



CampusEnergy2021

BRIDGE TO THE FUTURE

Feb. 16-18 | CONNECTING VIRTUALLY

WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16





A Path to Neutrality Part II : Princeton University TIGER – From Design to Construction

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CampusEnergy2021

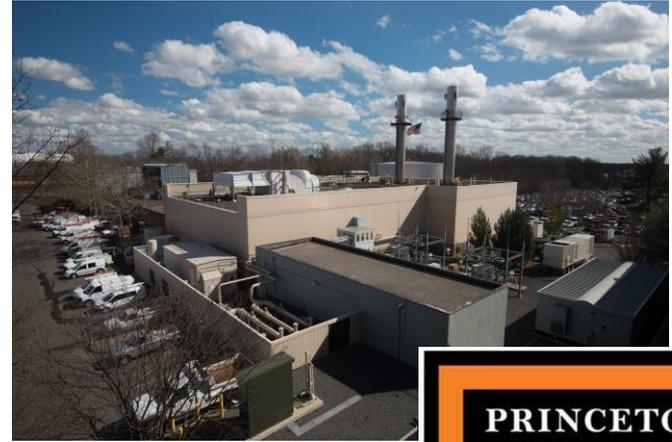
February 16 - 18, 2021



PRINCETON UNIVERSITY OVERVIEW

Utility System Key Attributes

- Chilled Water – 20,000 Tons
- Steam – 300,000 PPH
- Power Generation (CHP) – 15 MW
- Power Generation (Solar) – 4.5 MW (AC)
- Chilled Water TES – 40,000 Ton-Hours
- Chilled Water and Steam Piping – 70,000 LF/13.5 miles



FROM DESIGN TO CONSTRUCTION

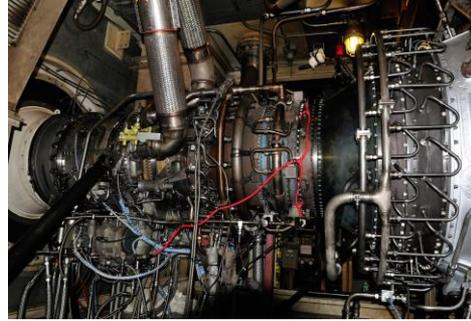
Princeton's Process

- Initial conceptual phase
- Schematic Design, Design Development, Construction Documents
- Many interim reviews and bid packages
- Budget reconciliations and VE items
- GMP at 85% Construction Documents

INFRASTRUCTURE MASTER PLANNING COMPLETE

Primary Issues Addressed

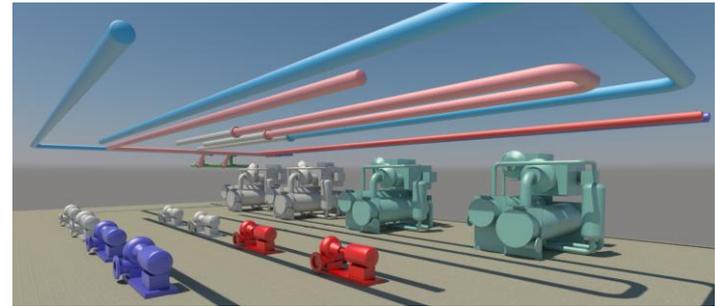
- Existing Infrastructure Condition
- Reliability and Resiliency
- Projected Load Growth
- Heating Hot Water Conversion
- GHG Emissions Reduction
- Financial Stewardship



FINAL RECOMMENDATIONS RE-CAP

Project Basis

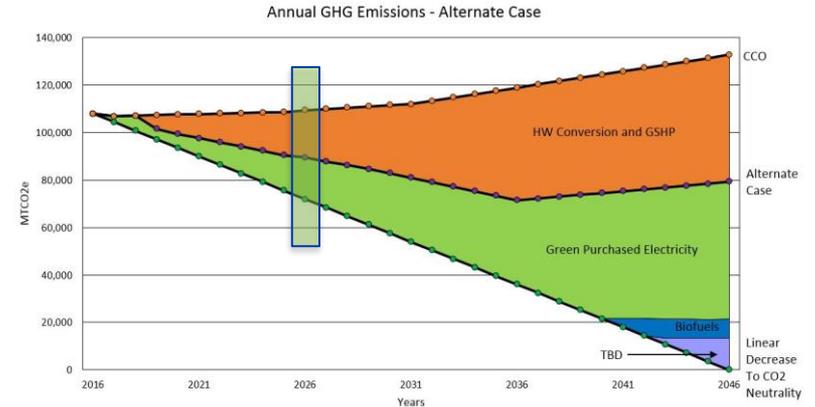
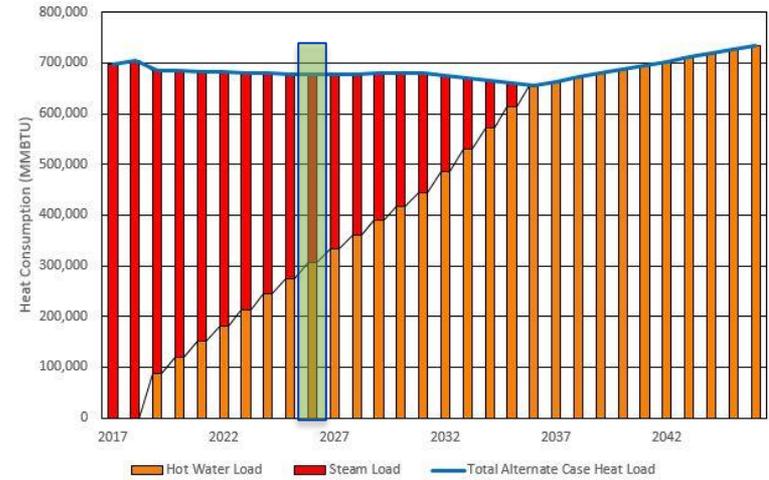
- Conversion from steam to hot water heating
- New 7,000-ton heat pump chiller plant - **TIGER**
- Designed for future expansion
 - ▶ No combustion/no cooling towers
- New heating hot water capacity at West Plant
- New heating hot water distribution network
- Installation of geexchange bore fields
- Hot and cold TES



ENERGY AND GHG SAVINGS

Key Impacts of IMP by 2026:

- 380,000 MMBTU reduction in natural gas consumption
- 1.6 MW increase in peak electrical load
- 58.7 MGal annual reduction in domestic water consumption
- 20,000 MTCO₂e annual reduction in GHG emissions



LESSONS LEARNED – DISTRIBUTION WORK

- Optimize test pit locations
- Order EN253 spares
- Consider burial depth and geotechnical conditions
- Welding standards – ASME vs EN Standards
- Consider a “mixed” piping system
- Get the team “on-board” early – owner and contractor training

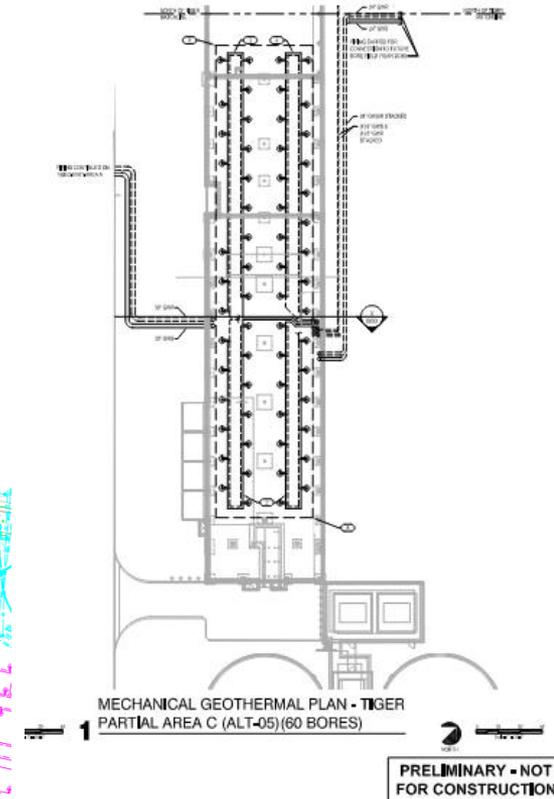
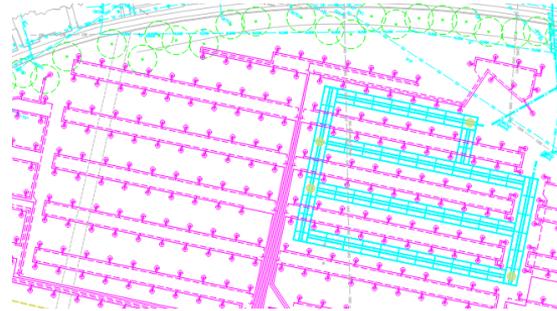
LESSONS LEARNED – TIGER (DESIGN PHASE)

- Plan for community engagement
- Consider campus plan when locating bores
- Engage vendors and CM/GC early if possible
- Bring CxA and controls vendors in early
- Consider skid-mounted vs. field erected



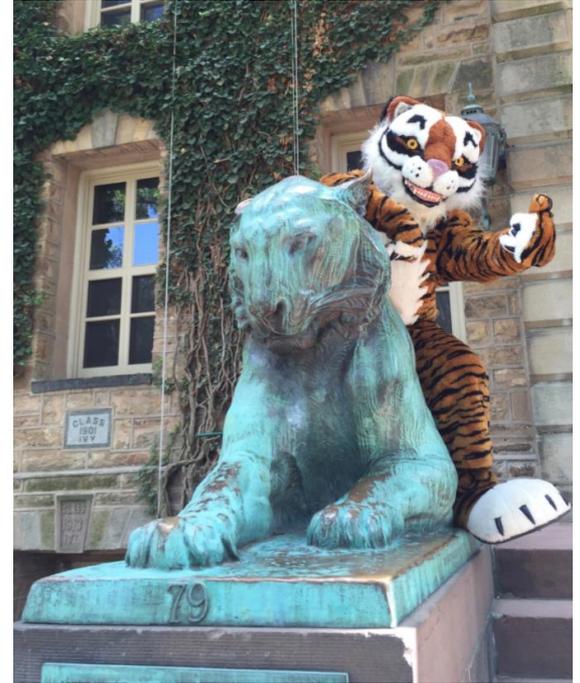
LESSONS LEARNED – GEOEXCHANGE BORES

- Consider local contractor capabilities and market
- Understand local regulatory requirements
- Have contingency plan to replace failed bores
- Ensure water chemistry/pipe material compatibility
- Bores can go under buildings
- Drilling can be disruptive!



OVERALL TAKEAWAYS

- Assume outreach/education will be required
- Expect major coordination efforts across campus
- Phased conversion plans offer major benefits
- Impacts of changes may not be understood
 - ▶ Focus/educated on impactful changes vs. buzzword or “headline” technologies



PROGRESS UPDATE

Issue for Construction drawings submitted January 2020

- 341 Geoexchange bores currently completed as of 2/8
- 3,000 LF of piping installed
- Currently working through NJ review process
- Building conversion progress – 9 buildings currently under design
- Construction Complete 12/2022 (estimated)

PROGRESS UPDATE - TIGER



PROGRESS UPDATE - TIGER



PROGRESS UPDATE – GEO BORINGS



PROGRESS UPDATE - DISTRIBUTION

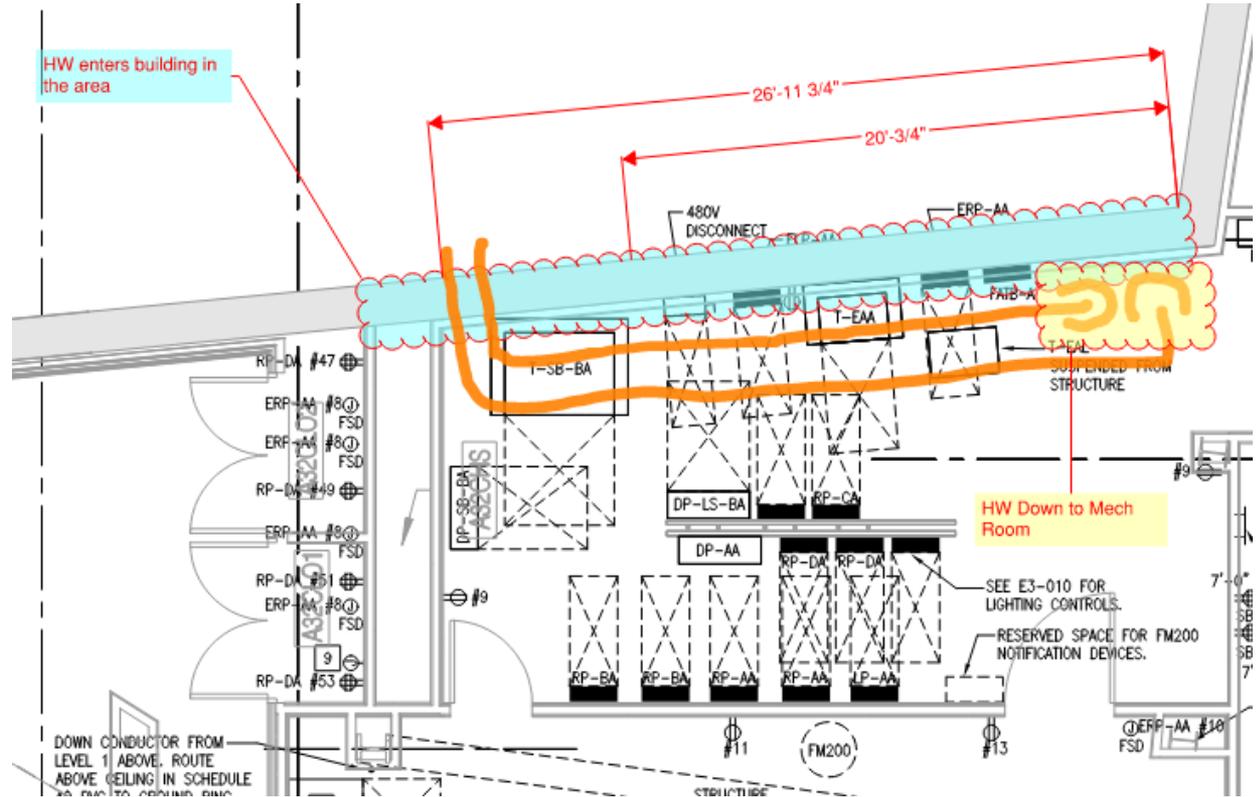


PROGRESS UPDATE



PROGRESS UPDATE – BUILDING CONVERSIONS

- 9 buildings
- 1.1MM SF
- More soon





Facilities

Engineering

BURNS  MCDONNELLSM