De-Carbonizing the Campus: Planning, Tools & Technologies

CampusEnergy2023

February 27 – March 2, 2023

Gaylord Texan Resort & Convention Center | Grapevine, Texas

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Vanderbilt University: Central Utilities Initiative

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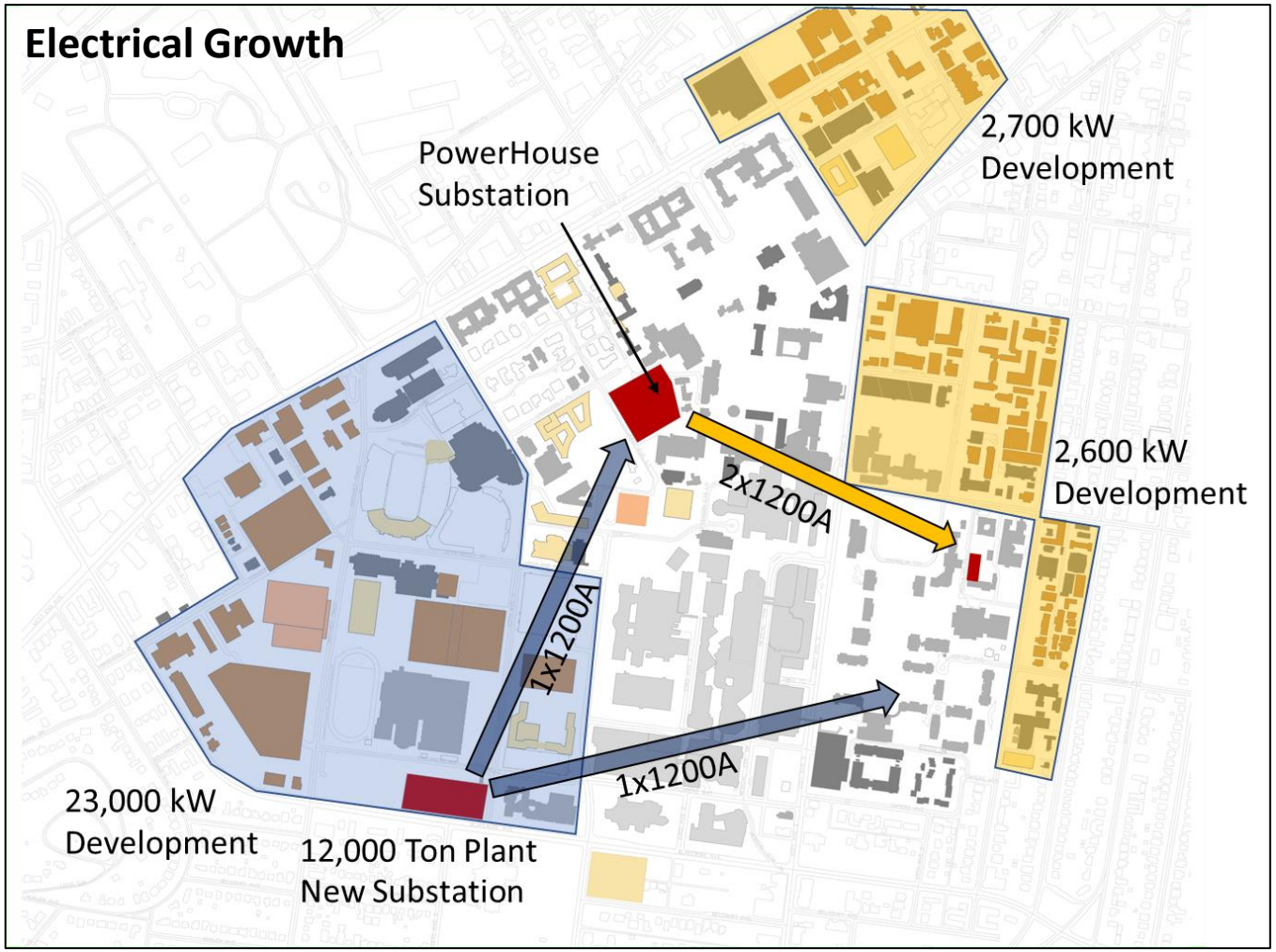
Background

- 110 Buildings over 330 Acres
- Total area ≈ 11 MSF

- Cooling (≈14,200 T Load)
  - Powerhouse (3,600 T)
  - Peabody (5,400 T)
  - Building plants
- Heating (≈290 KPPH Load)
  - NG: 460 KPPH / 360 KPPH firm
  - FO: 260 KPPH / 180 KPPH firm
- Power (≈50 MW Load)
  - 13.6 MW Onsite generation

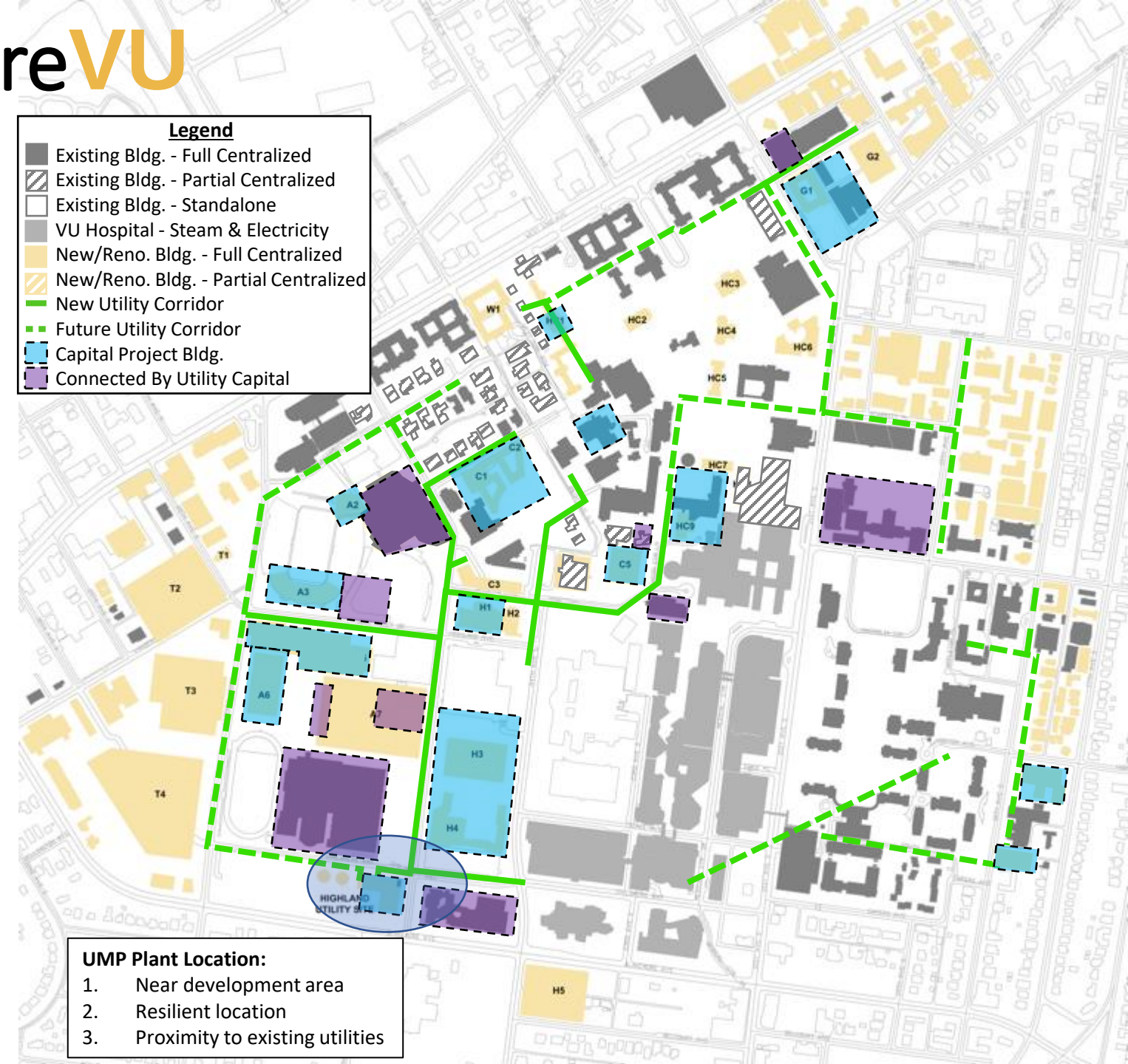
Goals for Campus Utility Infrastructure

1. Supports Vanderbilt's Mission
    a) 99% Uptime
    b) Safe
    c) Comfortable
    d) Interesting/invigorating
    e) Park like setting
    f) Non-polluting
    g) Cost effective
    h) Energy efficient
2. Provide heat, cooling & electricity
3. Maximize interconnections
4. Minimize number of plants



Flexibility for FutureVU

1. **Supports FutureVU Goals**
   - ☑ 99.999% Uptime
   - ☑ Safe
   - ☑ Comfortable
   - ☑ Interesting/invigorating
   - ☑ Park like setting
   - ☑ Non-polluting
   - ☑ Cost effective
   - ☑ Energy efficient
   - ☑ Research / Educational Opportunities
2. **First Cost: Centralized ≈ Decentralized**
   - \+ Less equipment required
   - \+ Larger equipment = installation savings
   - \+ Consolidate redundancy = less equipment
   - \+ Less space required at buildings
   - \- More distribution piping required
3. **Annual costs: Centralized < Decentralized**
   - \+ Higher efficiency = energy & GHG savings
   - \+ Lower electric rate
   - \+ Less equipment = Lower O&M
4. **Renewal cost: Centralized < Decentralized**
   - \+ Longer economic life
   - \+ Less to renew
   - \+ Less impactful to users
   - \+ Easier to pivot to plug / play new technologies

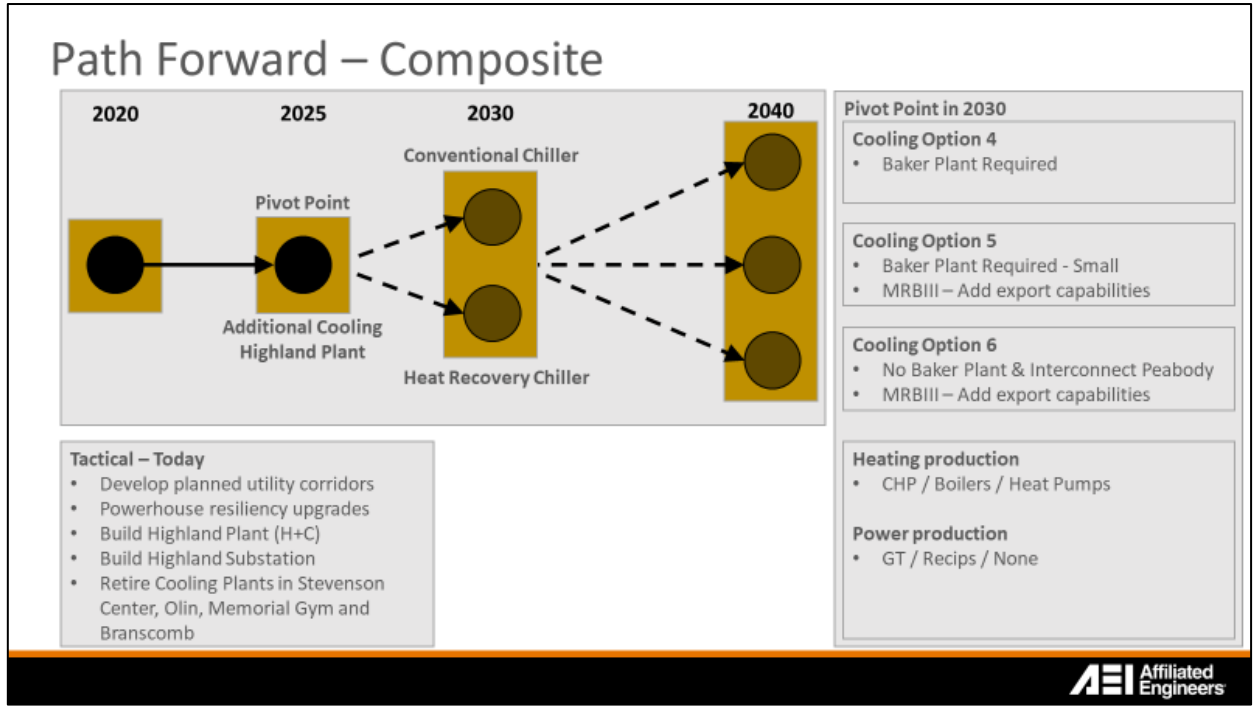


Utility Master Plan

Recommendations

- **Pivot**: Develop solutions for the existing generation that can pivot as renewable technology becomes more available and economical
- **Cogen**: Continue for foreseeable future
- **Chilled Water**: Continue to convert to district chilled water systems and eliminate unitary equipment
- **Hot Water**: Continue use of hot water for building loads that do not require steam. Connect where makes sense.
- **Power**: Convert 4.16kV to 13.8kV to increase reliability of electrical systems

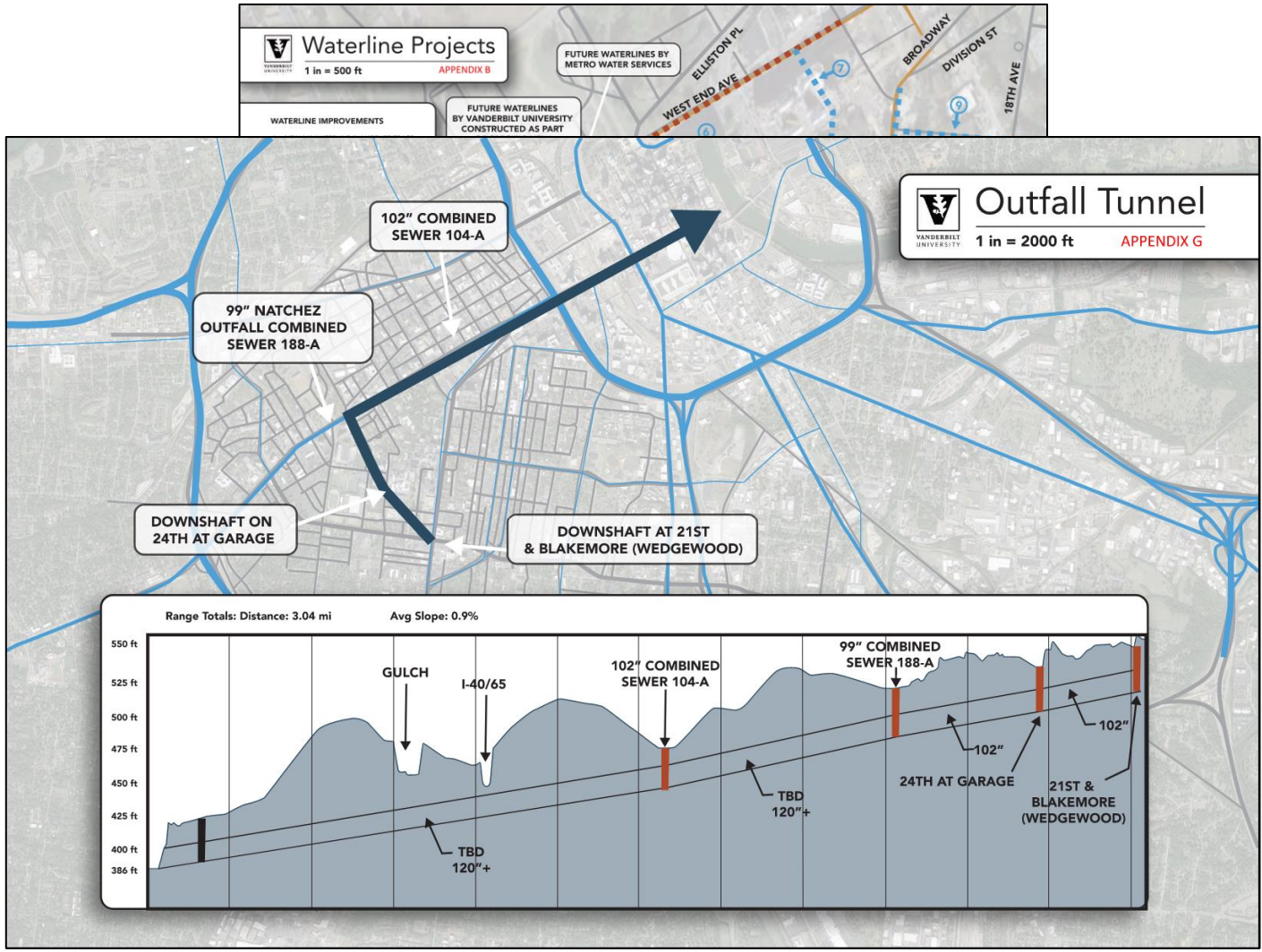
UMP Pivot Plan



Water Management Master Plan

Focus: Metro Upgrades / Separation

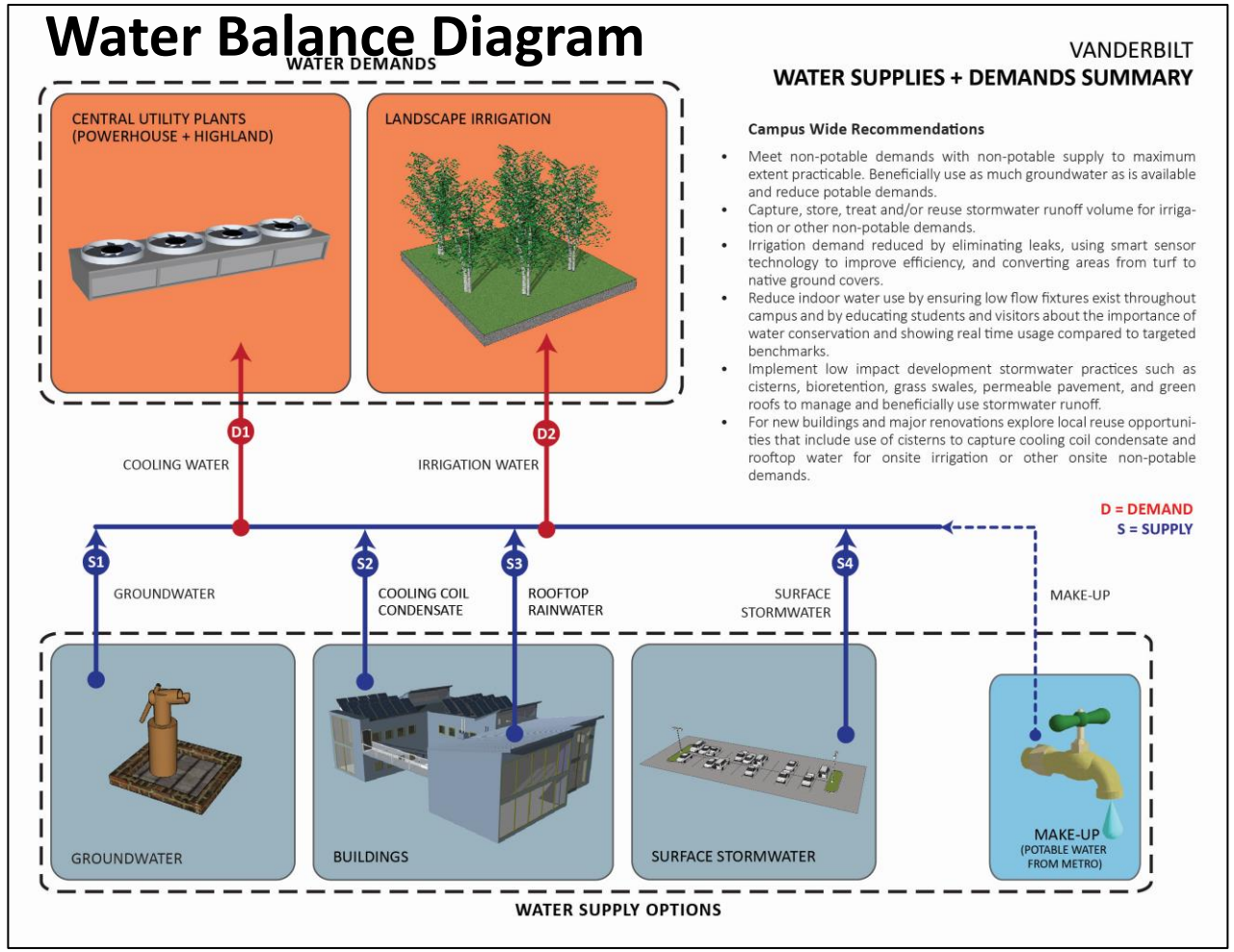
- **Upgrades**: Implementation of sanitary, storm and water upgrades that support the campus development and separate combo sewers.
- **Pipe Dream**: Broadway deep tunnel stormwater project being evaluated by Metro. Alleviates campus and city flooding due to undersized infrastructure.



Water Management Master Plan

Focus: Water Stewardship

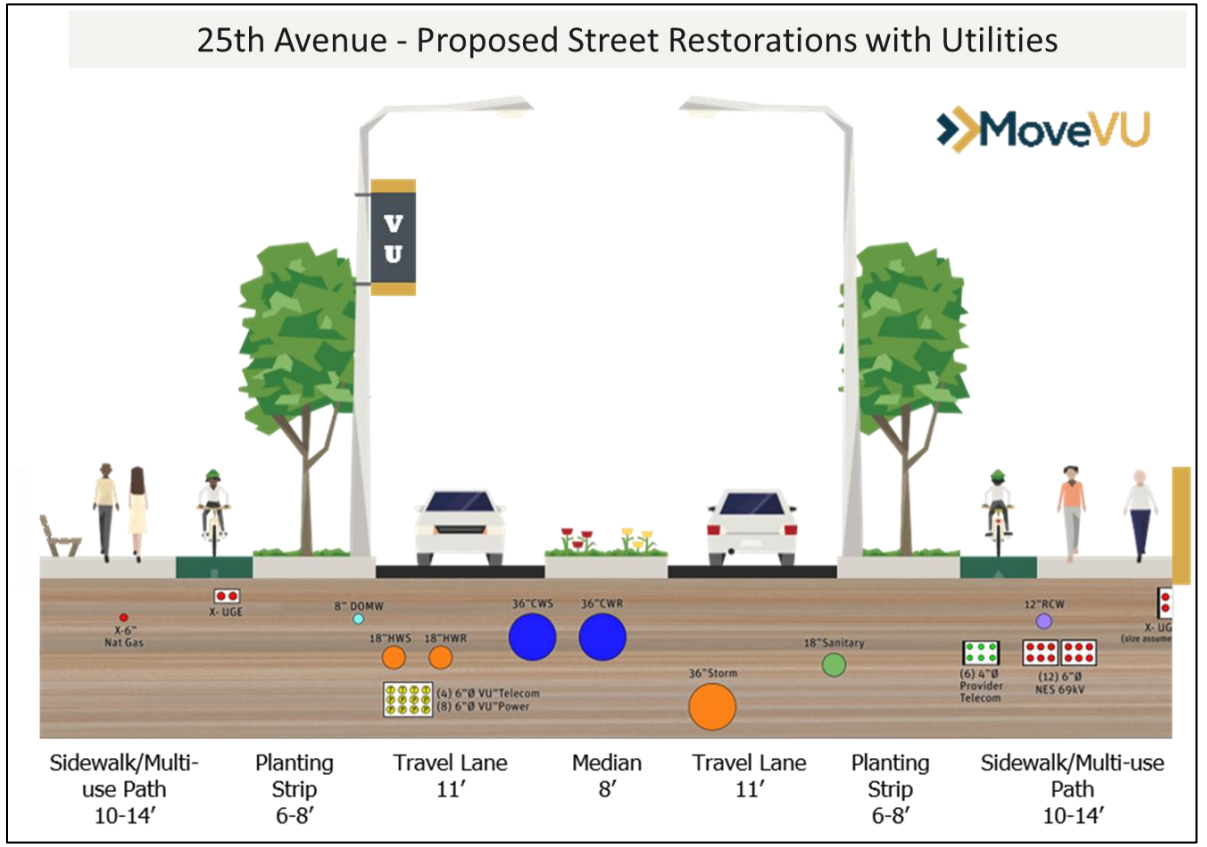
- **Established Series of Goals**
- **Groundwater**: Allocating space within Highland Plant for future groundwater reuse treatment system for makeup water in cooling towers.
- **Irrigation**: Proposed expansion of existing groundwater irrigation system that serves the Student Rec Fields to extend north and include the Athletics Fields.



Central Utilities Initiative – Opportunities

Owner's Project Requirements

- MoveVU
- Underground utility poles
- Minimize campus disturbance
- Engagement with campus

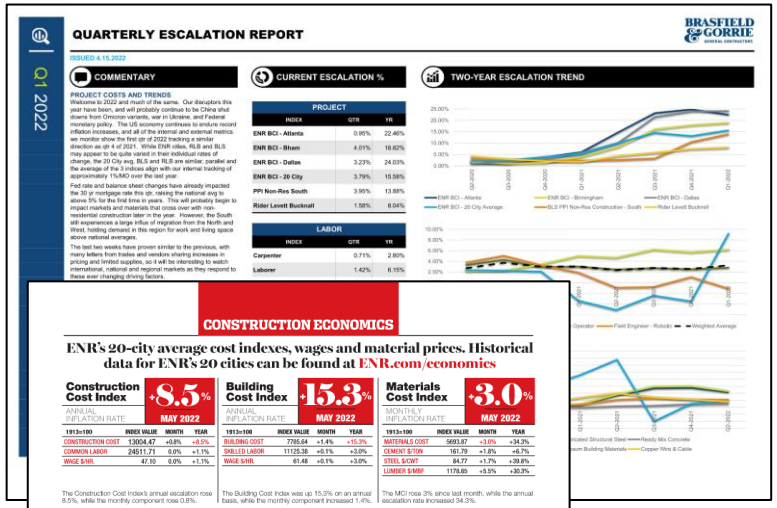


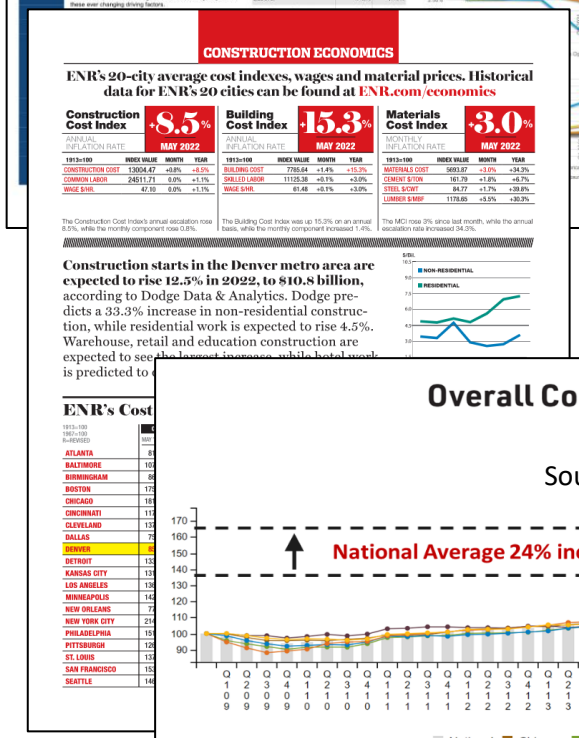
Pulling it all together…Notable Scope Increases

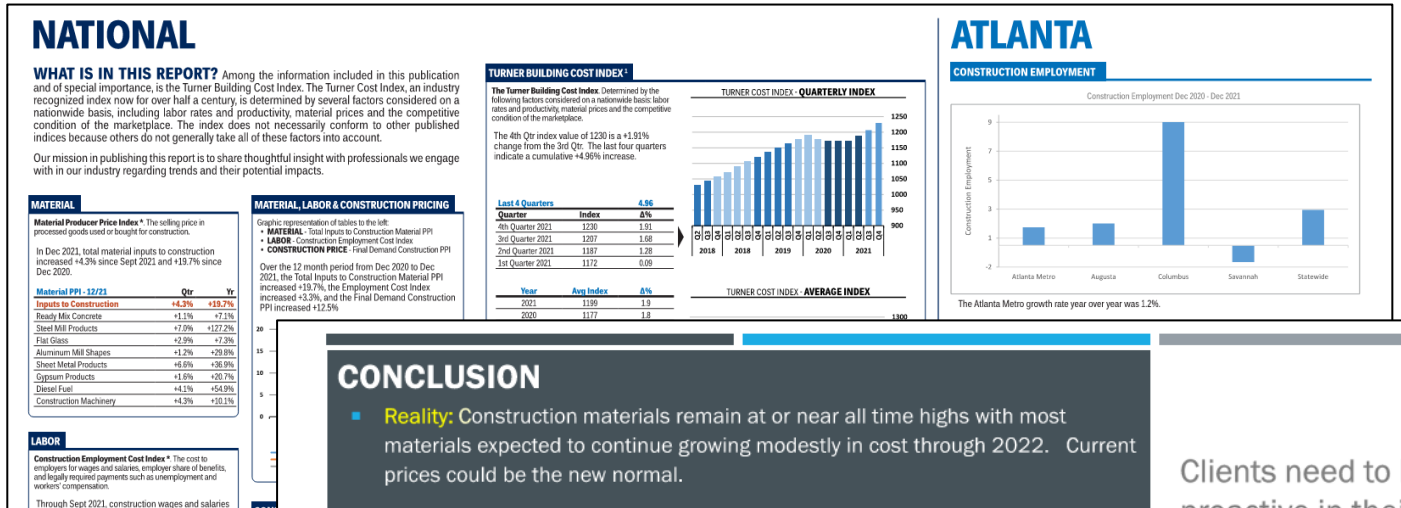
- **Highland Plant**
  - Site Selection
  - Integrated Substation
  - Loads: Timing & Increase
  - Plant Space: Larger, not Phased
  - Program Space
  - Flex Space
  - Downshaft Building Removal
- **Power House**
  - Larger CT & HRSG (H2 capable)
  - Gas Compressor
  - Fuel Oil Polishing Systems
  - HRSG-1

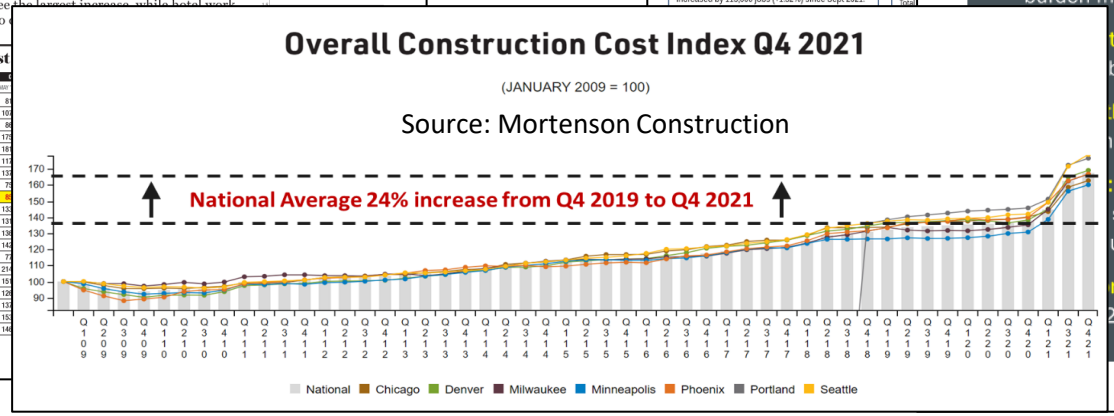
- **Utility Corridors**
  - Incorporation of MoveVU restorations
  - Utilities in Public Streets
  - Building connections & improvements
  - Underground of overhead public utilities (NES & 3rd Party Telecom)
  - Water Management Master Plan
  - 25th Avenue Tunnel
  - WEN Utilities
  - VUIT

And then Escalation…









CONCLUSION

- **Reality:** Construction materials remain at or near all time highs with most materials expected to continue growing modestly in cost through 2022. Current prices could be the new normal.
- **Recognize:** Inflation, largely silent for a decade, is very much alive and kicking.
- **Watch Supply:** Logistical and manufacturing issues are delaying a market correction. Clogged ports, lack of parts and chips, lack of workers, continue to burden manufacturing.
- **tes:** Keep a continued eye on the labor wages. High demand for borers is pushing wages higher.
- **he Envelope:** The use of jobsite technology and Prefabrication may e improvement to labor shortages.
- : Ordering materials with long lead times earlier in the design process. setting upon a generic approach. However, this introduces some risk if ust change.
- **n:** a minimum 6% inflation factor should be considered for future work 2022, then at least 4% - 5% for the next several years.

Clients need to be carefully proactive in their construction procurement strategies: *Early purchase of long-lead items, use of technologies and prefabrication to minimize jobsite labor, switching to alternate materials, and ensuring sufficient escalation and contingency budgets.*

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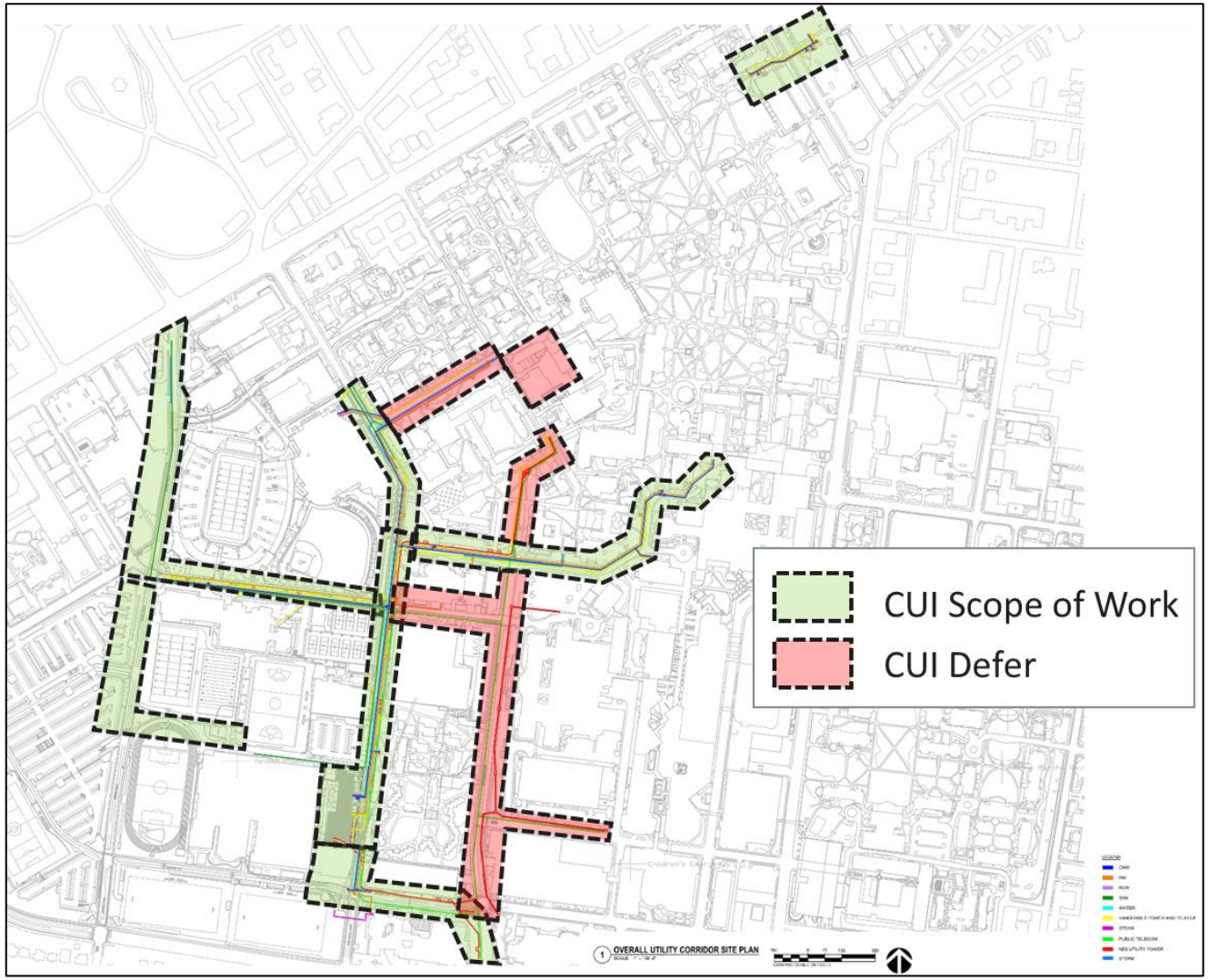
COVALUS PLAN · BUILD · EQUIP

What's being implemented?

- Highland Plant
  - 11,200 T initial / 14,000 T full build
  - 160 MMBtu
  - Integrated 100 MVA substation
- Utility Corridors
  - Hot Water
  - Chilled Water
  - VU Power
  - VU IT
  - Sanitary
  - Stormwater
  - Road Beautification
  - NES and 3rd Party Telecom ductbanks



Challenges with Implementation of CUI

First Cost

- Resiliency
- Efficiency
- Phasing
- Scope creep
- Connecting developer buildings
- Undergrounding overhead systems

Technical

- Why hot water?
- Why continuation of Cogen?
- Modification of building standards
- Changing refrigerant landscape
- Series counter flow 480V chillers
- Integration of reclaimed water

Planning for, Quantifying and Selling Resiliency

#1 Bring back to VU Goals

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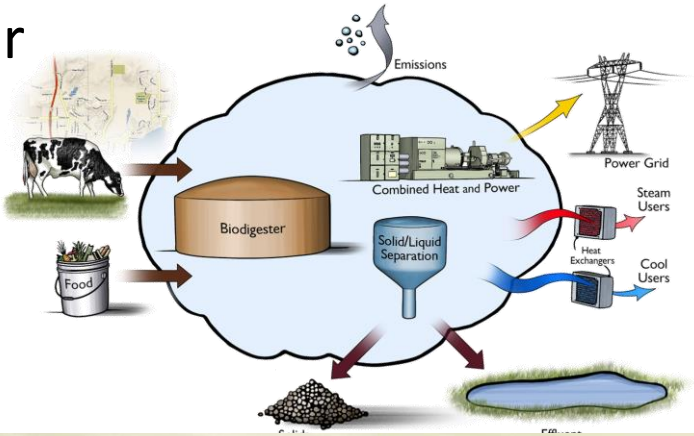
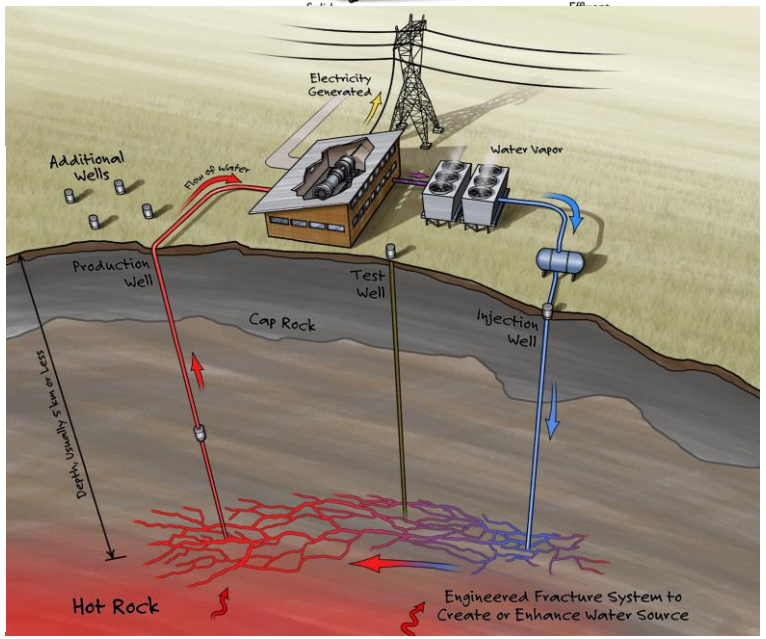
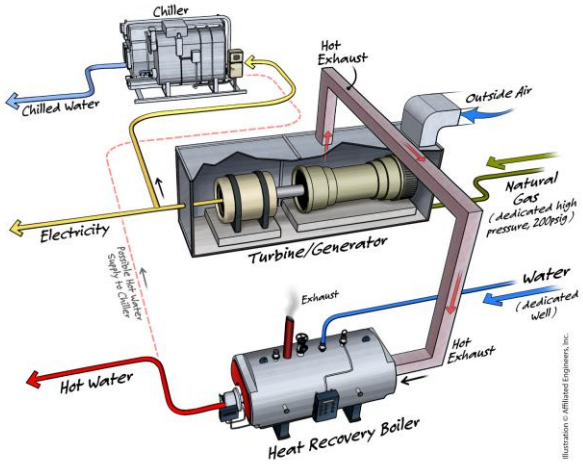
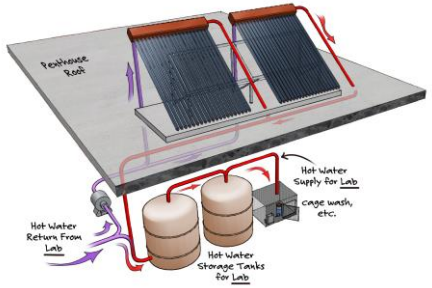
Why hot water?

- These sources can be used directly for heating hot water
  - ❑Natural gas with carbon capture
  - ❑Biofuel
  - ❑Electric hot water generators
  - ❑Geothermal – very deep wells
  - ❑Hot water solar
  - ❑Combined Heating and Cooling
  - ❑Heat pump (Geothermal)









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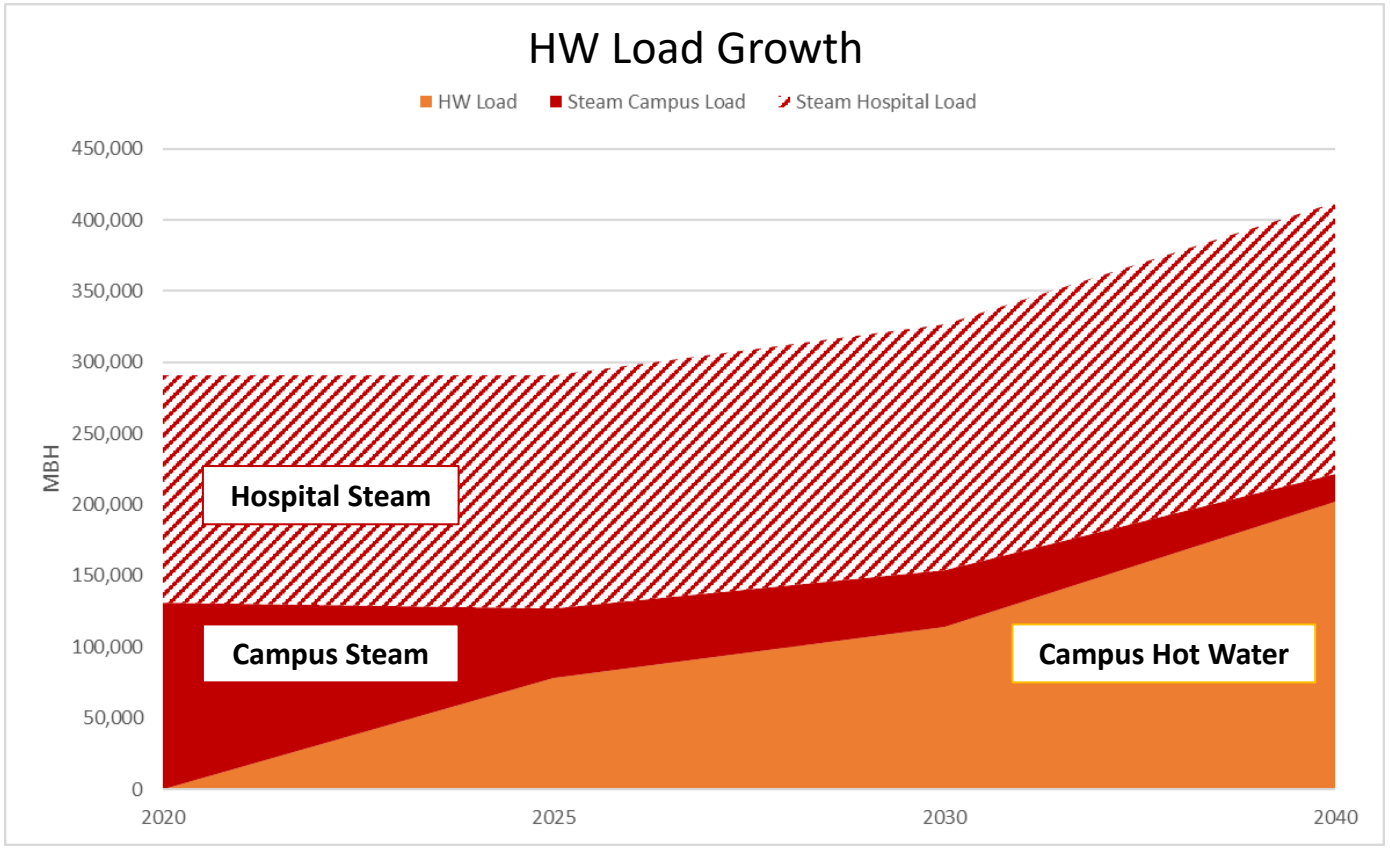

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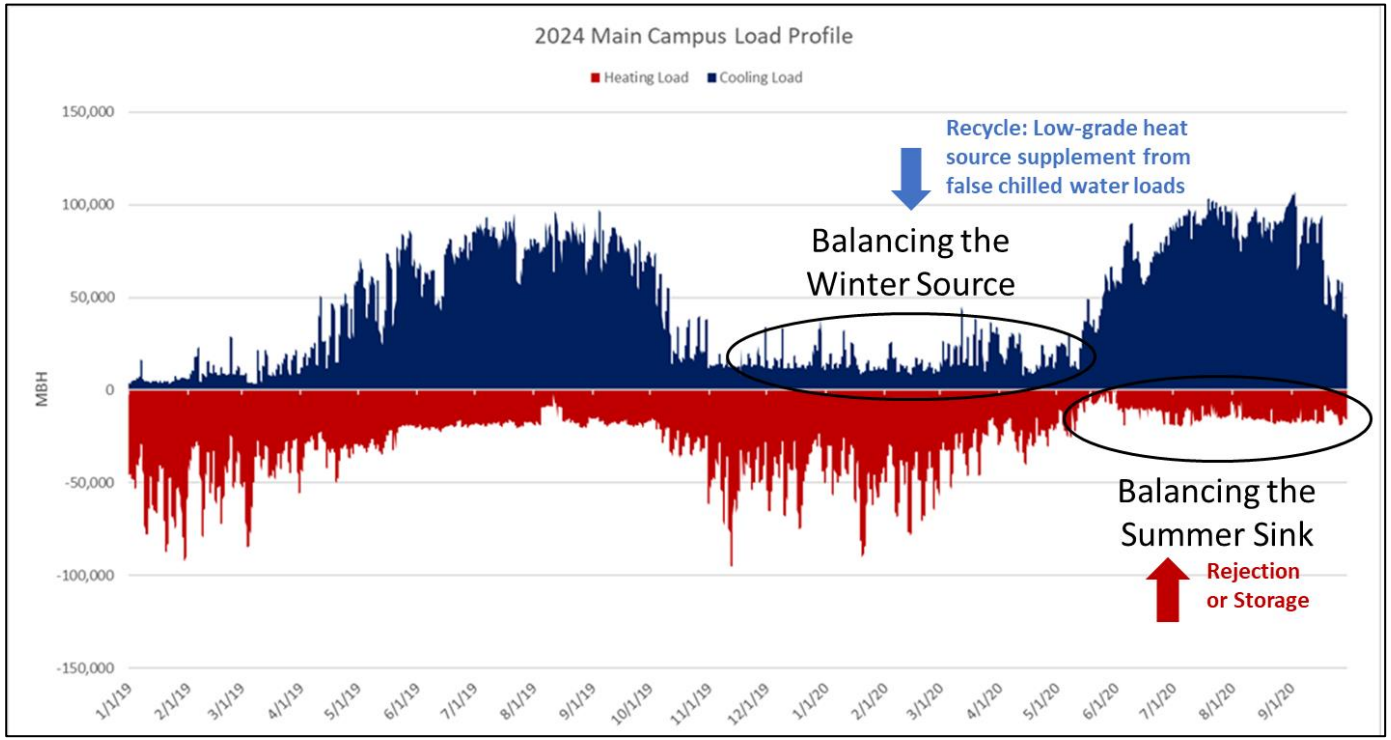
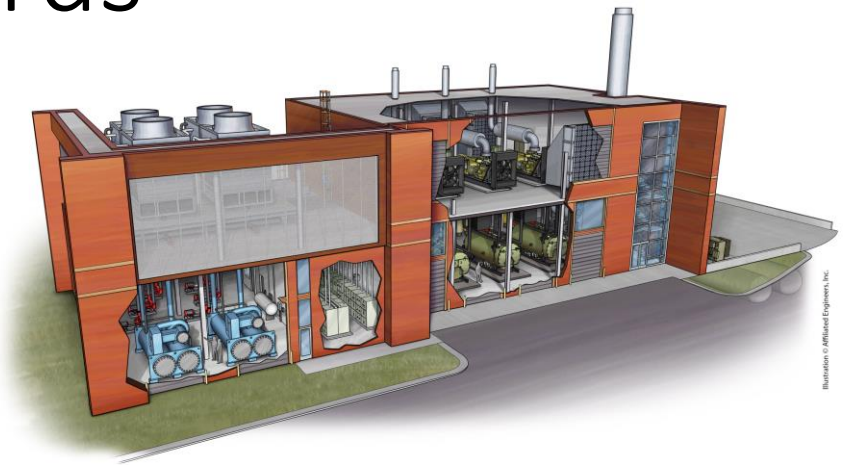
What does this mean to VU?

- Additional winter heat source.
- Additional summer heat sink.

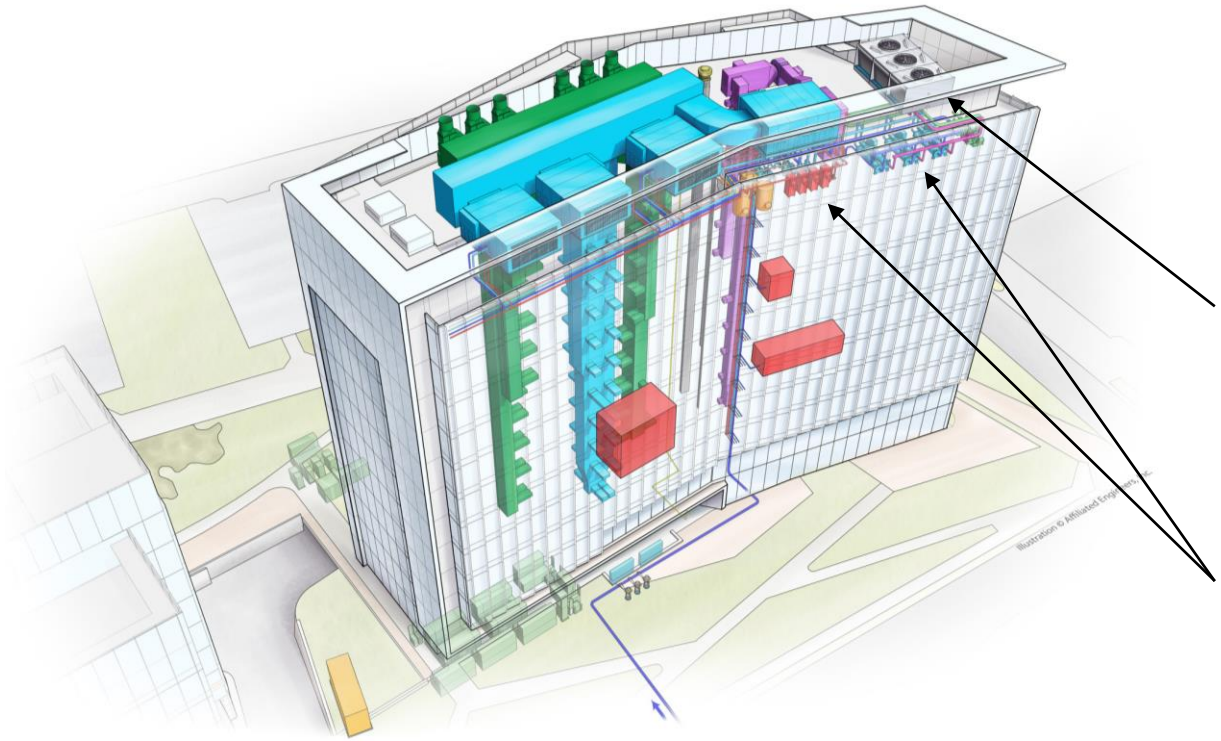


Modification of Building Standards

Centralized thermal systems example:
Consolidated equipment in a plant with underground distribution to buildings



Decentralized thermal systems example:



Cooling towers must be incorporated into the architecture and are difficult to access for maintenance

Chillers and boilers are typically located in basement or penthouse and difficult to access for maintenance

Lessons Learned

- Establishment of Goals
- Campus leadership communication
- Coordination with other planning
  - IT / Water / Sewer / Storm / Metro
- Target Value Design
- Establish a Pivot Plan

Questions?

Thank You!

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