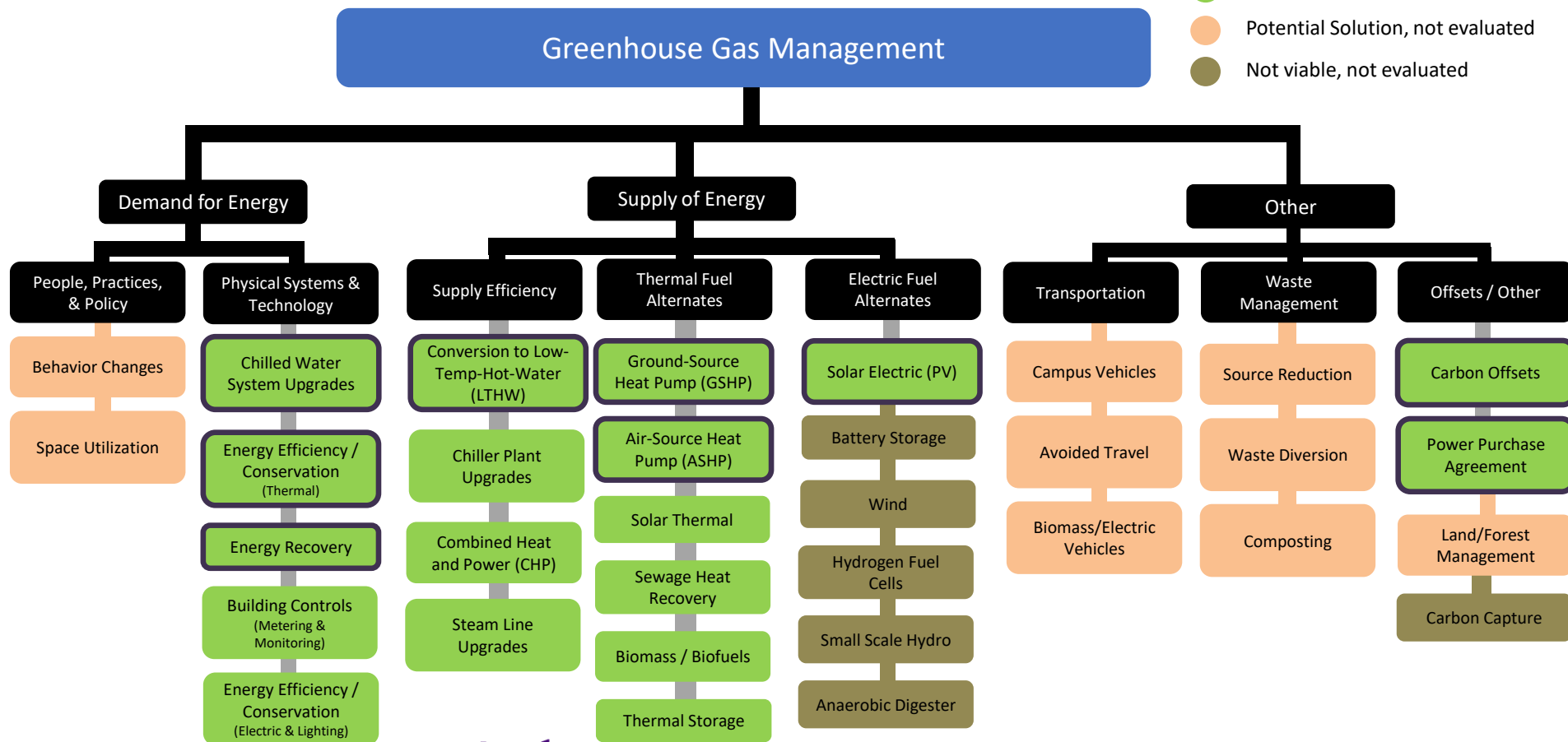


Decarbonization Guiding Principles

- **Minimize** burning fossil fuels
- De-commission steam (by 2030)
 - Convert to **hot water distribution system**
- **Electrify** heating load
 - Purchase renewable electricity
- **Redundancy**
 - Minimize single point of failure on heating system
- **Resiliency** (weather extremes)
- **Optionality** (future expansion, future technology, etc.)

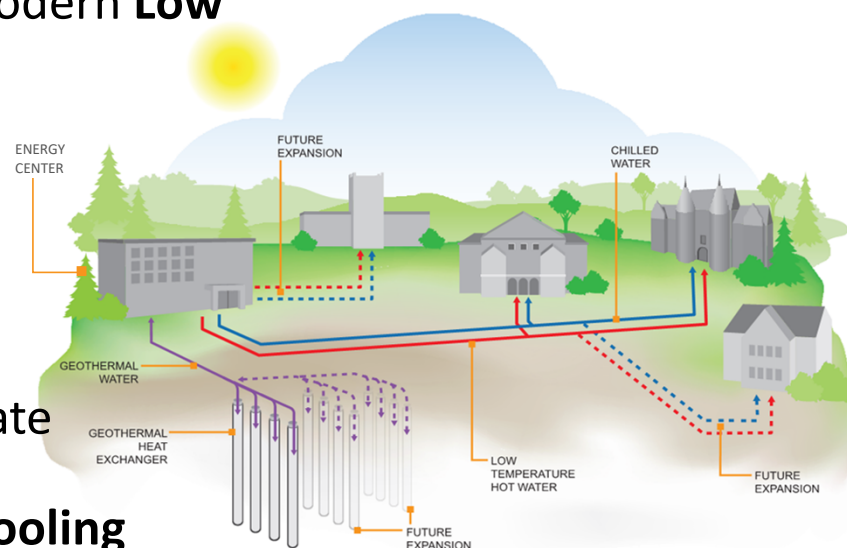
Decarbonization Strategies

-  Recommended Solution, evaluated
-  Potential Solution, evaluated
-  Potential Solution, not evaluated
-  Not viable, not evaluated

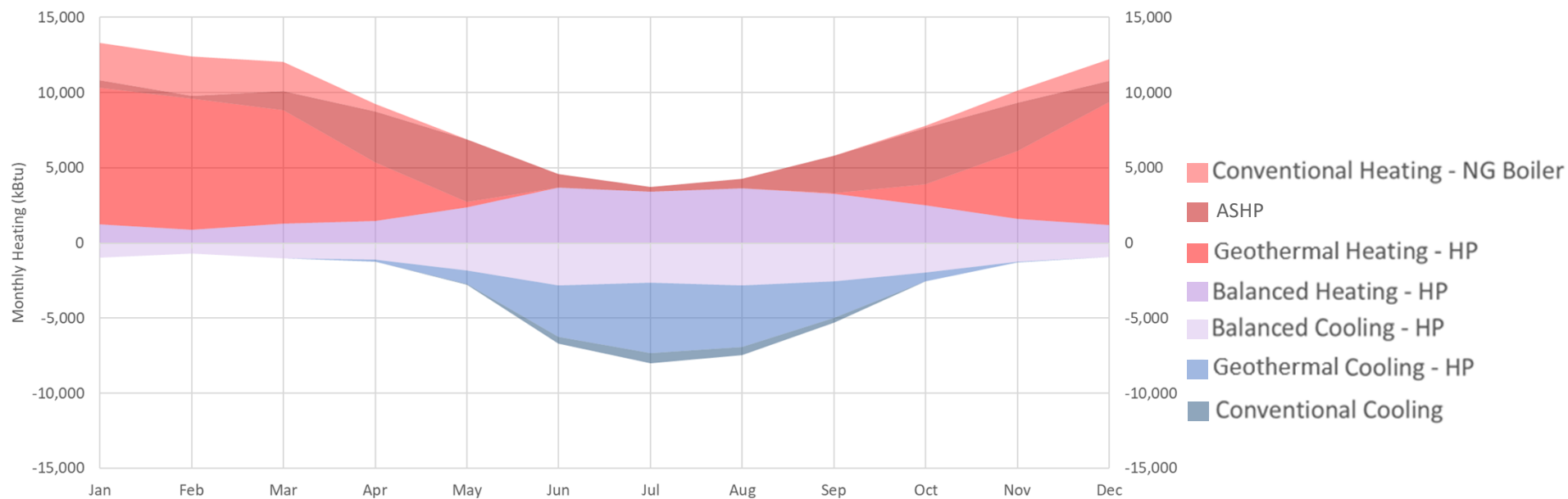


Path to Decarbonization

- Maximize **Energy Efficiency**
- Convert from antiquated and archaic steam to modern **Low Temperature Hot Water (LTHW)** heating systems
- Electrify heating and cooling through phased implementation of Heat Pumps
 - Heat Reclamation
 - Air-Source Heat Pump (ASHP) system
 - Ground-Source Heat Pump (GSHP) system
- Combine the **central cooling systems** and eliminate antiquated steam chillers
- Create capacity for future **expansion of central cooling**
- Purchase or generate 100% of electric requirements from **renewable** sources
- Purchase **carbon offsets** for residual GHG emissions



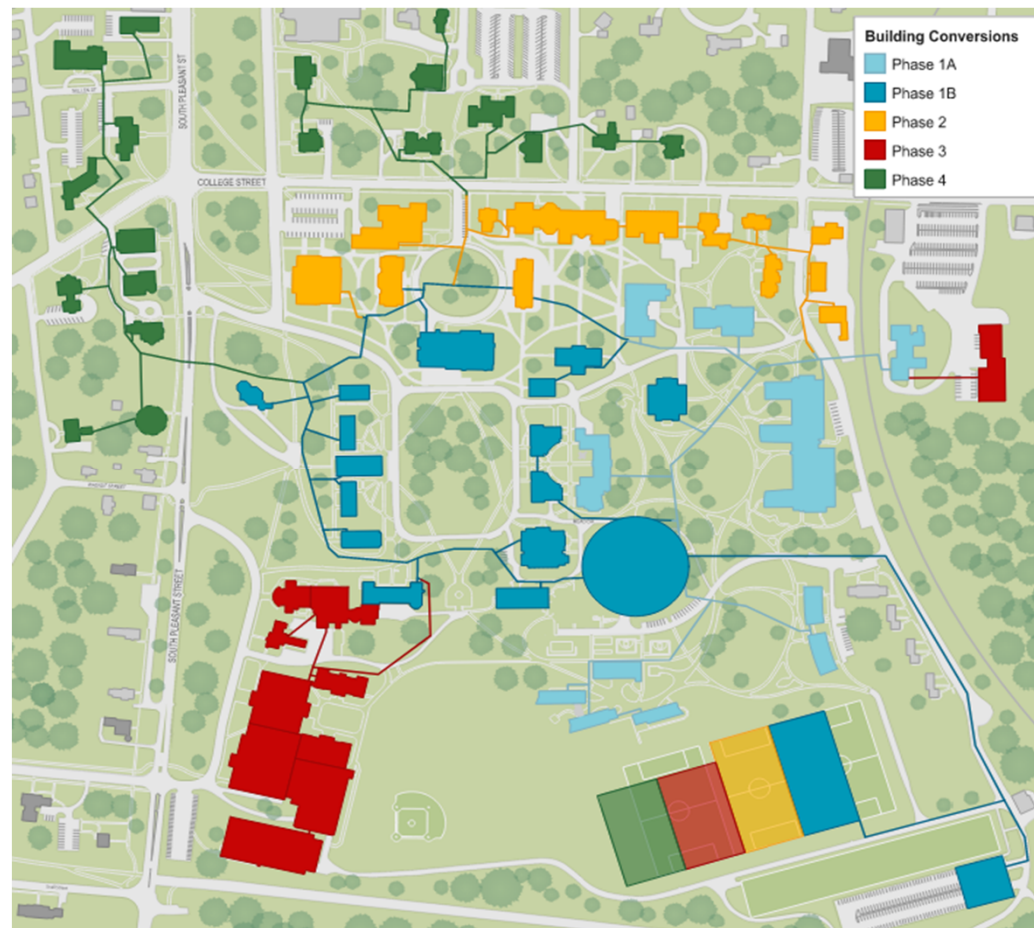
Annual Energy Profile



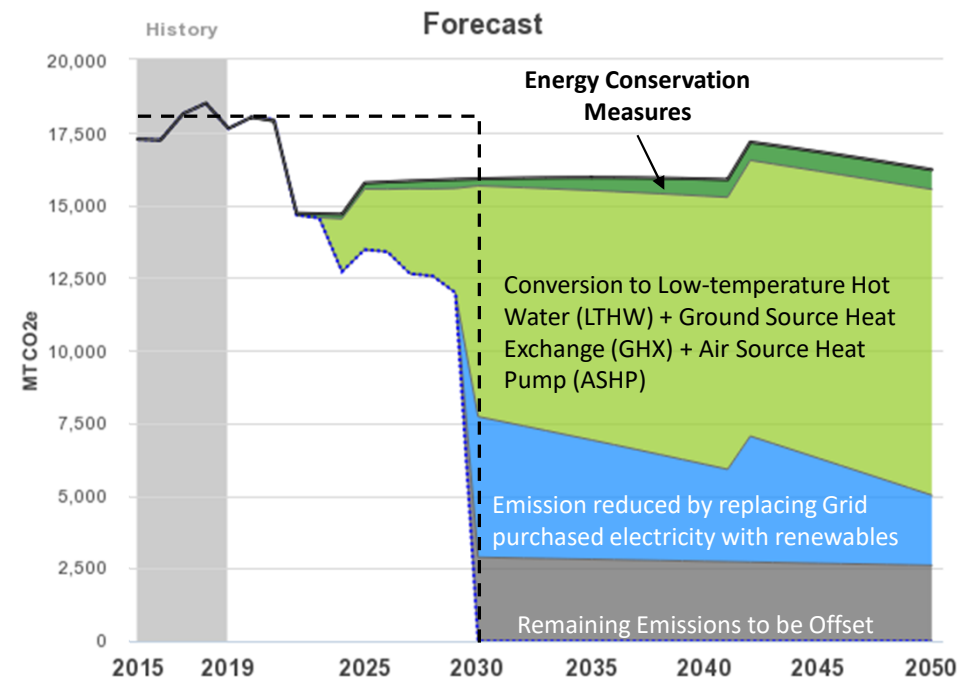
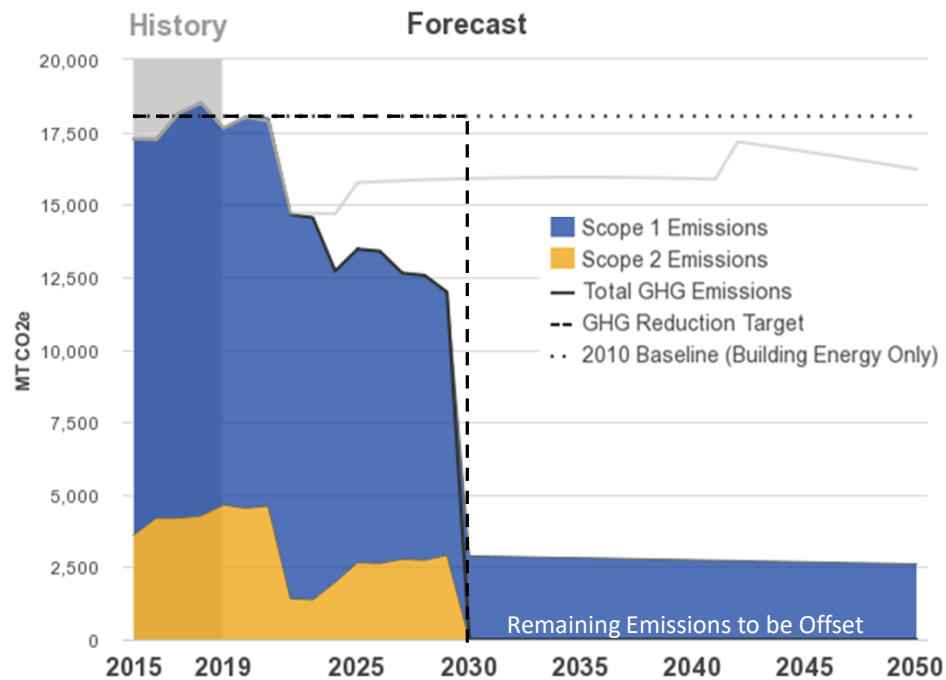
Heat Pumps produce ~80% of annual energy usage for district system

Phased Implementation

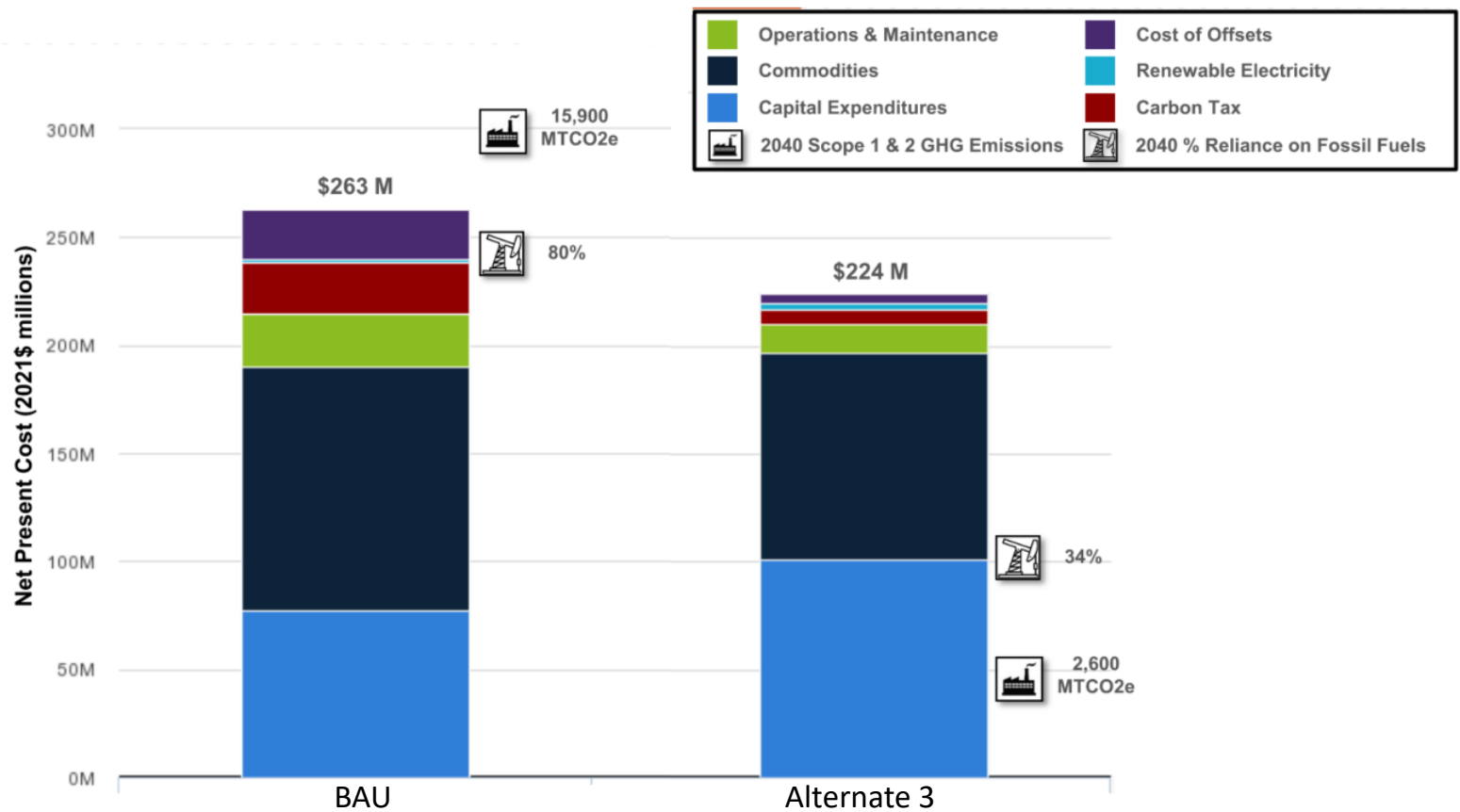
- Phase 1a – South-East Campus
- Phase 1b – Central Campus
- Phase 2 – North Core Campus
- Phase 3 – Athletic Buildings
- Phase 4 – NW Campus (Optional)



GHG Impact



Life-cycle Cost Comparison



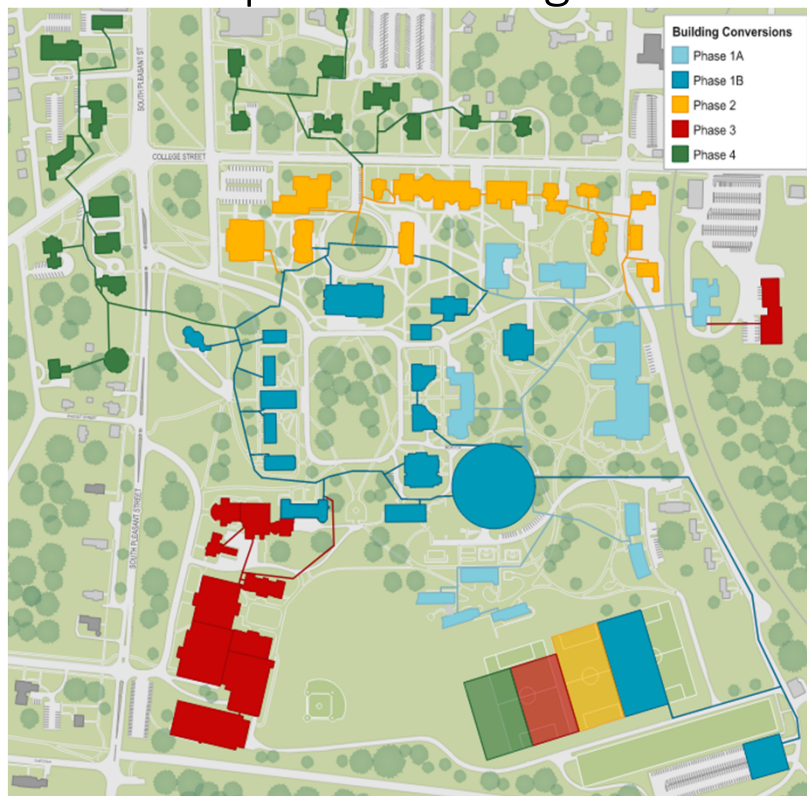


Value Propositions

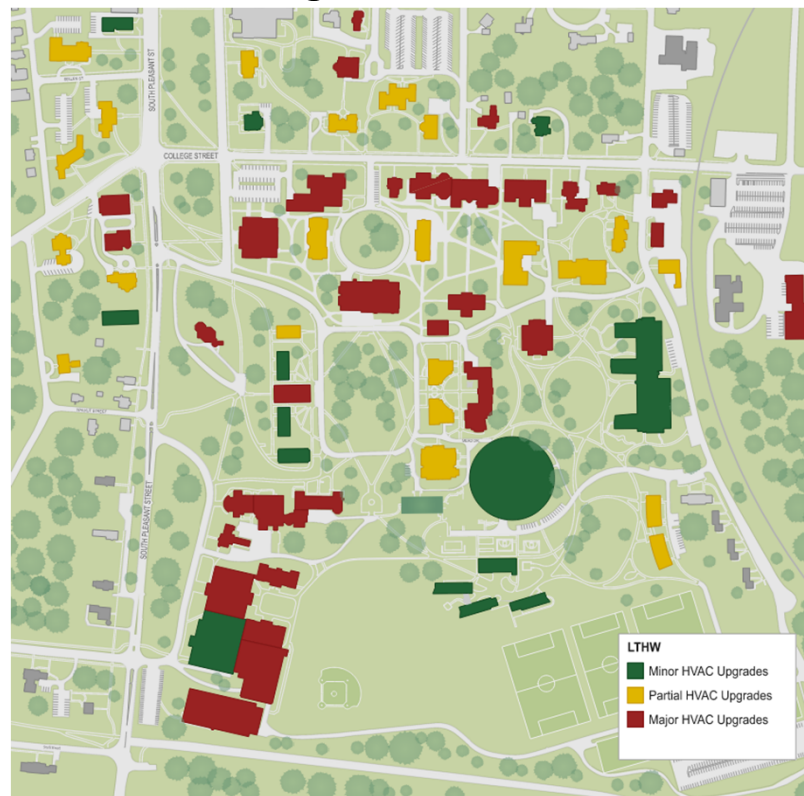
- Scope of Buildings
 - Core Campus vs peripheral buildings “in scope”
- Hot Water Temperature
 - Outdoor reset = save \$ on building conversion
- GSHP System Size
 - Diminishing returns on investment
- New Energy Center Location & Type of Construction
 - Real estate / architecture vs Cost

Value Proposition – Buildings

Scope of Buildings



Building Conversion Cost



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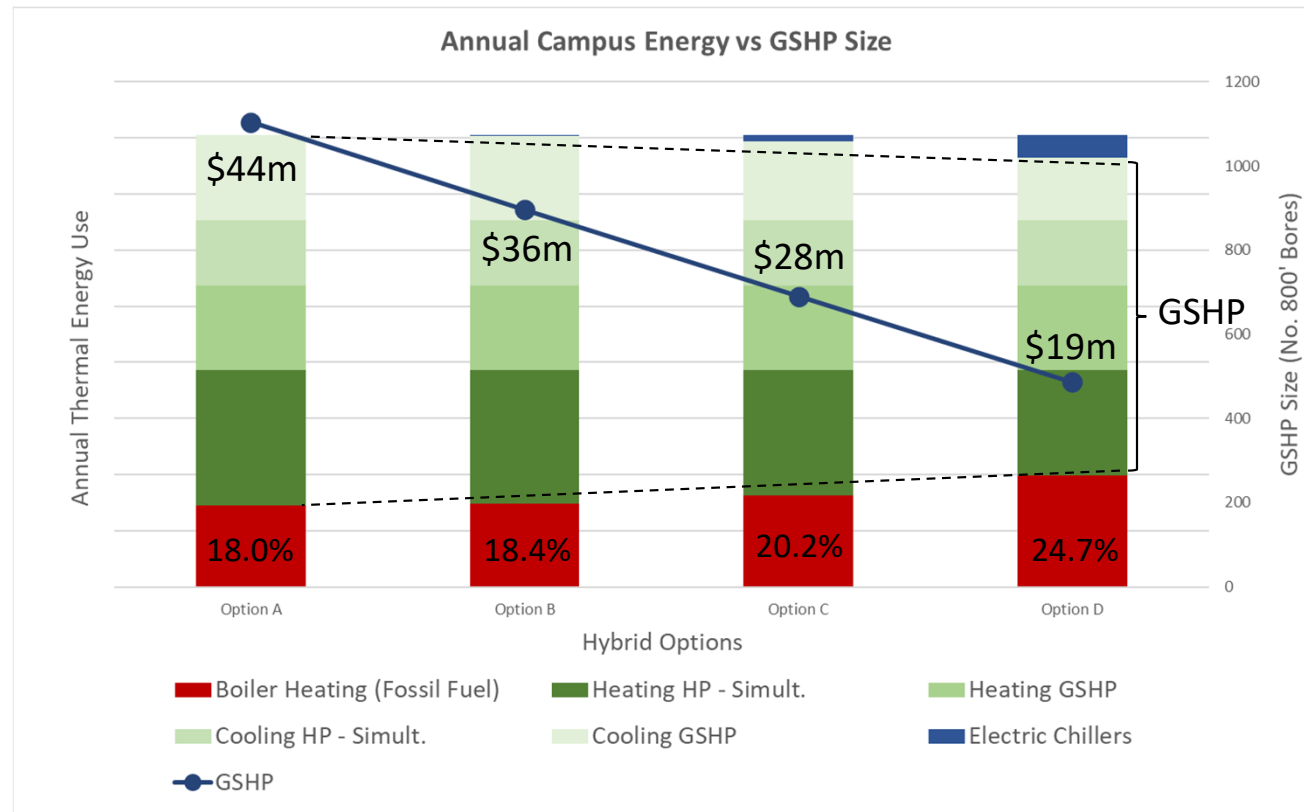
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Value Proposition – Ground Source Heat Pump Size

- **Diminishing returns** on GSHP as it increases in size.
 - GSHP is expensive investment
- Utilize **conventional and alternate systems** to supplement GSHP to optimize cost investment
 - Supplemental Heating: High-Efficiency Natural Gas Boilers and Electric Air-Source Heat Pumps
 - Supplemental Cooling: Electric Only Chillers and Cooling Towers

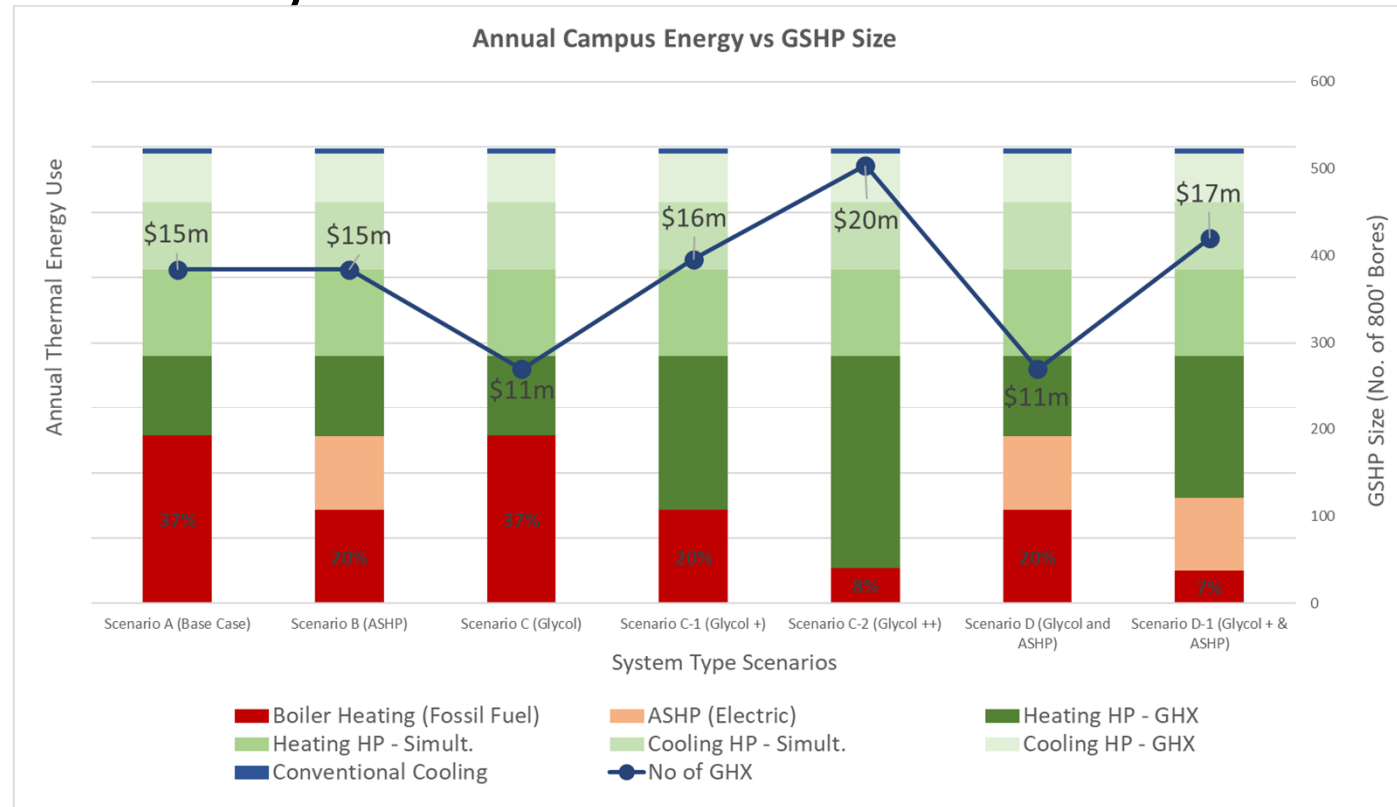



Note: Annual Energy includes added AC on campus

Value Proposition – System Scenarios

Additional Scenarios to balance cost and GHG reduction

- GSHP system Size
- Air Source Heat Pump
- Glycol



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- Value of project based on Life Cycle not only upfront capital
 - Buy-in / Commitment from Leadership
 - Capital & Disruption
 - Participation from Campus Leadership
 - Cooperation, Time, and Support
 - Thorough understanding of how energy is used on campus
 - Dialogue with colleagues and peer institutions
 - Identify comfort with innovation / new technology
 - Flexibility / “Optionality”
 - Changing campus needs, new technology, value propositions



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