District Energy for UC Davis Primate Research Center

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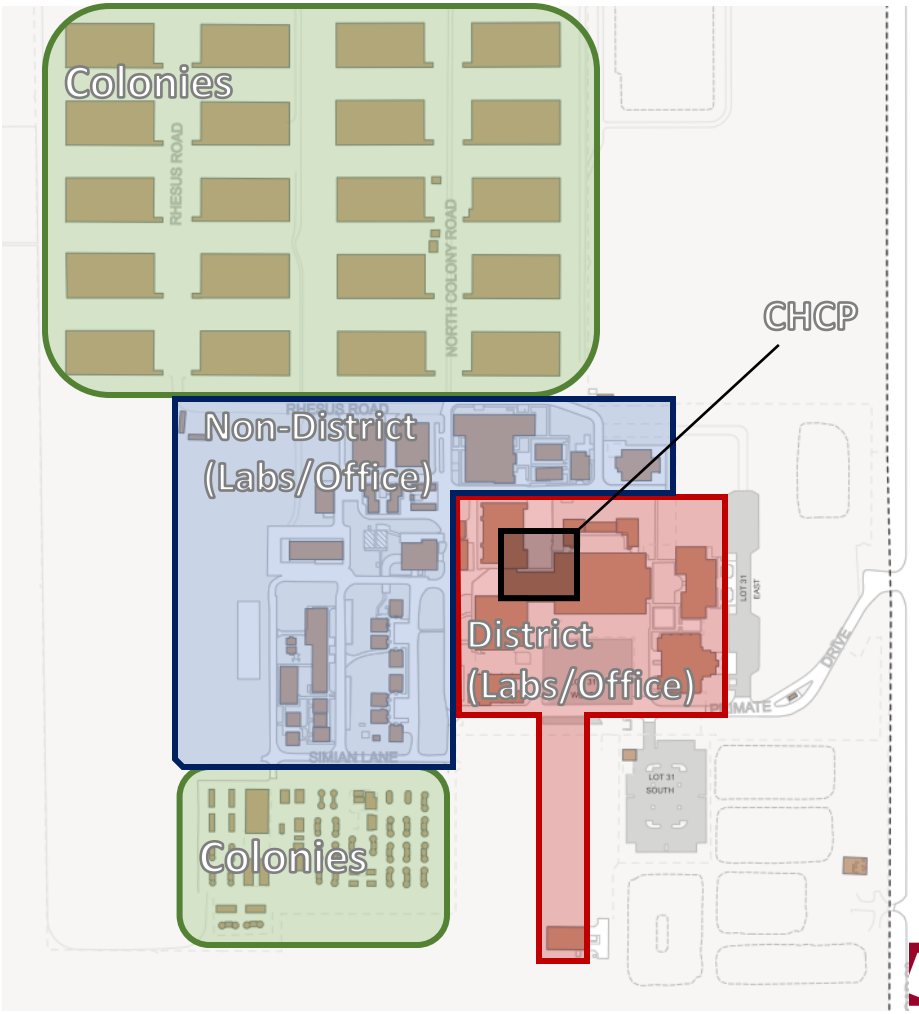
California National Primate Research Center



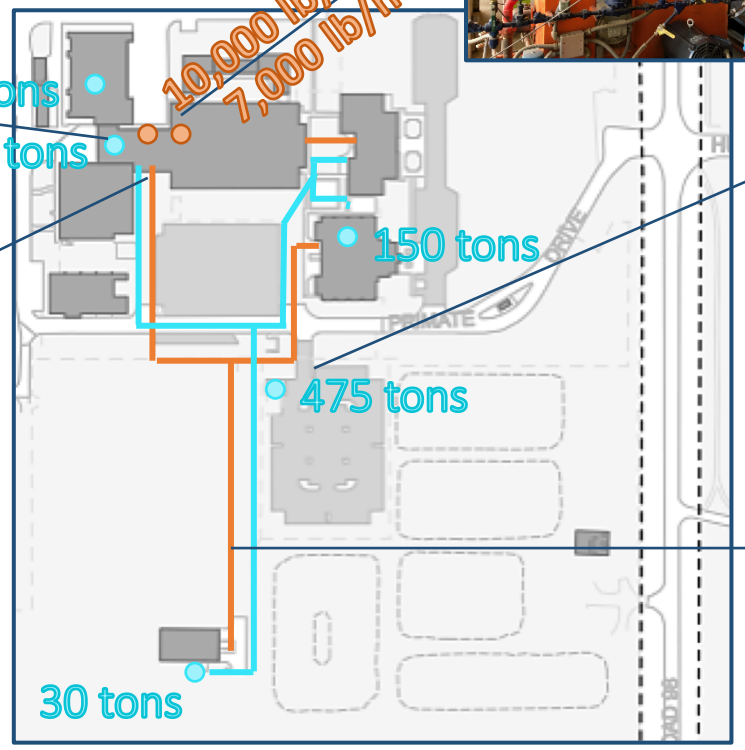
District Energy System Condition

Abs. Chiller
Over 30 yrs old

Boilers
22 yrs old

"New" Chiller and Tower
Repurposed from campus

Cooling Tower
Poor condition



Steam Piping
Needs
renewal
within 10 yrs

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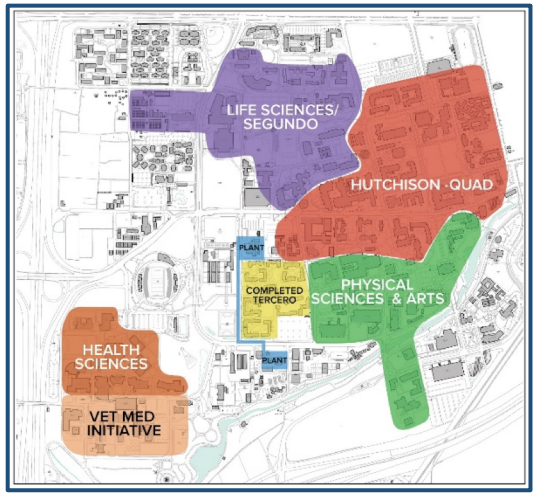
Project Objectives

- Renewal of energy infrastructure
- Improve redundancy
- Align energy supply with UC initiatives
- Improve efficiency
- Reduce operating costs
  - Eliminate need for 24/7 boiler watch



UNIVERSITY OF CALIFORNIA Carbon Neutrality Initiative

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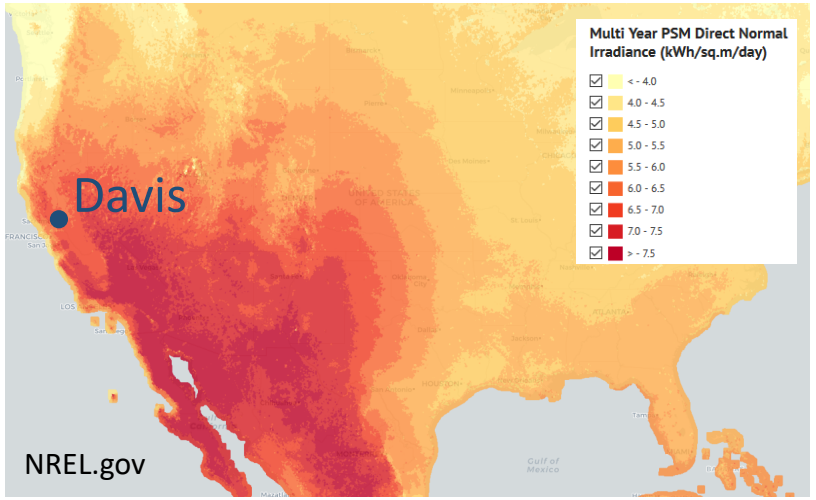
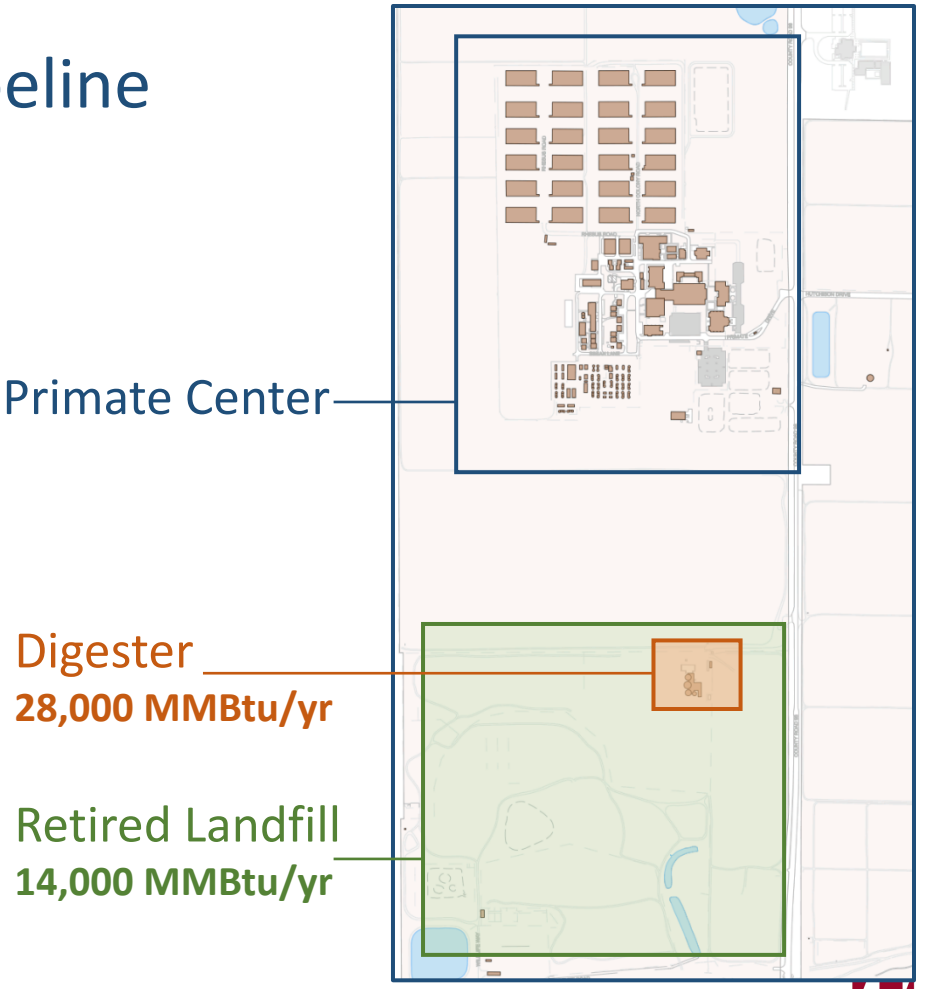
Nearby Energy Supply

- Biogas sources within 1 mile, existing pipeline
- Significant surrounding land area
  - Geothermal, solar thermal, solar PV
- Donated solar thermal panels





Leverage Available Funding Programs

Cal Solar Initiative (PG&E Incentive)

- $10/therm rebate to offset gas
- 2 year performance period

$800k Rebate Potential

$1.1MM Construction Cost (Installation Only)

Solar thermal panels donated to UC Davis

CNPRC Background and Project Objectives

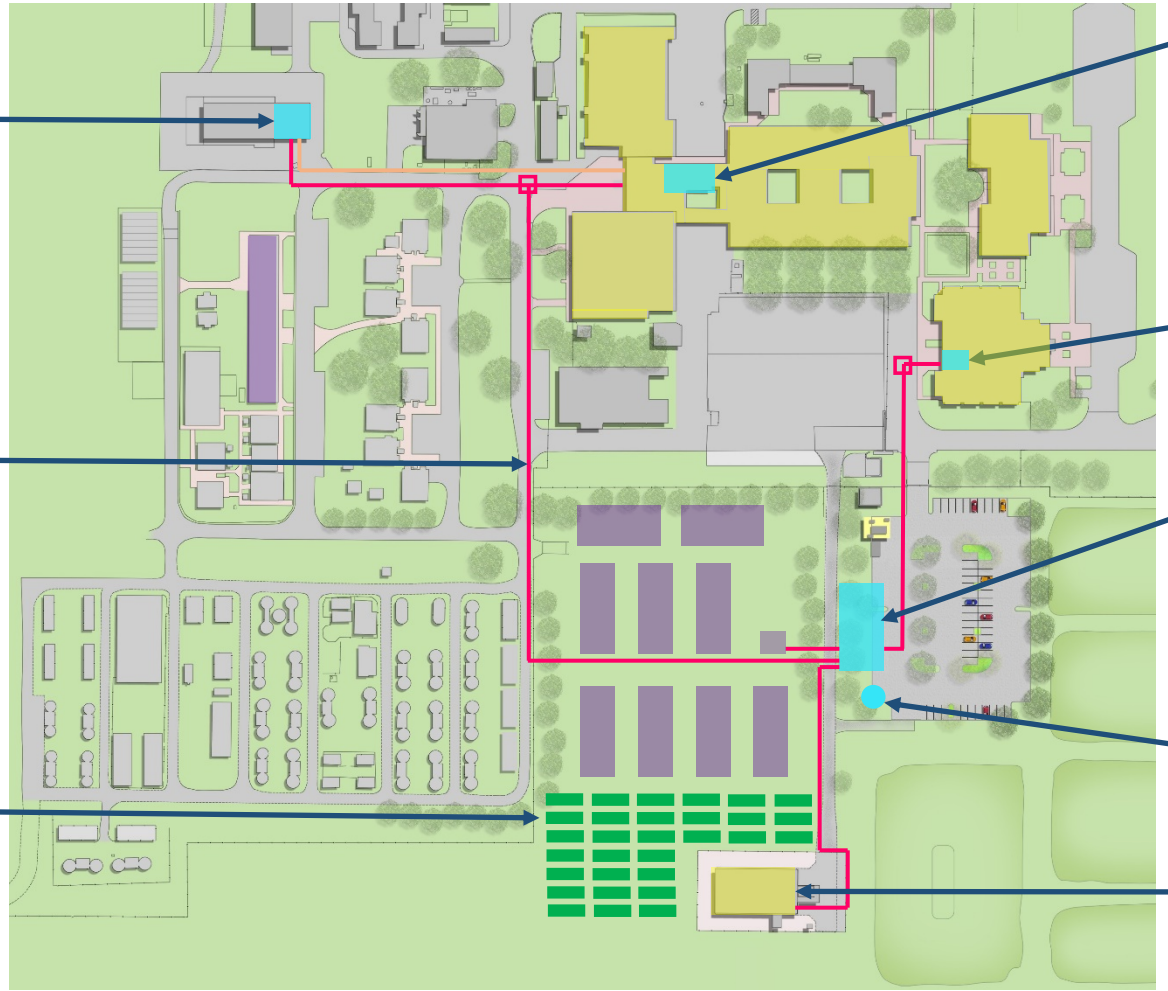
- Existing campus has very high energy utilization
  - Most spaces served are 100% Outside Air labs & animal holding
  - High process loads from cage washing activities and sterilization
  - Aging high pressure steam infrastructure
  - Piecemeal modular building construction in many cases
  - Minimal infrastructure investment over last 20 years.
- Project Goals
  - Convert comfort heating from steam to hot water.
  - Eliminate 24/7 boiler attendance
  - To the greatest extent technically feasible, utilize donated solar thermal collectors.
  - Serve remaining process loads with minimal to no Scope 1 carbon emissions

CNPRC Energy Improvements & CHCP

Primate Shop Building Plant:
- Electric process steam boilers
- 135 °F Industrial HW
- 195 °F Industrial HW
- Convert 1 cage washer to Hot Water operation

HHW Distribution Piping:
- Direct buried PEX construction
- Primarily a manifold & "home run" configuration limiting field joints and valve boxes

Solar Thermal Collector Field:
- Approximately 300 total panels
- Faces due south for maximum annual production



Main Lab/Animal Building:
- Demo existing steam plant
- Steam to HW conversion
- Convert 2 cage washers to hot water operation
- New indirect heater for DHW

CCM Lab Building:
- Electric process steam boilers
- Remove existing heating HW boiler

New CHCP Building:
- Electric chillers
- HHW Boilers – NG, Biogas, Propane
- Water source solar thermal heat pumps

25,000 MBtu HW Thermal Energy Storage Tank

Quarantine Building:
- Steam to HW conversion
- New Indirect heater for DWH

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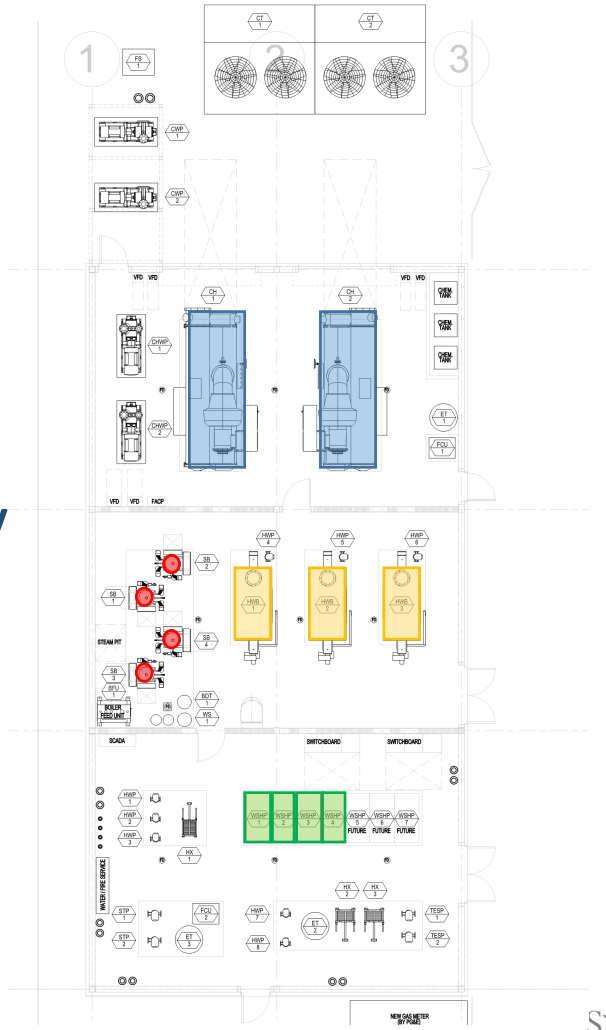
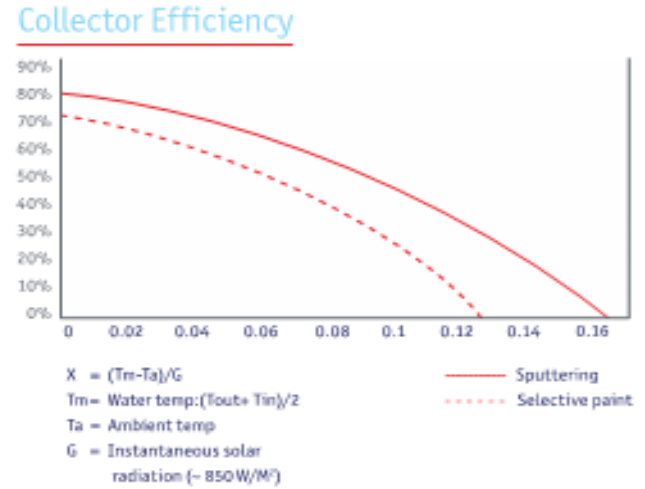
New Central Heating and Cooling Plant (CHCP)

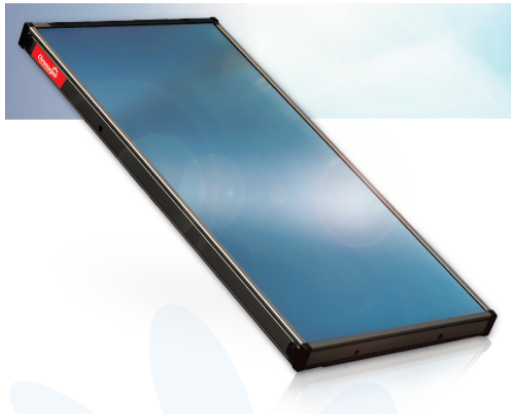
- New 3,250 Sq. Ft. Building Housing:
  - Two 550 Ton Electric Chillers (blue)
  - Three 3,980 MBH Flexible Watertube Boilers (yellow)
  - Four 93 kW electric high-pressure steam boilers (red)
  - Four 680 MBH Water Source Heat Pumps for solar thermal system (green)
- Estimated 47% of annual heating load satisfied by solar thermal + heat pump output.
- Modular expandable system with potential geothermal and HR chiller integration.
- Need for 24/7 boiler attendance eliminated.

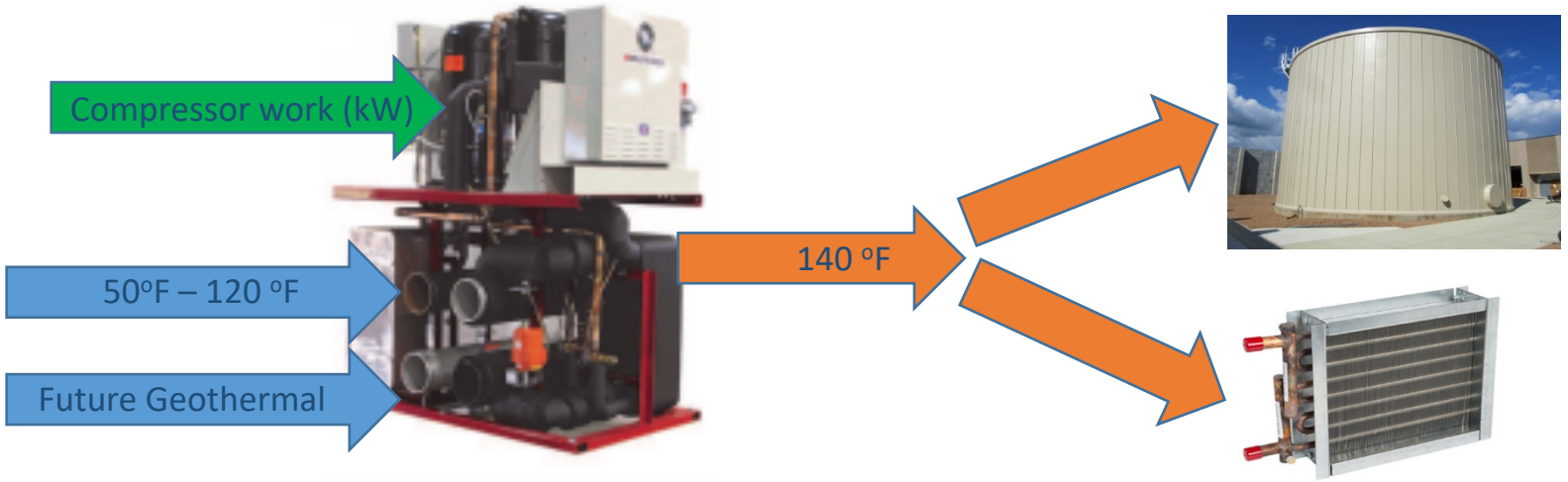


Solar Thermal Heat Pump System

- Solar Thermal Collector Conversion Efficiency Depends on Several Factors:
  - ISO Efficiency = $0.736-0.68438(P/G) – 0.00132(P^2/G)$
    - P=Entering Water Temp (Deg. F.) – Ambient Temp (Deg. F)
    - G = Global Radiation
  - By passing through heat pump, collector entering water temperature can be controlled







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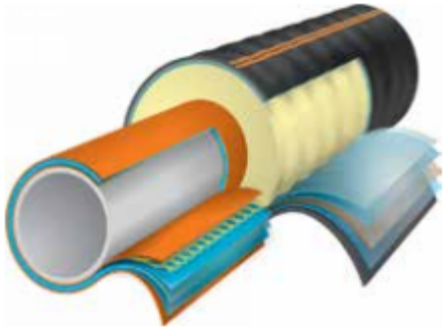
Underground HW Distribution System

- PEX Flexible Piping System
  - Magnitude of CNPRC heating loads allows relatively small pipe sizes of 6” and smaller.
  - PEX piping available pre-insulated (up to 4”) and field insulated in larger sizes.
  - Flexibility to route around existing utilities rather than relocate.
  - Manifold & home-run design eliminates most field joints, tees, and valve boxes.
  - Valve boxes only for future system expansion.



Summary

- CNPRC district energy system needed substantial improvements:
  - Redundancy, reliability, sustainability, efficiency
- Multi-faceted solution to satisfy diverse district needs
  - Integrated solar, heat pump, and HW TES
  - Biogas-ready
  - Electrical steam and high-temp HW production
- Load sizes and site layout suitable for PEX
- Alignment with UC initiatives
  - Significant carbon reduction
  - Designed to fully electrify in the future

Questions?

Thank You!

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