Community Scale Electrification:

Network Piping Distribution Options

Moderator: Sue Dougherty / *NYSERDA*

Panel: Brian Urlaub / *Salas O'Brien*

Mike Kingsley / *Ramboll*

Steve Grgas / *Wendel*

Agenda

NEW YORK STATE | NYSERDA

Sue Dougherty NYSERDA

- Funding support for large-scale thermal projects

Mike Kingsley Ramboll

- Overview and explanation of distribution piping options

Brian Urlaub Salas O’Brien

- Project examples of different piping options

Steve Grgas Wendel

- Steam to low temp hot water piping conversions

Large-Scale Thermal Design Funding (PON 5614)

Sue Dougherty, Program Manager
New Construction and Thermal Energy Networks Team

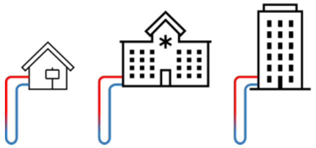
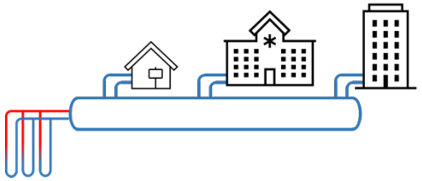
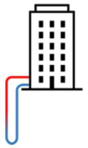
NEW YORK STATE | NYSERDA

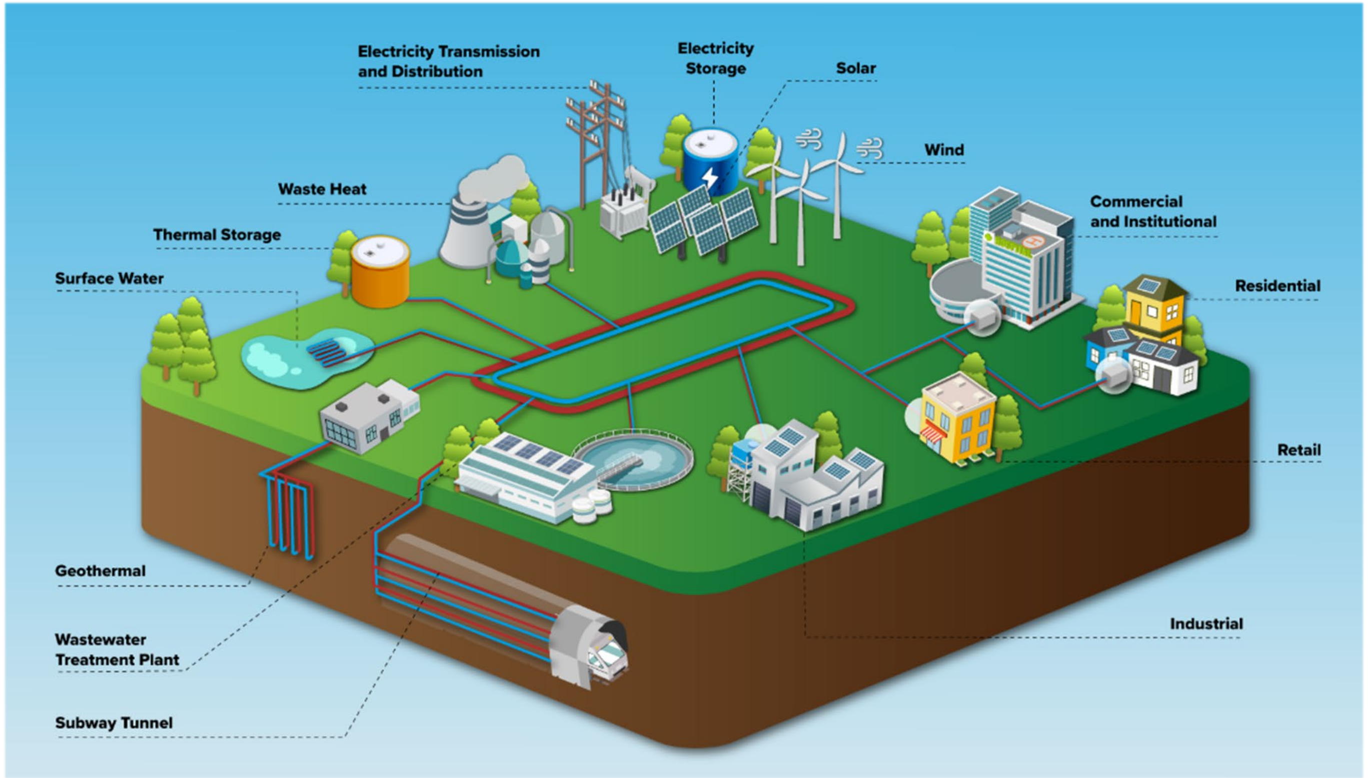
Large-Scale Thermal*

Provides heating, cooling, and hot water to a single building or multiple buildings using **heat pumps** and **low-carbon thermal resources:**

- Geothermal / Ground
- Waste heat
- Surface water
- Wastewater
- Air
- Thermal storage

*Based on eligibility for NYSERDA's PON 5614 Large-Scale Thermal program

Min. Conditioned Space	Standalone	Networked
250,000 SF		
100,000 SF		



PON 5614 Incentives

Funding for replicable large-scale thermal system **design** projects that significantly reduce GHG from heating, cooling, and hot water, primarily in existing buildings.

Single or Multiple Buildings	Minimum Conditioned Space (SF)	Maximum NYSERDA Funding Per Award	Required Proposer Cost-Share
Multiple	250,000	Up to $750,000 (existing buildings[1]) Up to $300,000 (new construction[2])	50% of total project cost
Single	100,000		

1. Total conditioned space ≤ 50% new construction
2. Total conditioned space > 50% new construction

Feasibility Study and Design Funding

FlexTech (PON 4192)

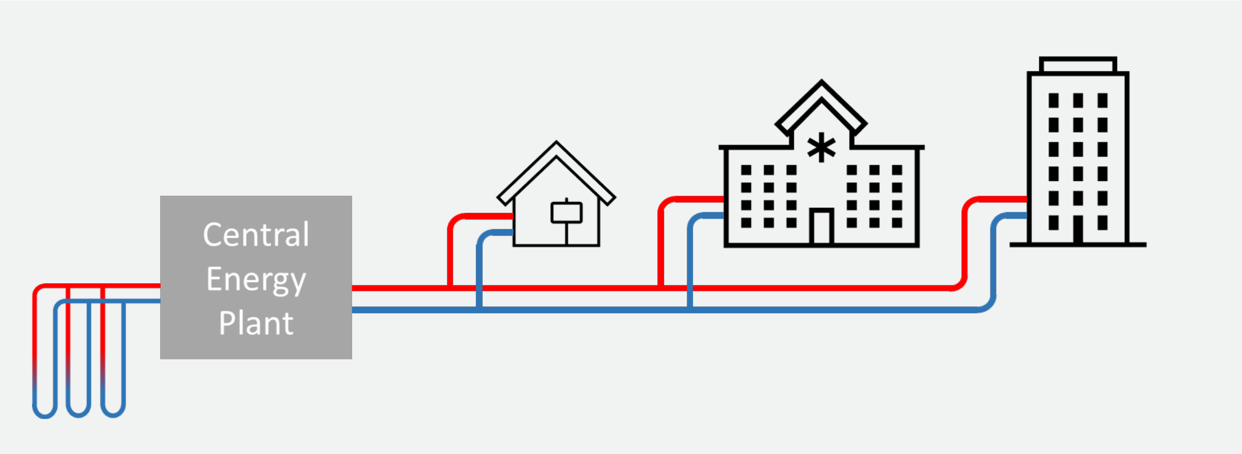
- Support for technical services to perform energy studies and planning
  - Includes geothermal and large-scale thermal **feasibility studies**
- Open enrollment with minimum 50% proposer cost-share
  - Apply anytime
- Learn more by visiting the FlexTech website
- Find a FlexTech consultant

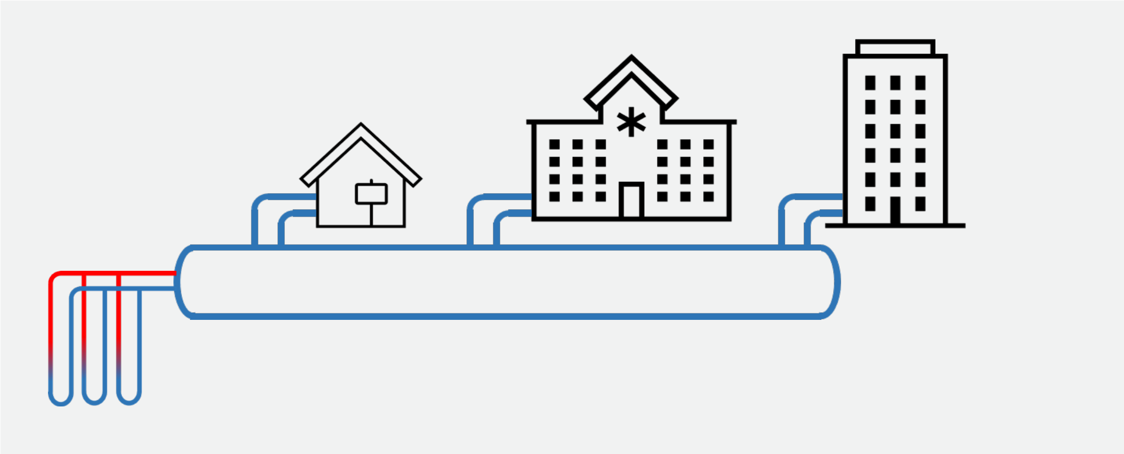
Large-Scale Thermal (PON 5614)

- Support for large-scale thermal **design projects**
- Competitive solicitation
- Round 3 proposals due 7/31/25 at 3pm ET
- Learn more by visiting PON 5614 solicitation page

Contact: District.Thermal@nyserda.ny.gov

Thermal Energy Networks





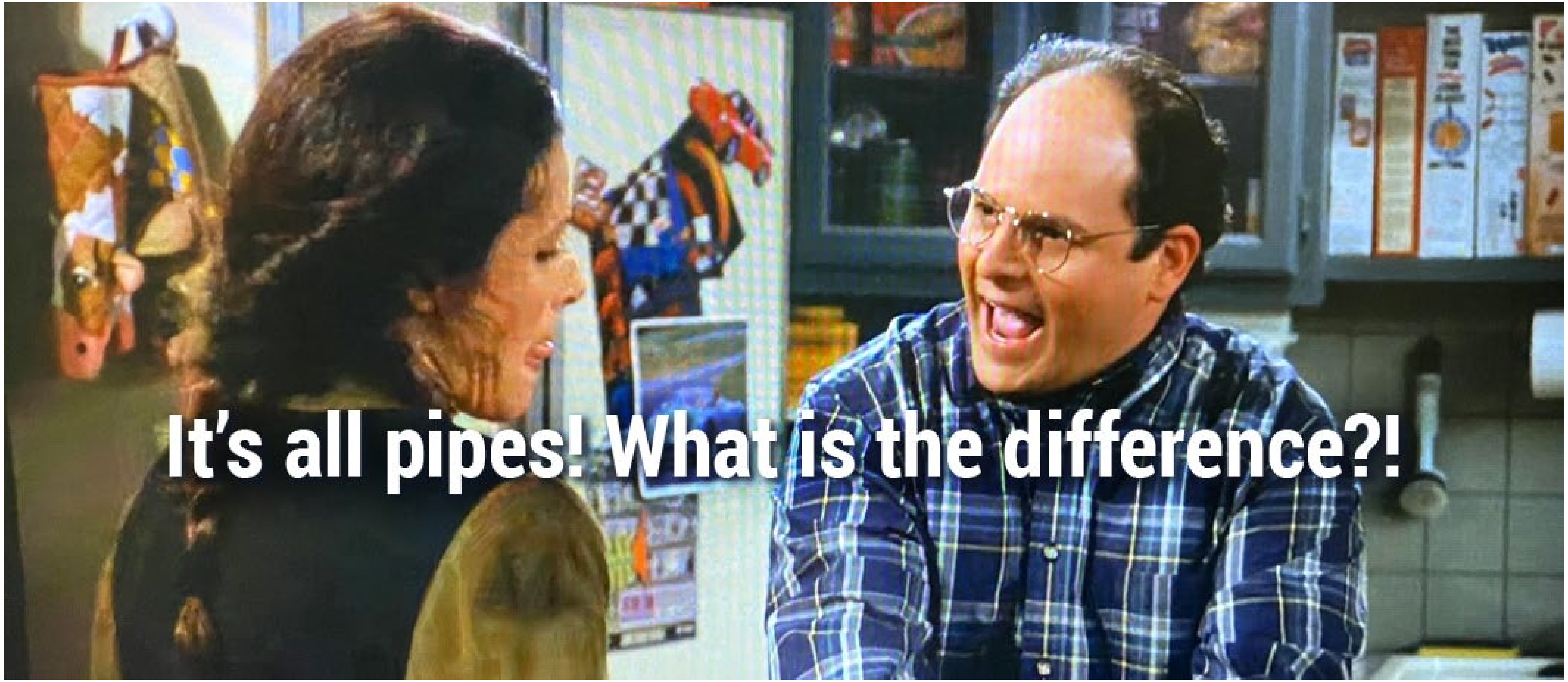
Centralized ("4G" systems)

- Heat pump(s) at central plant produce hot/chilled water
- Hot/chilled water distributed to each building to provide heating/cooling and domestic hot water
- Heating only (2-pipe), cooling only (2-pipe), or heating and cooling (4-pipe)

Distributed ("ambient" temperature systems)

- Low temp ("ambient") water distributed to each building
- Heat pumps in each building provide heating/cooling and domestic hot water
- Heating and cooling (1-pipe or 2-pipe)

What’s the Difference?!



Seinfeld scene. Accessed April 16, 2025. https://drivenets.com/

Community Scale Electrification

Network Piping Distribution Options

NY-Geo – April 23, 2025

Michael Kingsley, Senior Technical Manager

RAMBOLL

Bright ideas.
Sustainable change.

Thermal Energy Network (TEN) configurations

Descriptions

Comparisons

CLCPA Considerations

Evolution of TENs (district energy systems)

Designation	Description
1^{st} Generation District Heating (1G)	Steam
2^{nd} Generation District Heating (2G)	Pressurized hot water >100°C (212°F)
3^{rd} Generation District Heating (3G)	Hot water <100°C (212°F)
4^{th} Generation District Heating (4GDH)	Low temperature hot water <70°C (158°F)
4^{th} Generation District Heating & Cooling (4GDHC)	Low temperature hot water <70°C (158°F) Associated district cooling waste heat used as heat source
5^{th} Generation District Heating & Cooling (5GDHC, Ambient Loop)	Ambient Water or Glycol at 10-30°C (50-86°F) serves as heating source or cooling sink for building heat pumps

Low temperatures enable use of efficient electric heat pumps – decarbonize heating

Provide cooling as well as heating

Typical characteristics of 4G and 5G TENs

Characteristic	4G Systems	5G Systems
Primary Concept	Fully centralized, low temperature hot water to buildings; can be coupled with centralized district cooling	Thermal source network distributes ambient temperature fluid to building water-source heat pumps that generate heating and cooling
Number of Pipes	2 (4GDH) or 4 (4GDHC)	1 or 2
Pipe Materials	Insulated Steel or High Temperature Polymer (Heating) Insulated Polymer (Cooling)	Uninsulated Polymer
Typical Temperature Range	Heating: 50-70°C (122-158°F) Cooling: 4.5-10°C (40-50°F)	10-30°C (50-86°F) Ambient Water or Glycol (Heating Source or Cooling Sink)
Typical Delta-T	Heating: >22° C (>40°F) Cooling: 6-11°C (10-20°F)	3-8°C (5-15°F)
Pipe Dimensions	Smaller diameter piping due to high delta T	Larger diameter piping due to low delta T

Performance aspects of 4G and 5G TENs

Performance Aspect	4G Systems	5G Systems
Energy Exchange	• One-way thermal energy transfer • Heat recovery chillers (4GDHC)	• Thermal energy transfer between customers and with central thermal source
Thermal Sources	• LTHW from central heat pumps using low temperature sources (same as 5G) • Proximity to the central plant affects feasibility • High temperature waste heat can be used directly for heating	• Ambient temperature sources can supply the ambient loop anywhere along the loop (even remote from the energy center) • High temperature waste heat can be used but with a loss of exergy (availability)
Thermal Losses	• Thermal losses greatly reduced from previous generations due to lower operating temperatures	• Negligible thermal losses
Demand Flexibility, Redundancy & Resilience	Central plant facilitates: • Thermal energy storage • Redundant equipment and backup sources (including non-electric sources) • Dispatchable electric demand flexibility • “Plug and play” new technologies	• Building level systems are more difficult to apply demand flexibility approaches due to cost and space constraints • Thermal mass of the distribution system will reduce peak demand compared to individual building heat pumps, but not dispatchable without storage or non-electric assets

Performance aspects of 4G and 5G TENs

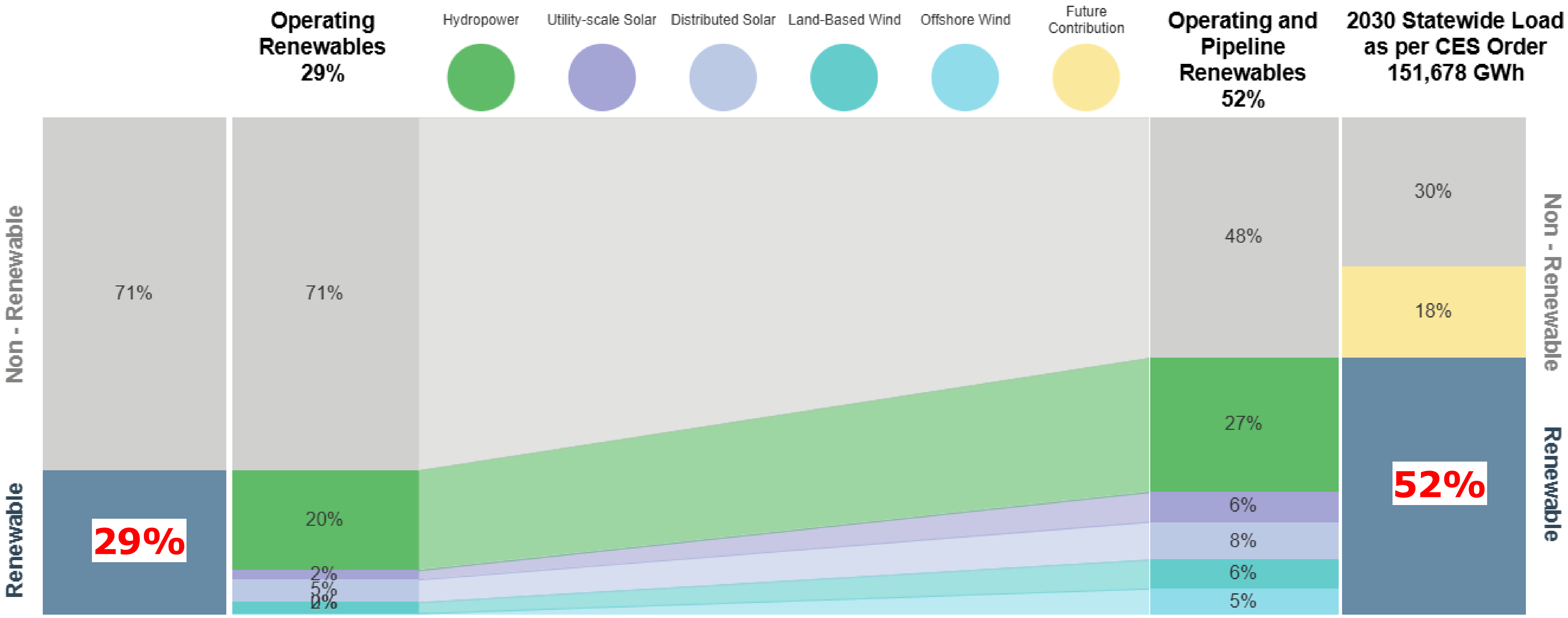
Performance Aspect	4G Systems	5G Systems
Capital Cost	• Expensive energy center and distribution system • Inexpensive building heat exchangers • Retrofit to accept the district hot/chilled water can be a major cost • Economies of scale for large-scale equipment • Total system capacity requirement is reduced due to load diversity • Easy application of base and peaking load technologies can reduce cost • Thermal energy storage and backup systems can be more cost-effective at central plant	• Less expensive energy center and distribution system • Building heat pump costs, including: - Small-scale equipment - Full capacity (no network diversity) - Electric service upgrades - Interface to existing HVAC • Difficult to apply base/peak load technologies and thermal energy storage (cost and space requirements)
Operational Cost	• Demand flexibility can shift electricity use to lower cost hours • Electricity rates at central plant may be lower than at the buildings, reducing heat pump operating cost	• Limited demand flexibility without storage or non-electric assets • Negligible thermal losses from the distribution system

Electric grid evolution

NYS electric grid evolution

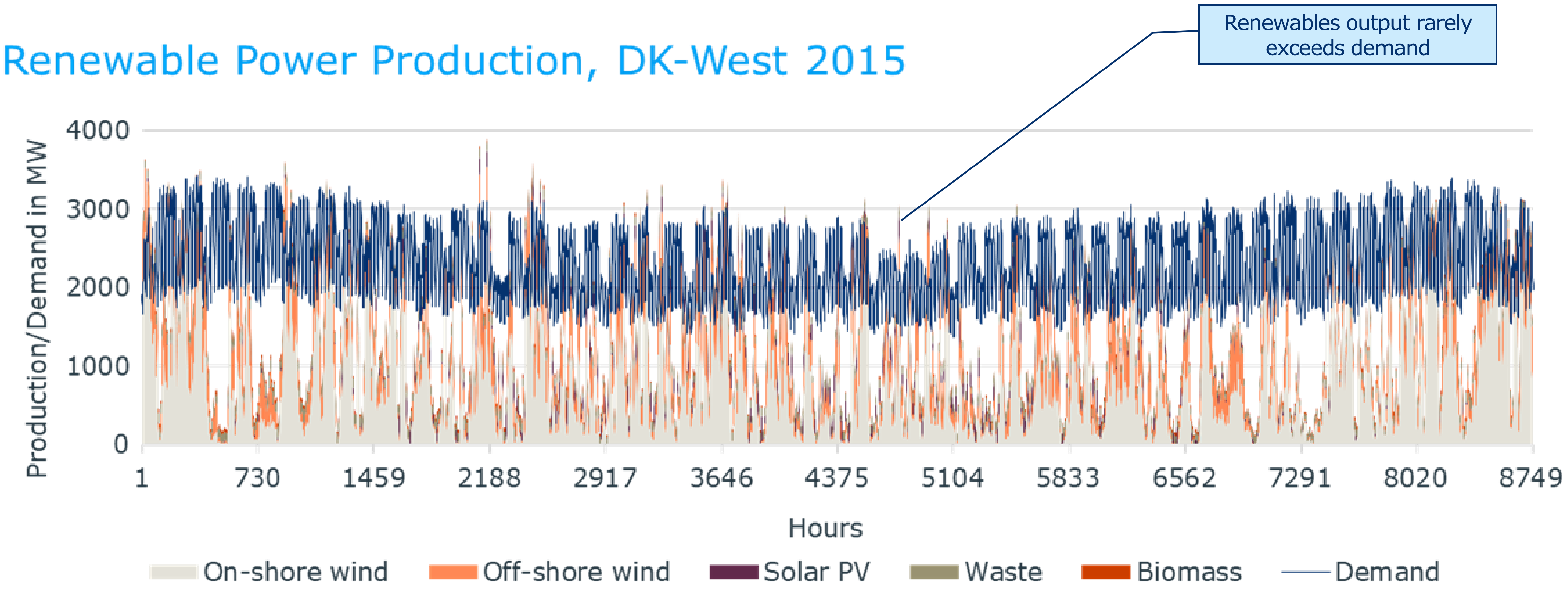
Climate Leadership and Protection Act (CLCPA)

- 70% of electricity from renewables by 2030
- 100% zero-emission electricity by 2040



Danish electric grid evolution example

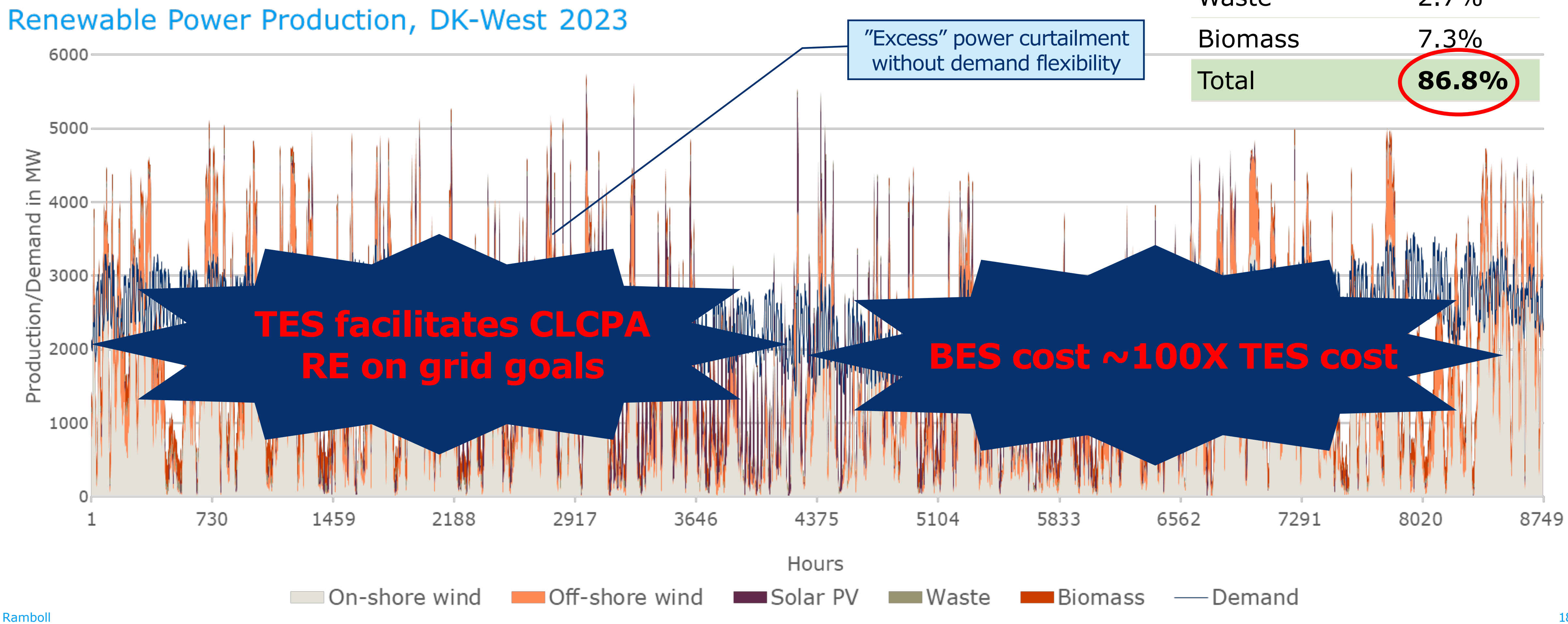
Danish electric grid ~55% renewables in 2015



Thermal storage facilitates RE on the grid

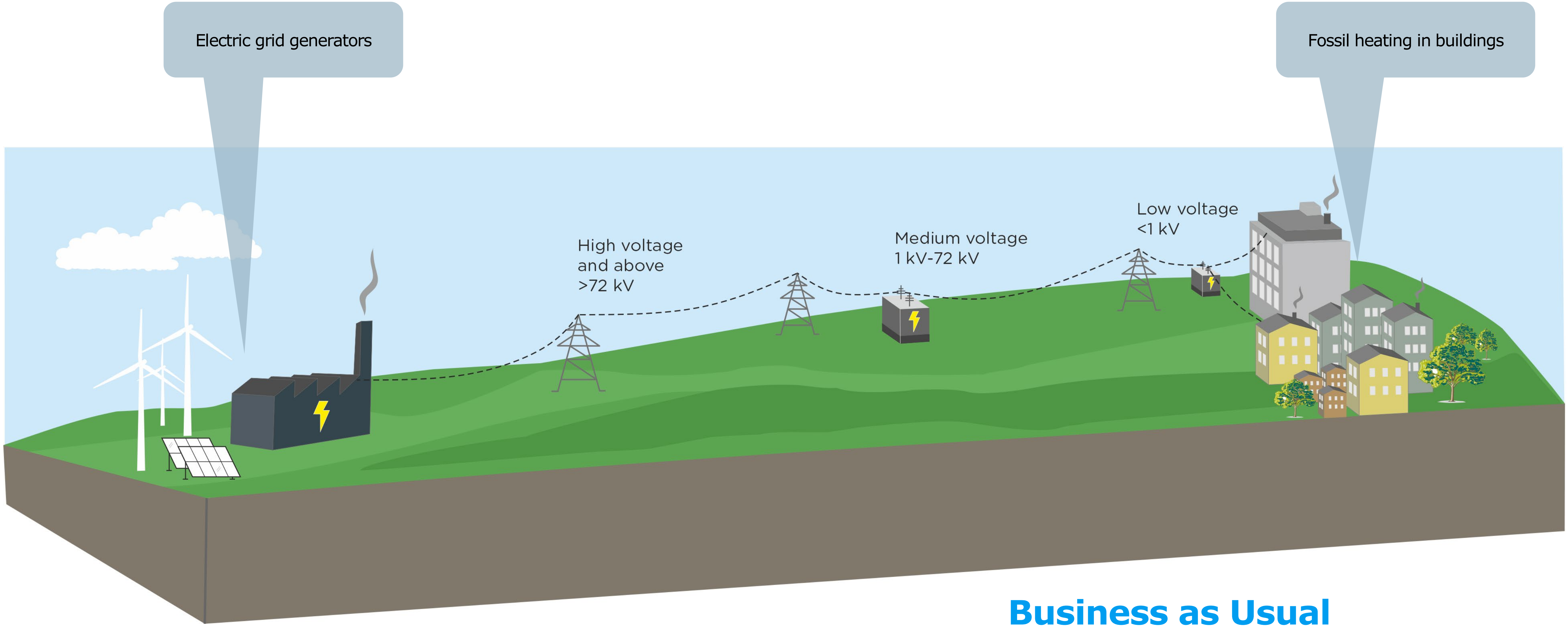
Thermal Energy Storage (Power-to-Heat) is largest source of demand flexibility on the Danish electric grid

2023 Danish grid	
Onshore Wind	44.3%
Off-shore wind	22.3%
Solar PV	10.2%
Waste	2.7%
Biomass	7.3%
Total	**86.8%**

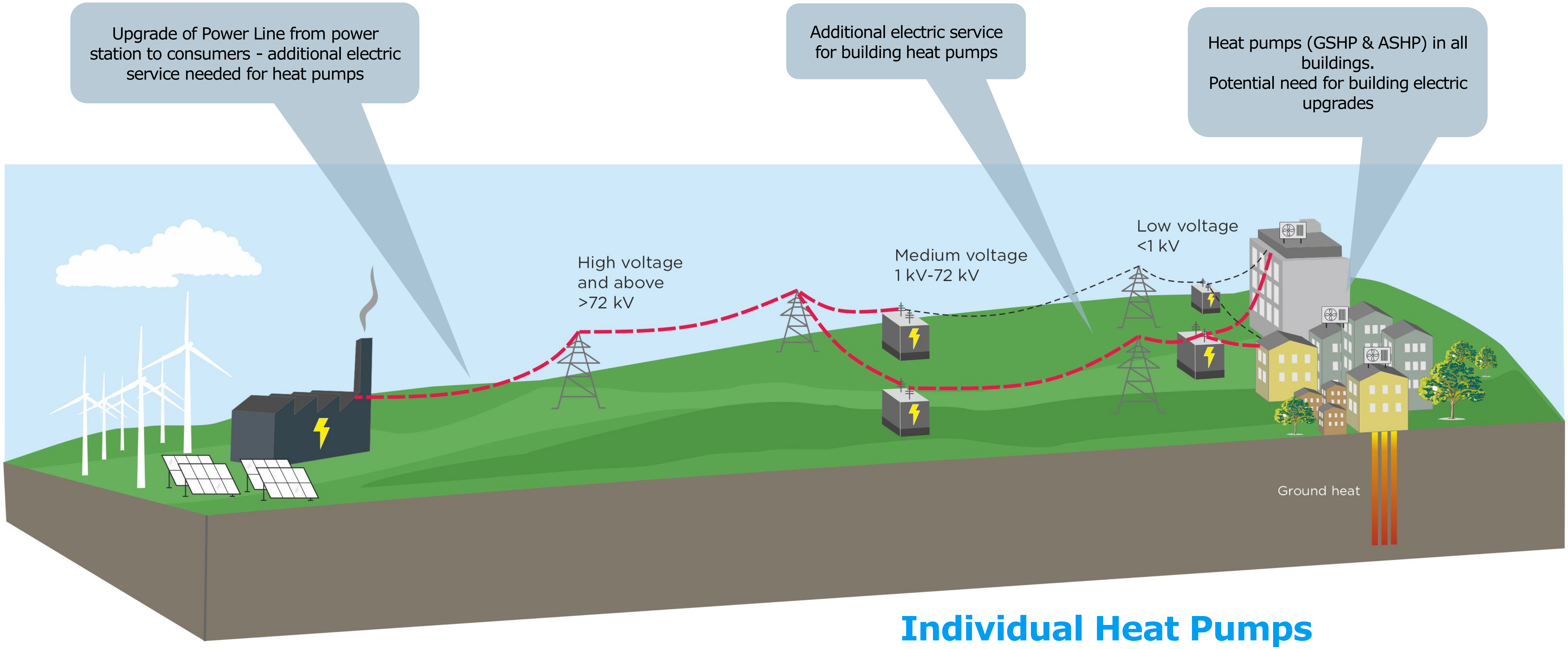


TEN adoption at scale

Electric grid upgrade requirements

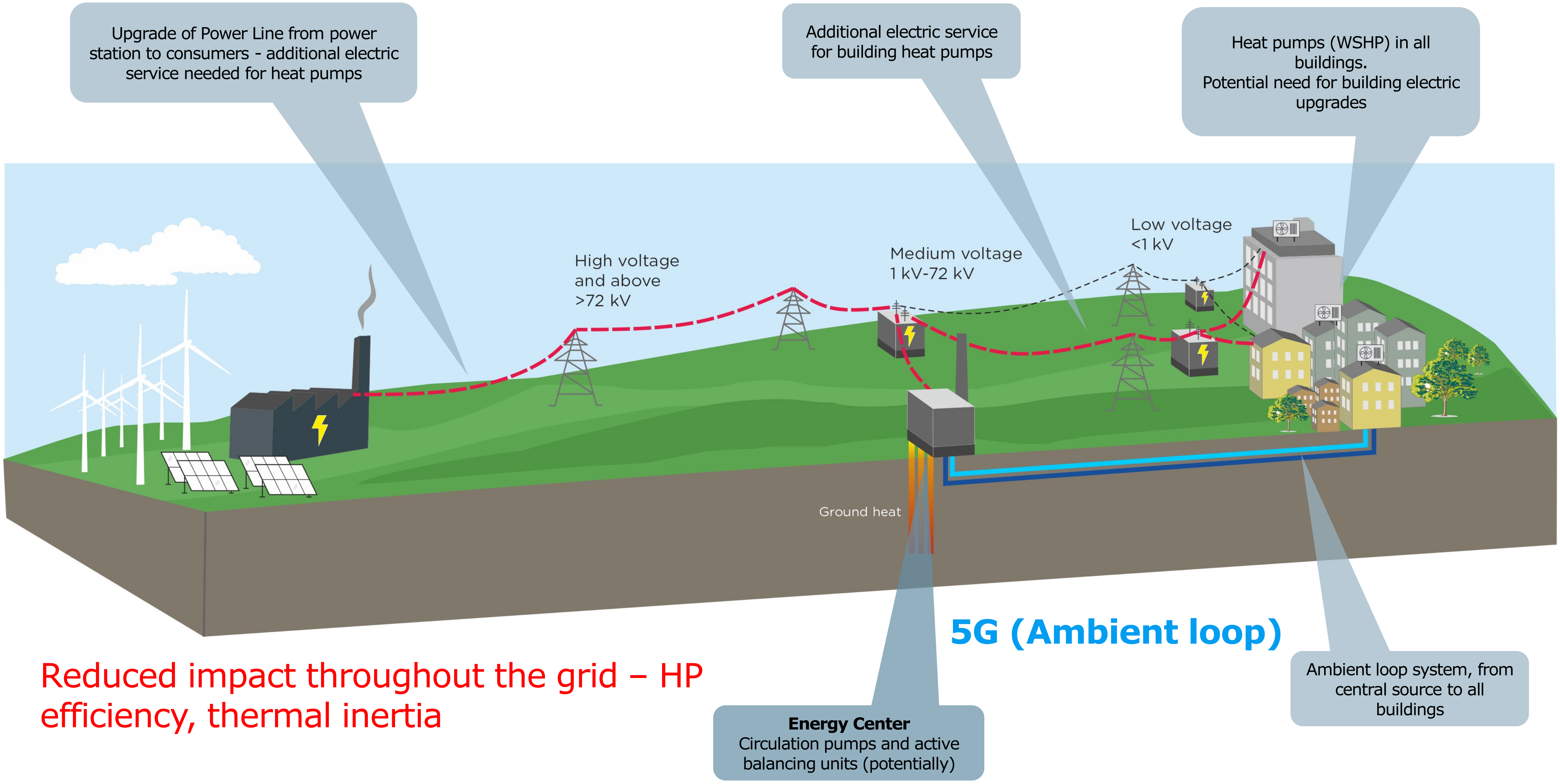


Business as Usual



Individual Heat Pumps

Maximum impact to the grid – upgrade and new capacity throughout

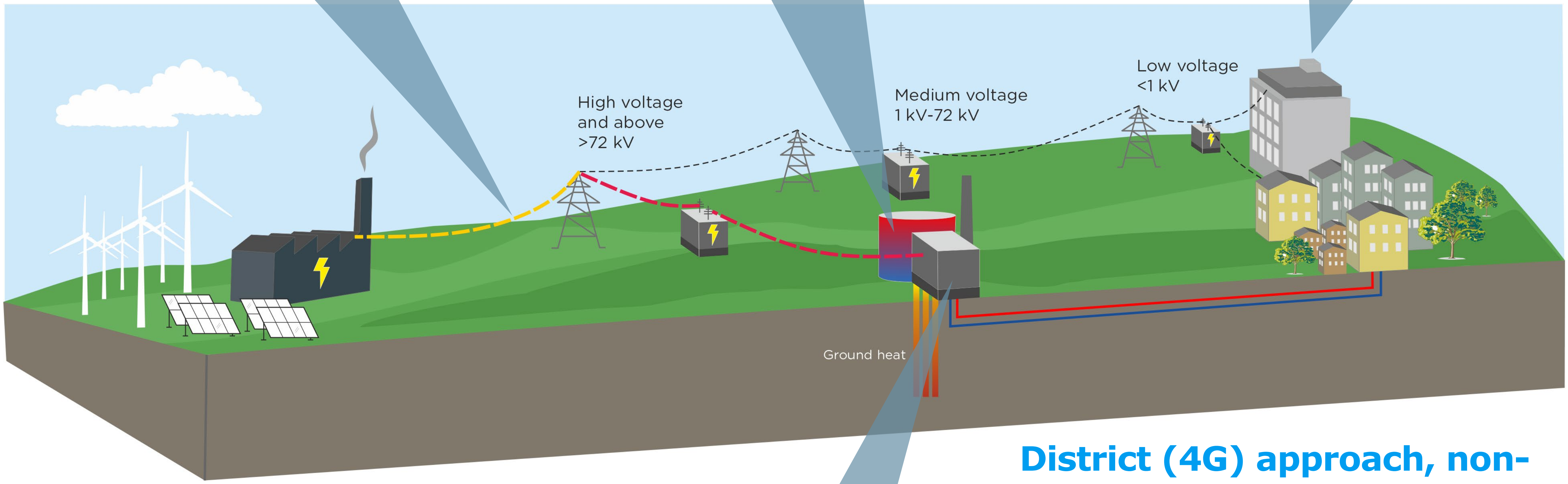


Reduced impact throughout the grid – HP efficiency, thermal inertia

HPs will not operate when wholesale prices are high. Entire power system upgrade not necessarily required

Thermal Energy Storage (TES) creates flexibility in the energy system, reducing peak demand and requirements for electrical upgrades

No building-level HPs.
No upgrades to low voltage system required



District (4G) approach, non-electric peaking/backup

Energy Center
Baseload HPs
Non-electric Peaking Boilers
(fossil or bio-based)

Lowest impact to the grid – no building upgrades and apply demand flexibility

Conclusion

- No one-size-fits-all solution
  - 4G, 5G, and individual HPs will have their applications
  - Hybrid solutions are also possible
- Use holistic planning for best result
- Design solutions that work today while considering how the future grid and TEN implementation at scale affect each other

Thank you!

Michael Kingsley, PhD, PE
Senior Technical Manager, Energy
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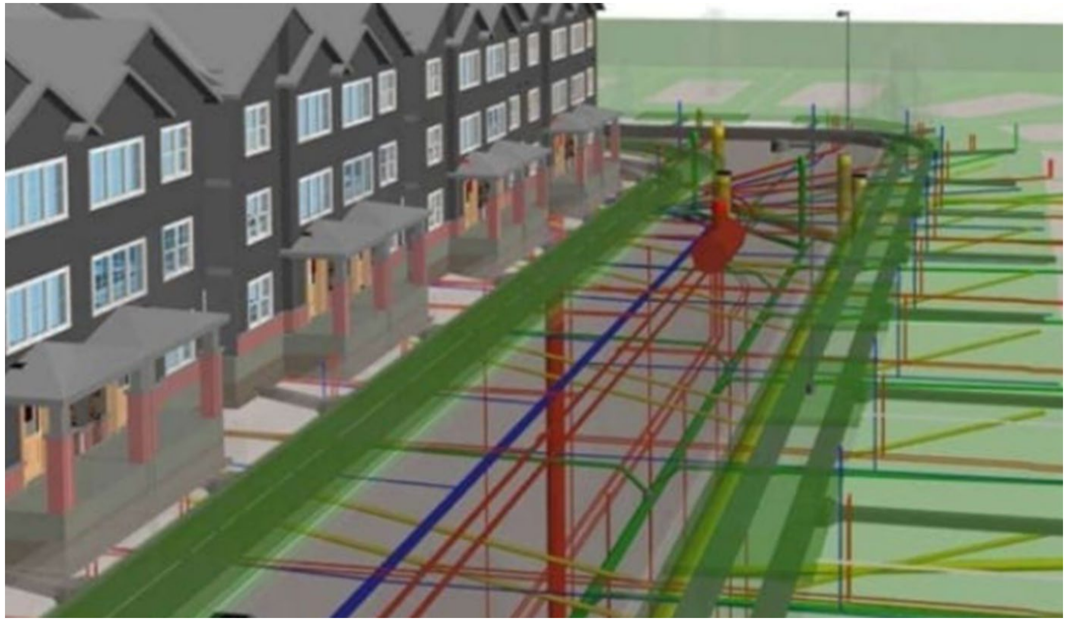
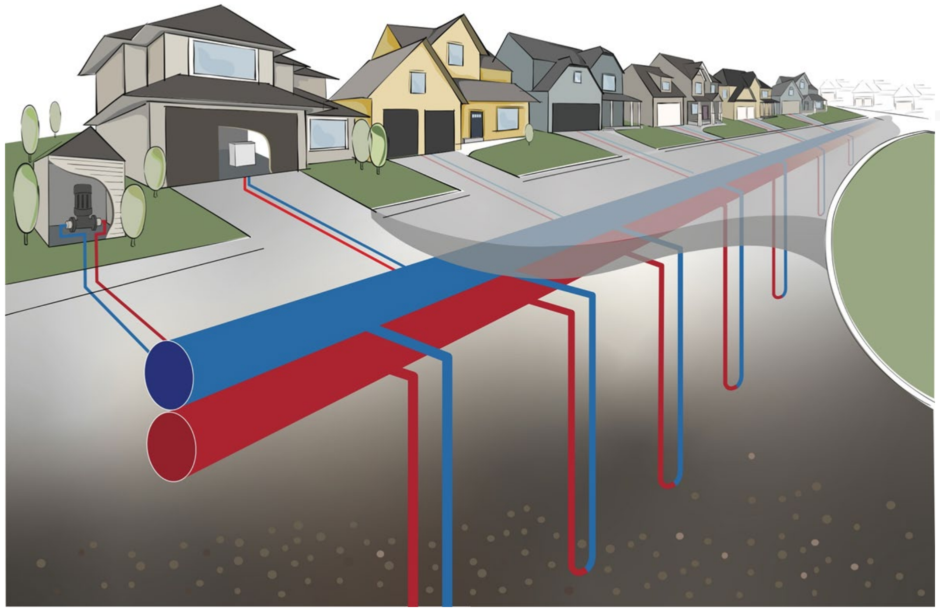
RAMBOLL
Bright ideas.
Sustainable change.





Thermal Energy Networks (TEN);

Project Examples – 4G & 5G

PRESENTED BY

Brian Urlaub

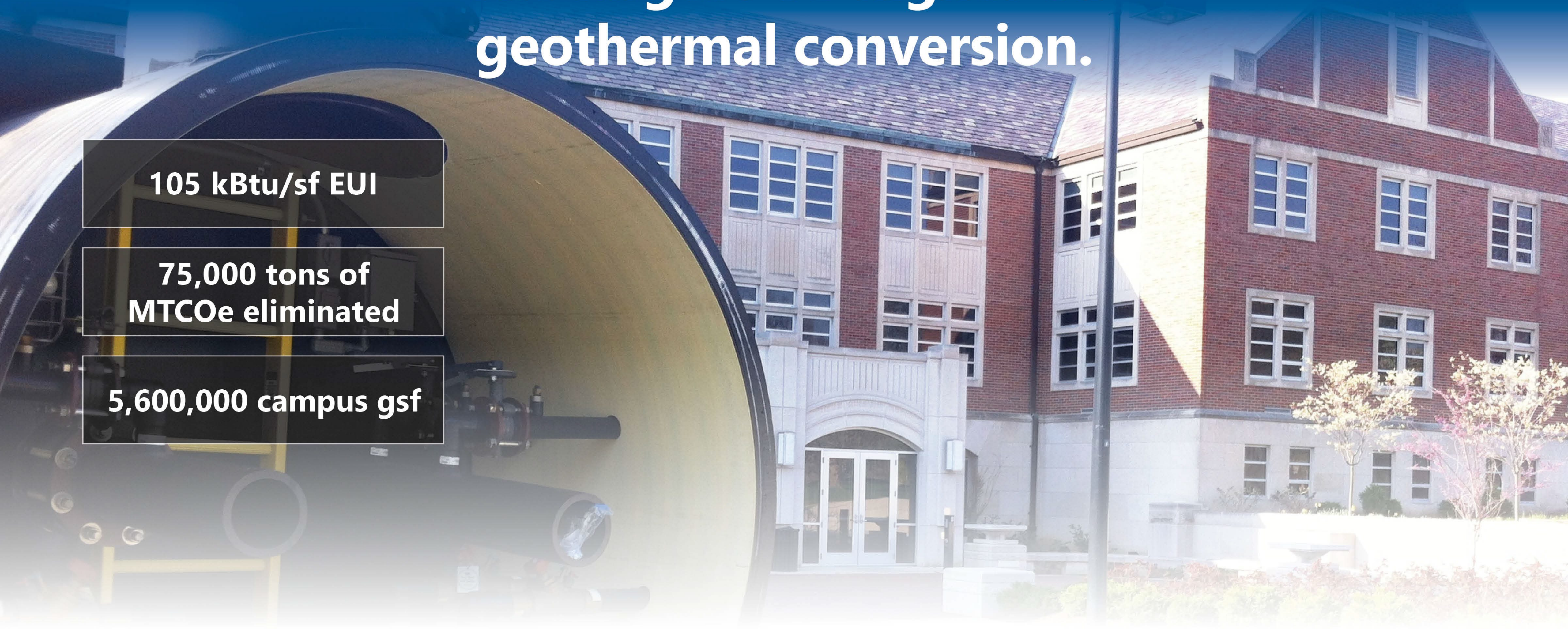
Director of Geothermal Operations

Brian.Urlaub@salasobrien.com

Salas O'Brien

Ball State, Muncie, IN

The largest US higher ed geothermal conversion.



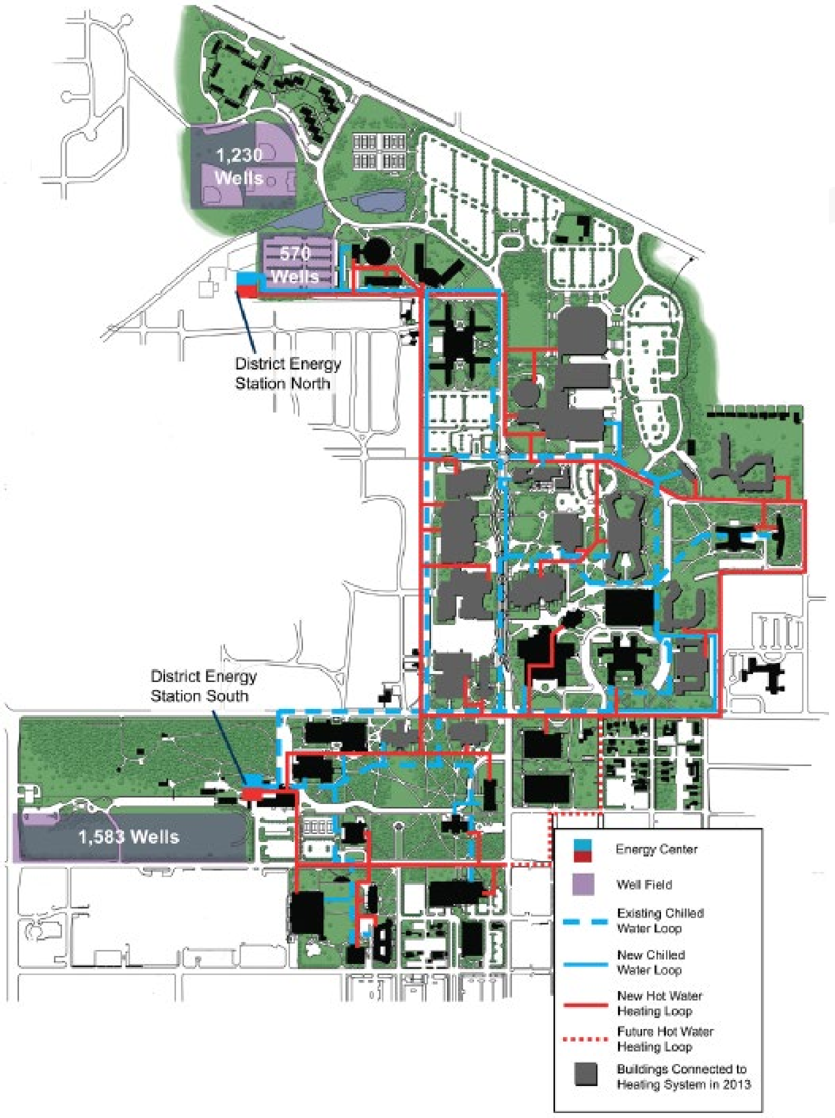
105 kBtu/sf EUI

75,000 tons of MTCOe eliminated

5,600,000 campus gsf

Ball State University – *Muncie, IN*

- Centralized 4-Pipe Distribution
- Conversion Facts
  - 10,000 Tons Cooling
  - 152,000,000 BTU/HR Heating
  - 5,600,000 GSF Heating Conversion
  - 47 Building Heating Conversion
  - Includes 300,000 GSF of Expansion
  - 2 District Energy Stations
  - 150°F HWS
  - 2813 Vertical Bore Holes
- Campus Energy Use Intensity
  - Prior to Geothermal Conversion – 175 Kbtu/SF/Yr
  - Fiscal Year 2013 / 2014 – 123 Kbtu/SF/Yr
  - Final Project Completion – 105 Kbtu/SF/Yr



Salas O'Brien

District Energy Station North

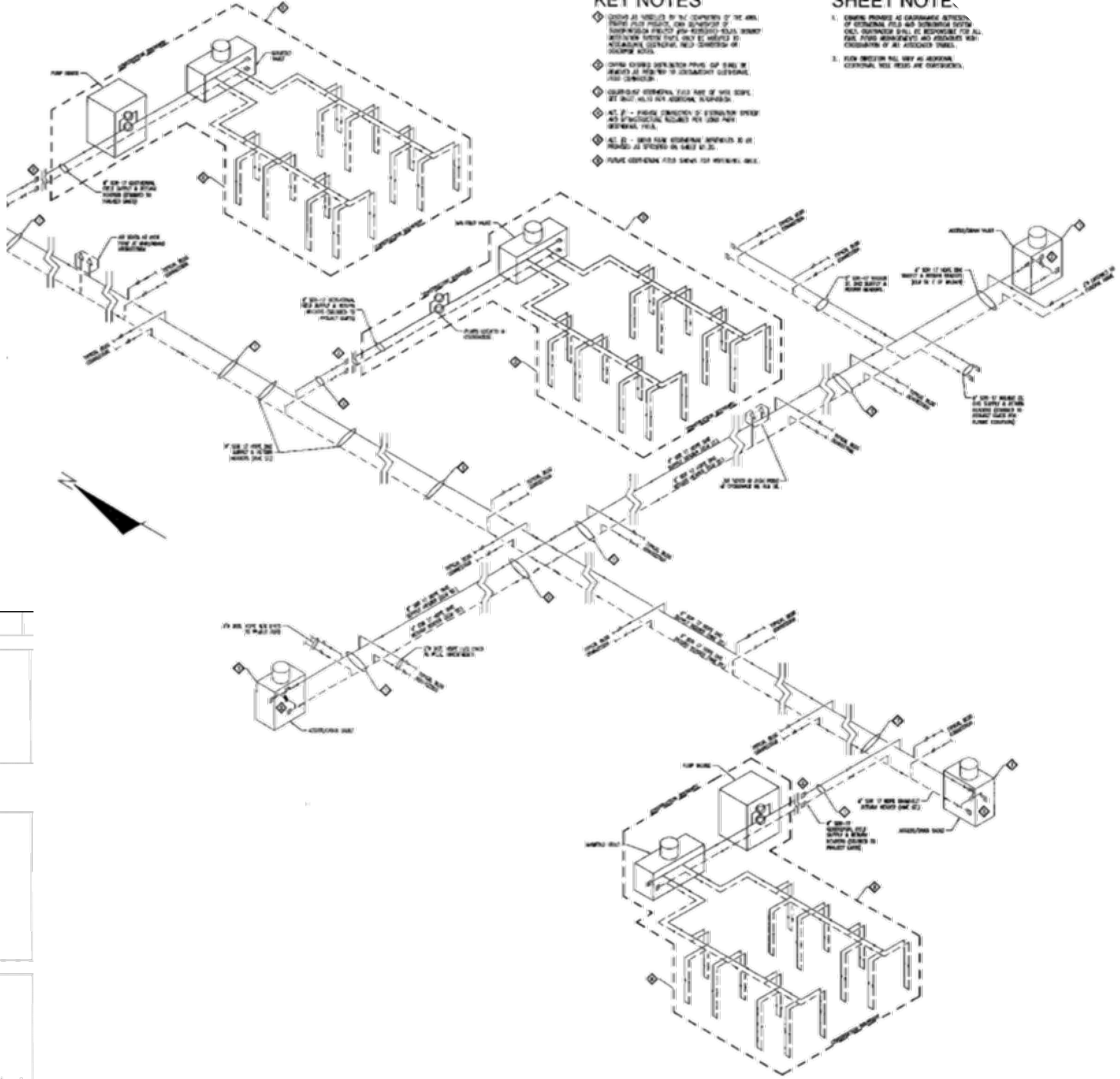
12,000 SF, Completed June 30, 2011

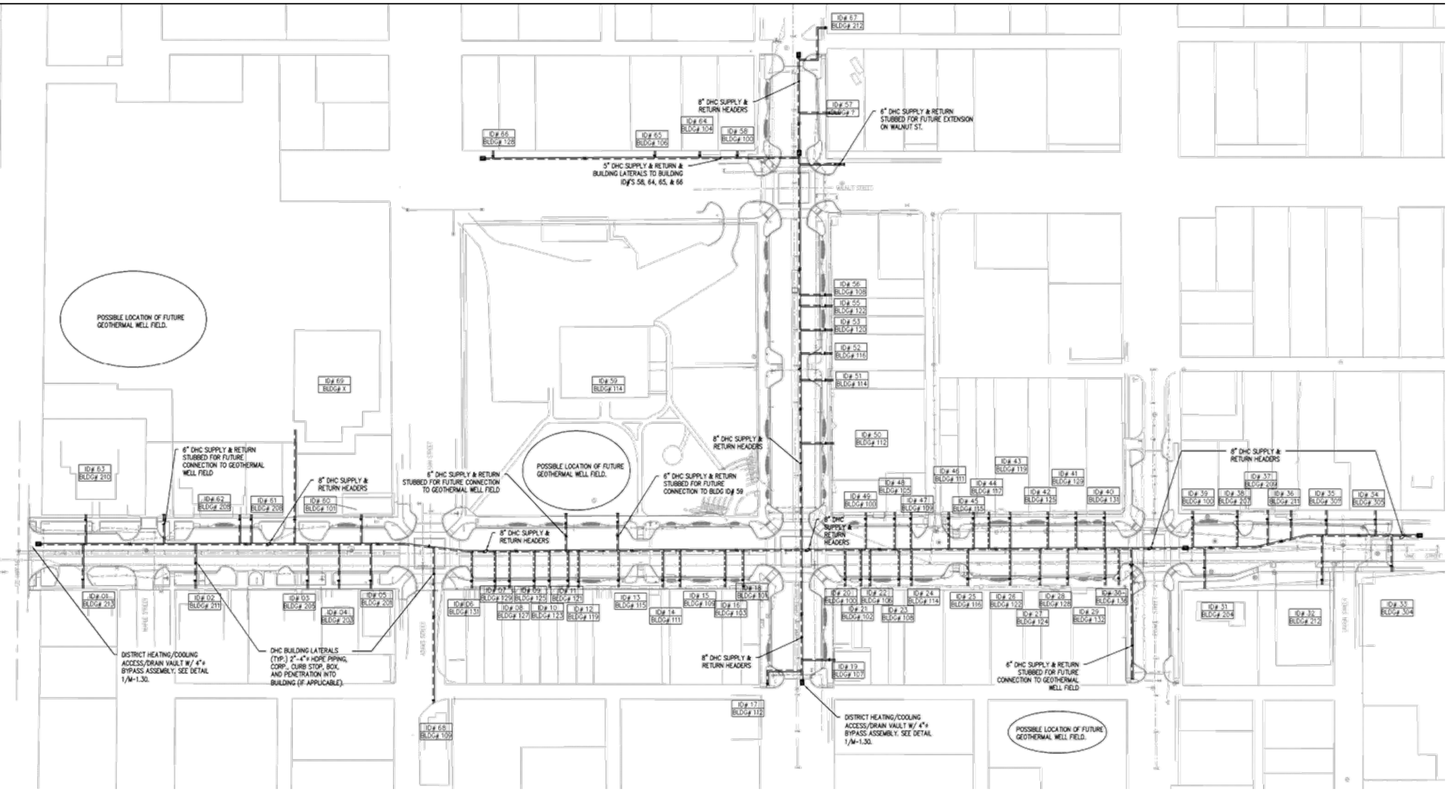
Projected LEED Silver

West Union, Iowa
TEN Project

Downtown Business District:

- Common loop serves multiple buildings (54 stubbed, 14 in Service)
- 2-Pipe Ambient distribution system
- Unitary GSHP’s serving each building
- Central pumping at each building and at each Ground Loop Heat Exchanger





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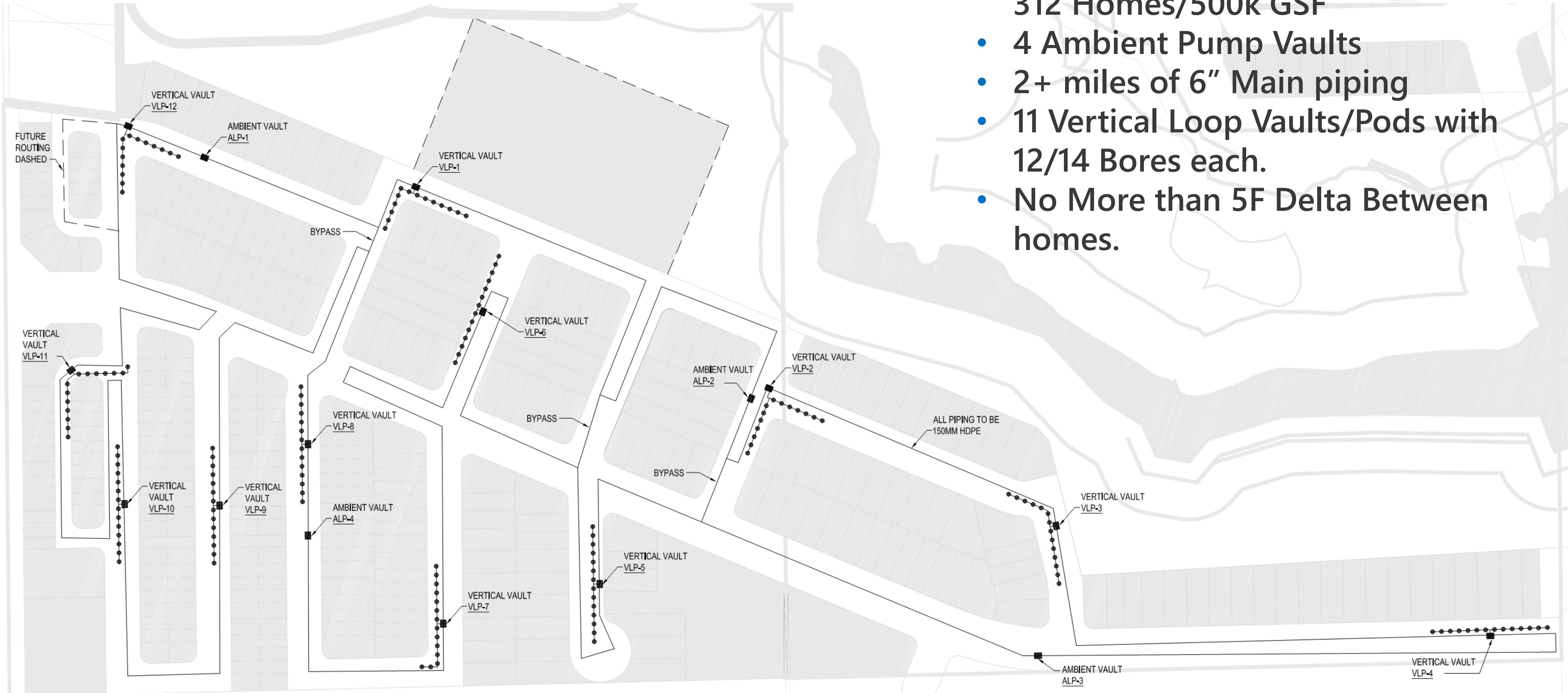
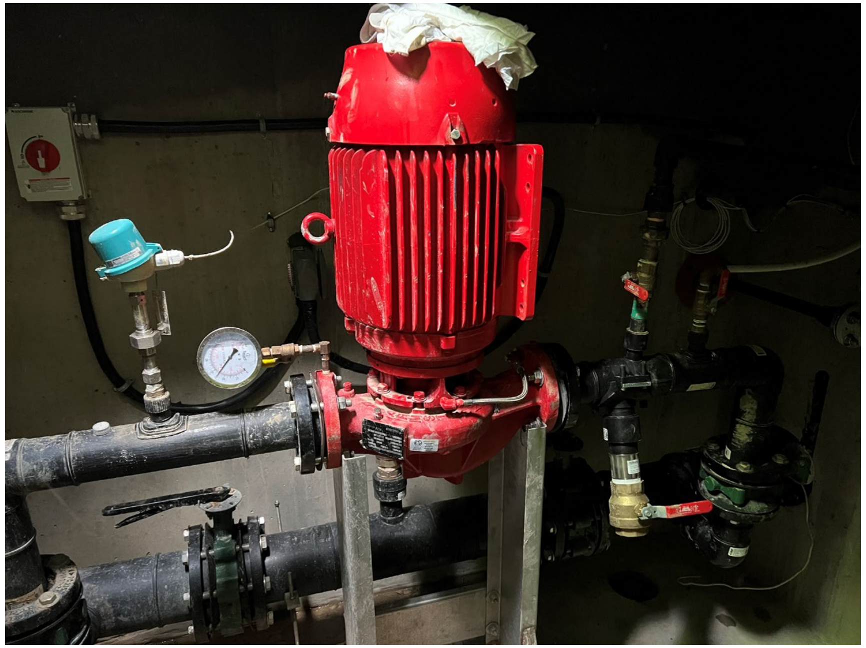
Single Family New Construction - Toronto

- Single Pipe Ambient Loop Serves 312 Homes/500k GSF
- 4 Ambient Pump Vaults
- 2+ miles of 6" Main piping
- 11 Vertical Loop Vaults/Pods with 12/14 Bores each.
- No More than 5F Delta Between homes.





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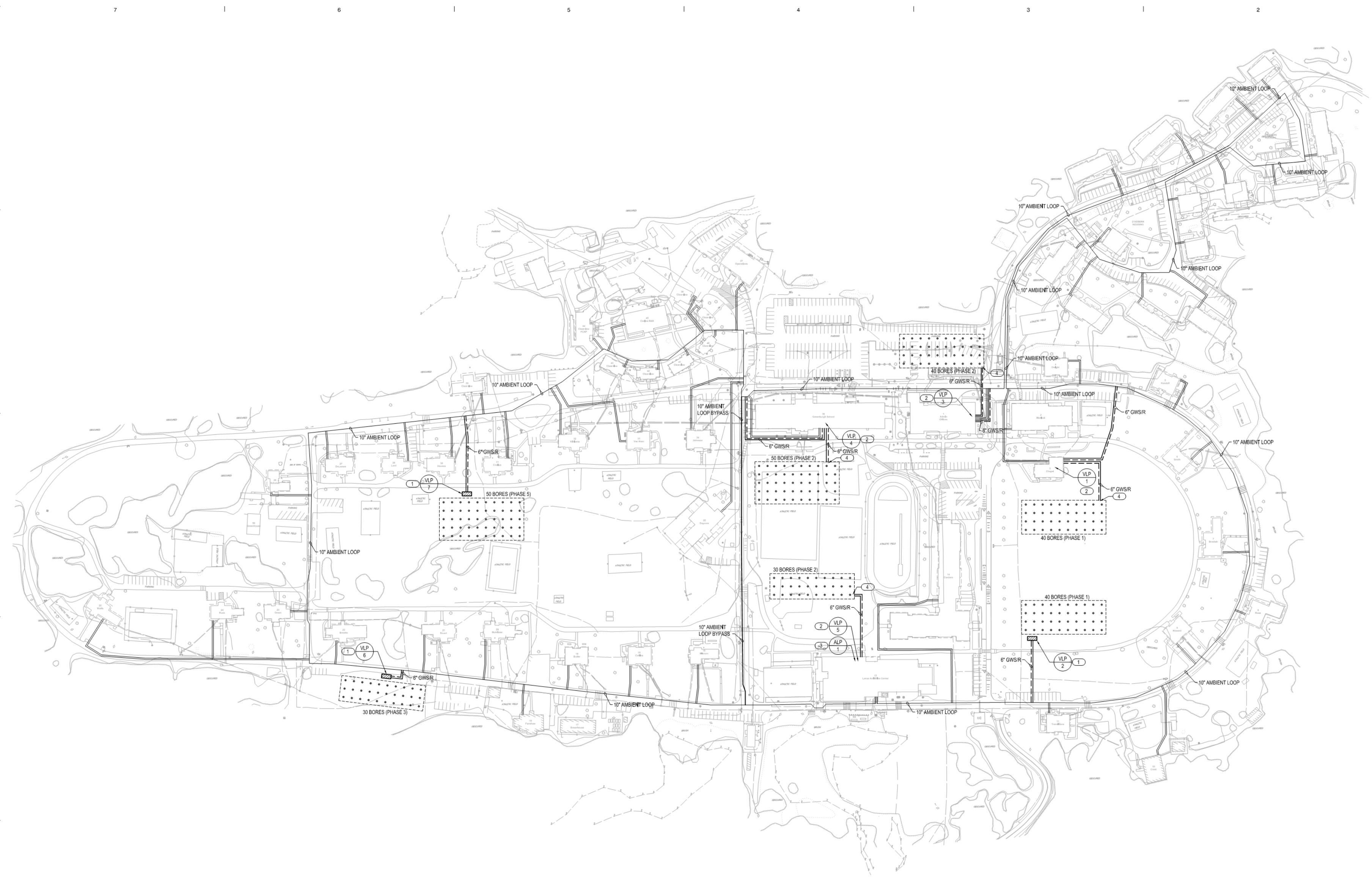
Campus Project (NY)

TEN System Layout



- Single Pipe Ambient Loop
- 65 commercial and residential buildings
- 7 distributed GLHE's
- Single Owner/Campus
- Buildings are mostly 80+ years old
- Utilize buildings for housing infrastructure as much as possible

Salas O'Brien

FRAMINGHAM, MA

Phase 1 Phase 2 Potential Customers

Salas O'Brien

Ambient Geothermal Loop with multiple energy sources

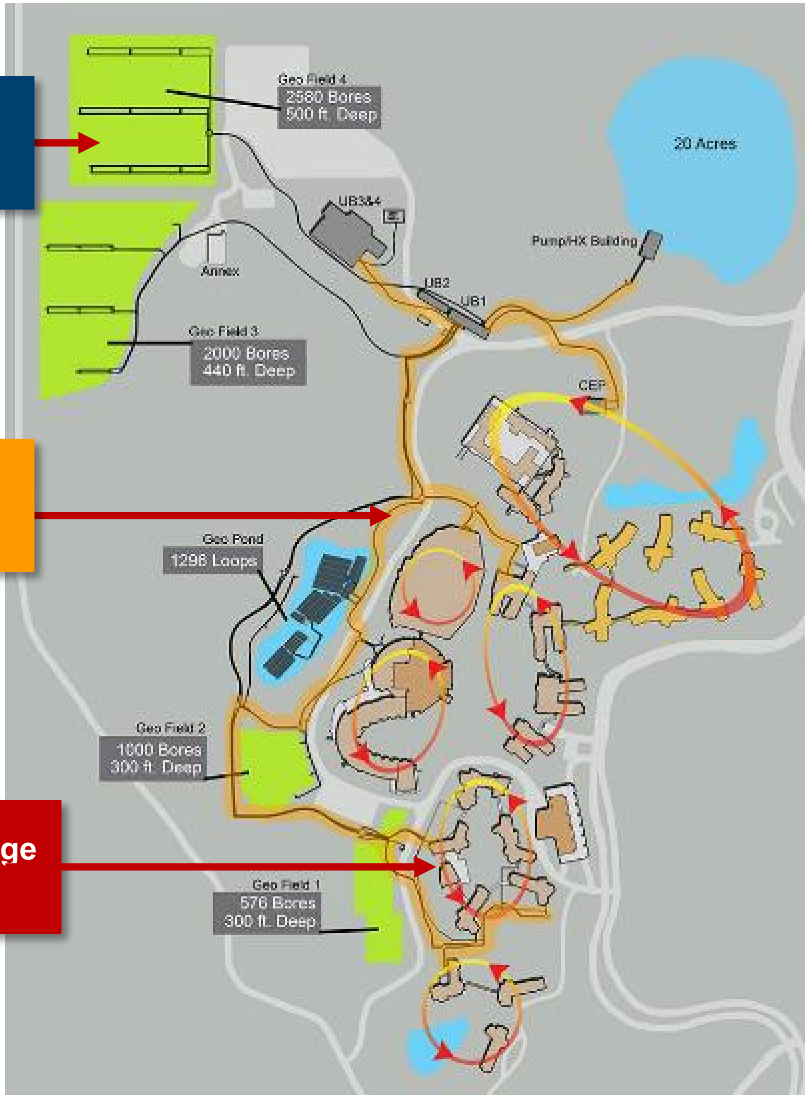
Auditorium

Training Facility

Energy Source

Energy Loop

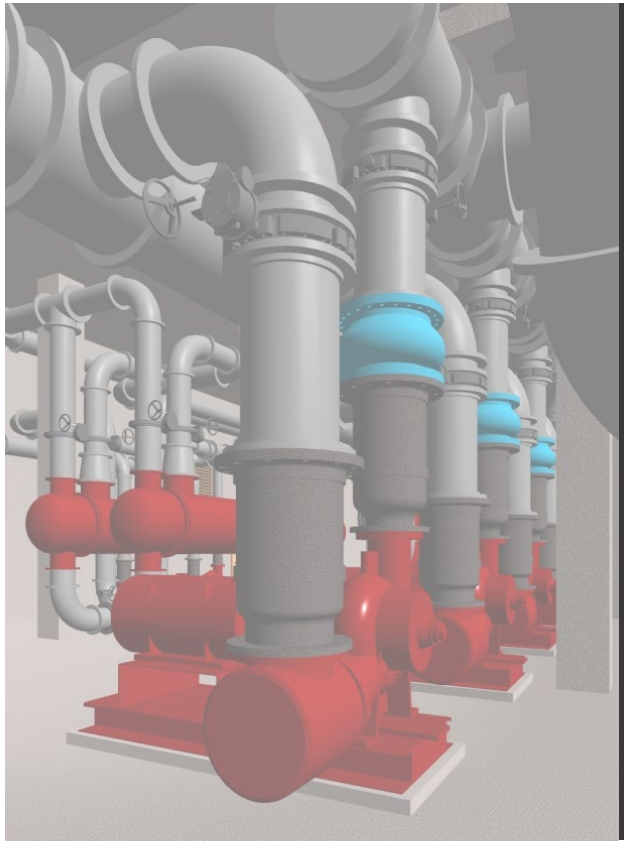
Energy Usage Loops

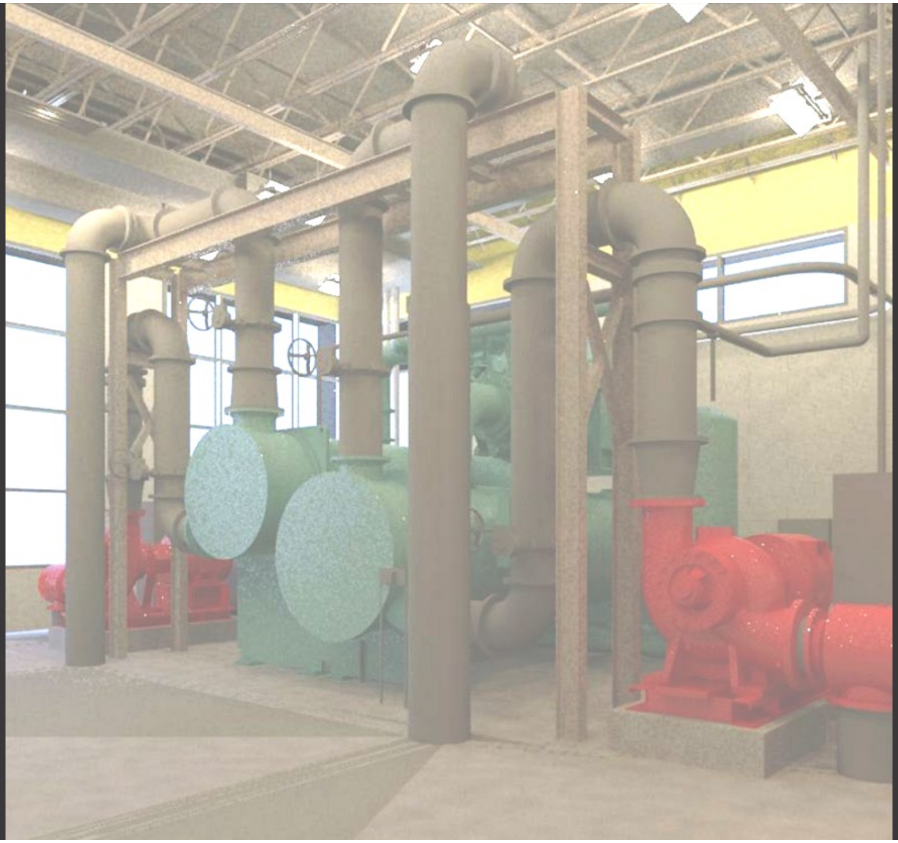


Office Space

Dining Facility

Data Center





Thank You!

- Contact Information | brian.urlaub@salasobrien.com

Salas O'Brien

Steam to Low-Temperature Hot Water Conversions

Steve Grgas
Senior Project Development Engineer

wendel

Agenda

- Benefits of Converting Steam to LTHW
- Key Considerations
- Financial Strategies
- Challenges
- Case Studies
- Question & Answer

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Low-Temperature Hot Water Conversions
Thermal Energy Networks

Benefits of Converting to LTHW Systems

- **Energy Efficiency Improvements:**
  - LTHW systems reduce thermal losses, leading to significant energy savings
  - Closed-loop nature minimizes water and energy waste
- **Operational Cost Reductions:**
  - Substantial reduction in maintenance and distribution costs
- **Infrastructure Modernization:**
  - Replace aging steam infrastructure, enhancing system reliability
  - Improved control over distribution system

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Key Considerations for Conversion

- **Assessment of Existing Infrastructure:**
  - Evaluate condition & capacity of current systems
  - Consider reusing existing infrastructure or upgrading/replacing equipment
- **Temperature Requirements:**
  - Analyze building heating demands for LTHW system compatibility
  - Possible need for building envelope improvements or HVAC system modifications
- **Phased Implementation Approach:**
  - Incremental retrofits to spread costs over time and minimize disruption
  - Prioritize buildings/zones based on energy use, infrastructure condition, and occupancy

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Financial Strategies for Cost-Effective Conversion

- **Life-Cycle Cost Analysis:**
  - Compare initial costs with long-term savings in energy & maintenance
  - Include potential future costs related to carbon pricing and regulations
- **Leveraging Incentives and Funding:**
  - Explore available grants, rebates, and financial incentives for energy efficiency and decarbonization
  - Engage stakeholders for funding and support
- **Operational Savings Reinvestment:**
  - Reinvest savings from reduced costs into further energy efficiency projects
  - Offset initial capital expenditures with savings

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Challenges and Mitigation Strategies

- **Technical Challenges:**
  - Address compatibility issues with targeted upgrades & retrofits
- **Financial Constraints:**
  - Phased implementation plans & securing external funding to manage upfront costs
- **Stakeholder Engagement:**
  - Communicate benefits and long-term savings to stakeholders for support

Case Studies

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PRIVATE UNIVERSITY

PROJECT | Laboratory Electrification Pilot

SCOPE OF WORK OVERVIEW
- 210 Ton Heat Pump
- Electric Autoclaves
- Ultrasonic Humidification
- Wellfield

DESIGN CONSIDERATIONS
- 140F Hot Water
- Electrical Needs
- HW System Stress Test

TOTAL COSTS | $13,000,000

Thermal Energy

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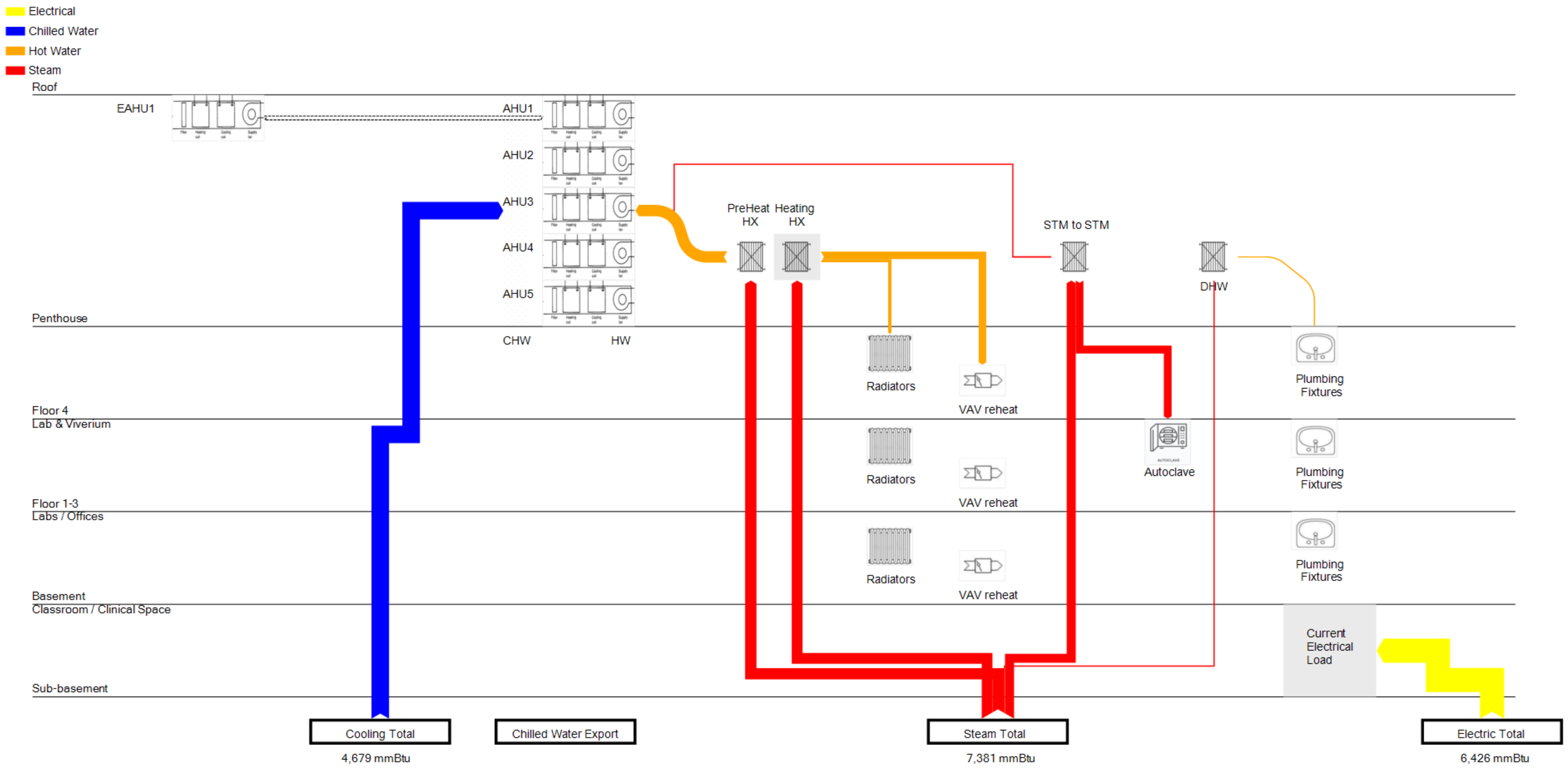
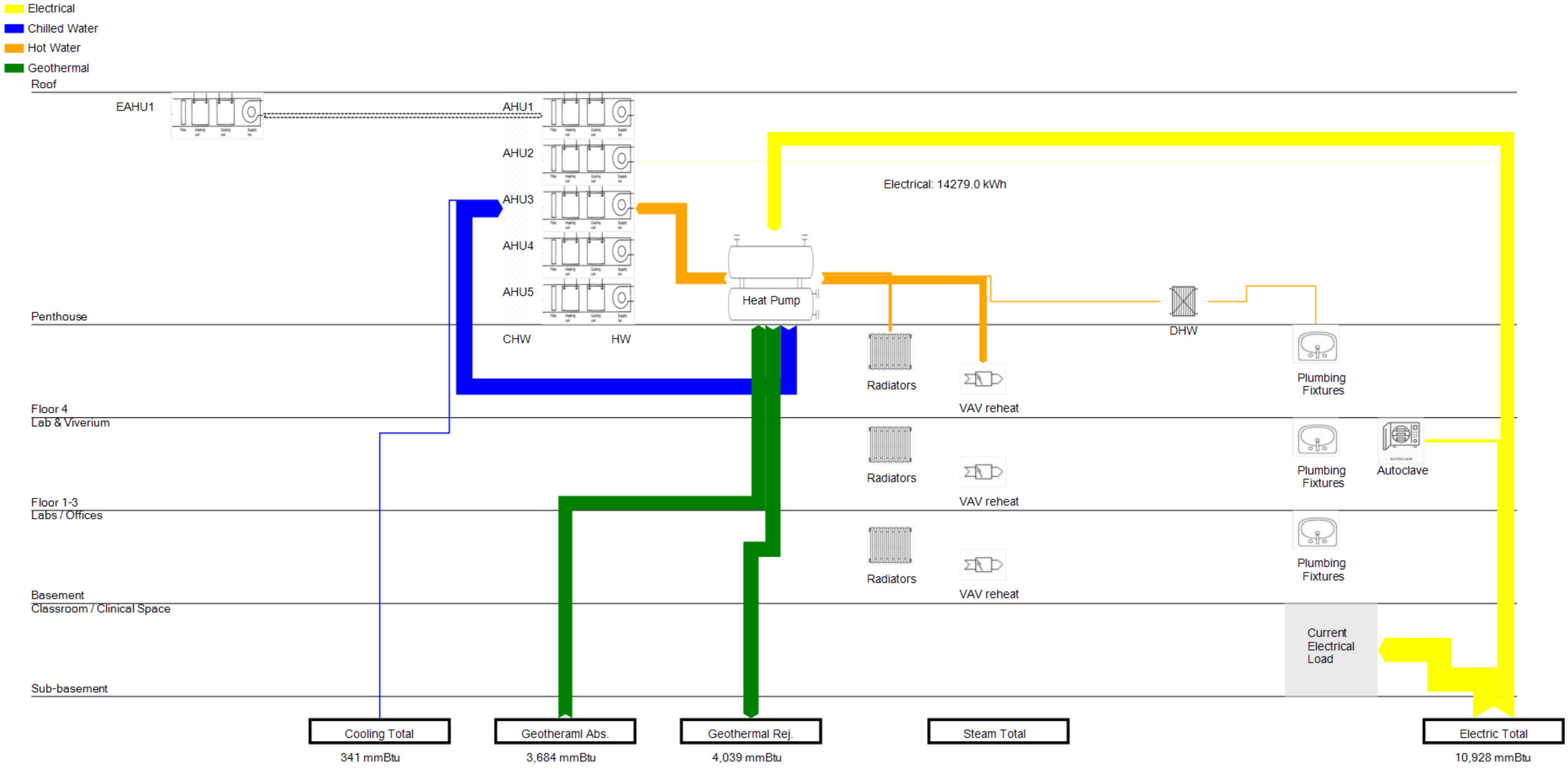
CURRENT SYSTEM



PROPOSED SYSTEM



BROOKLYN MUSEUM

PROJECT | Deep Energy Retrofit

SCOPE OF WORK OVERVIEW
- 150 Ton Heat Pump
- Steam-to-HW Conversion
- New Condensing Boilers
- DHW Heat Pumps
- Energy Efficiency Measures

DESIGN CONSIDERATIONS
- 140F Hot Water
- Condensing Boilers Peaking/Resilience
- HW System Stress Test
- Adaptable to Long Term Options

TOTAL COSTS | $28,600,000

Thermal Energy

STATE GOVERNMENT

MASTER BUILDER

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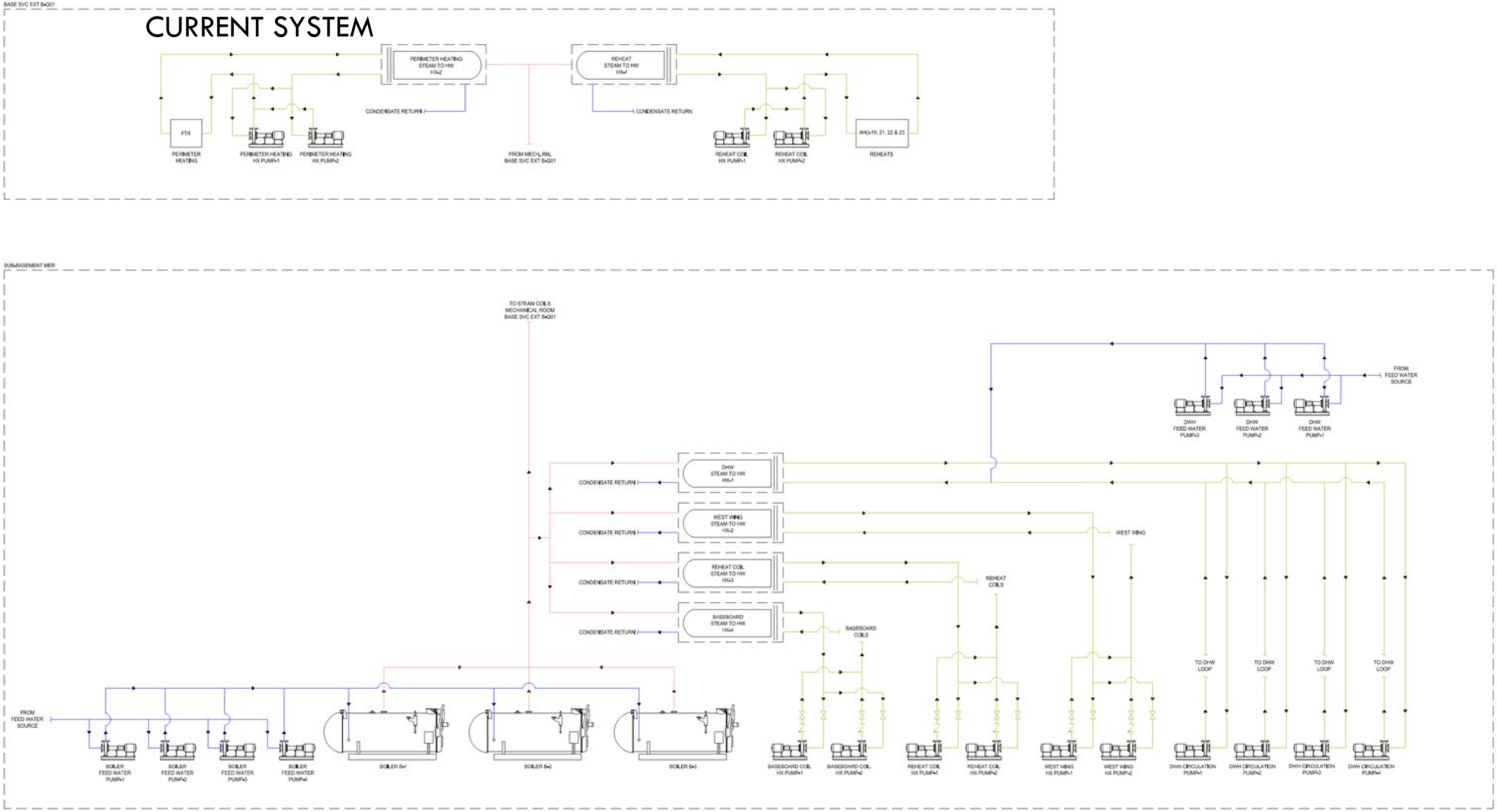
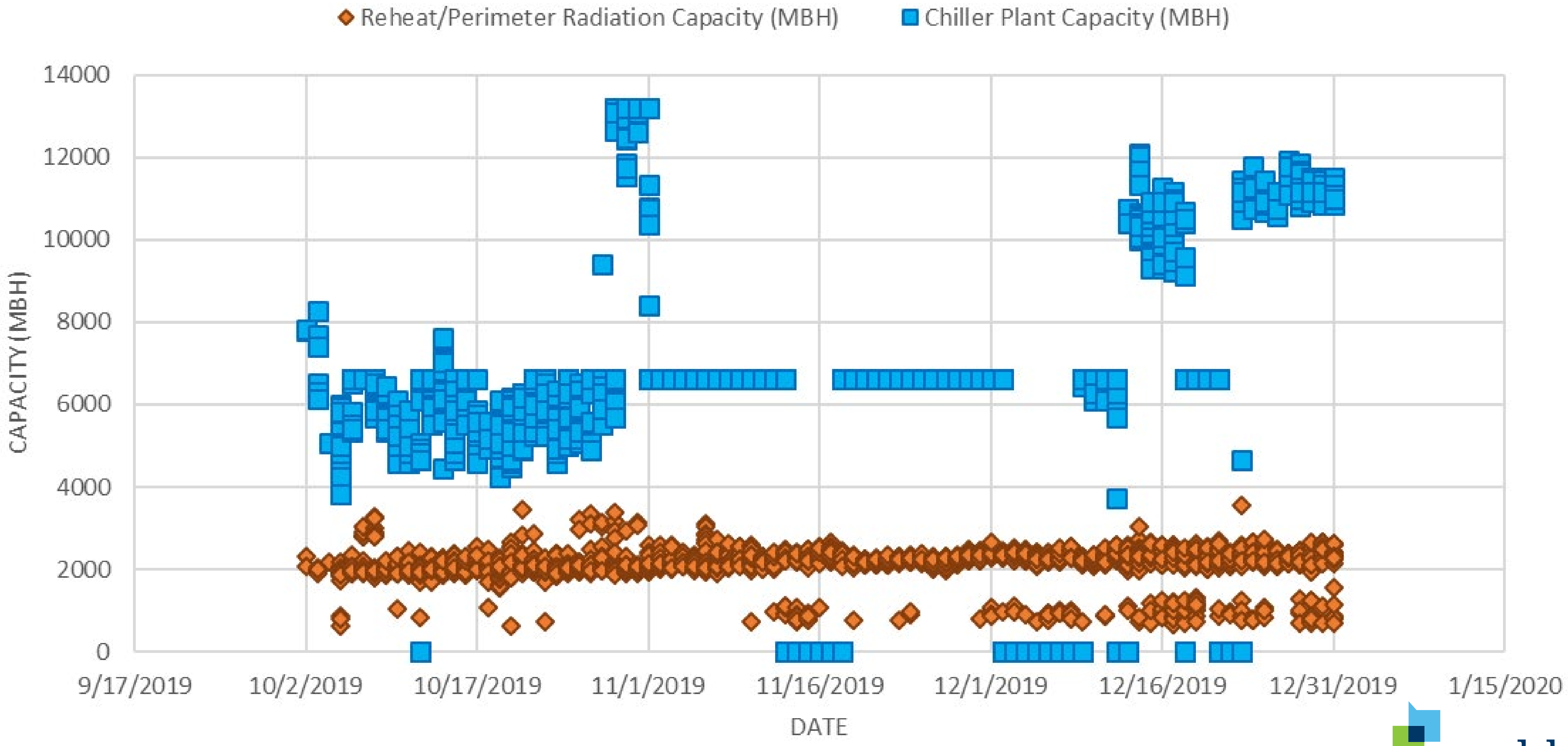
CURRENT SYSTEM



1 EXISTING STEAM / HOT WATER SCHEMATIC
SCALE: NOT TO SCALE

SIMULTANEOUS HEATING/COOLING TREND ANALYSIS



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EEMs

- EEM 4.1 Direct Digital Controls Conversion
- EEM 4.2 HVAC Controls Optimization
- EEM 4.3 Unoccupied Shutdown
- EEM 4.4 Morning/Afternoon Warmup/Cooldown
- EEM 4.5 Discharge Air Temperature Reset
- EEM 4.6 Static Pressure Reset
- EEM 4.7 Enthalpy Economizer (Humidity)
- EEM 5.2 Water Side Economizer & Optimization
- EEM 5.3 Heat Recovery Chiller / Heat Pump
- EEM 6.2 Boiler and Steam to HW Conversion
- EEM 7.3 Single Zone Variable Volume
- EEM 9.4 RCx and Advanced Analytics
- EEM 11.1 Heat Pump Domestic Hot Water
- EEM 13.2 Solar Photovoltaic Array
- EEM 14.1 Misc. Updates to EEM 4.6, 4.7, and 5.2

Total Cost (M&L w/Bonds): $28,600,000

Total NG Savings: 444,659 therms ↓

Total GHG Savings: 3,231 MT CO2 ↓

$/GHG Saved: $8,849/MT CO2 ↓

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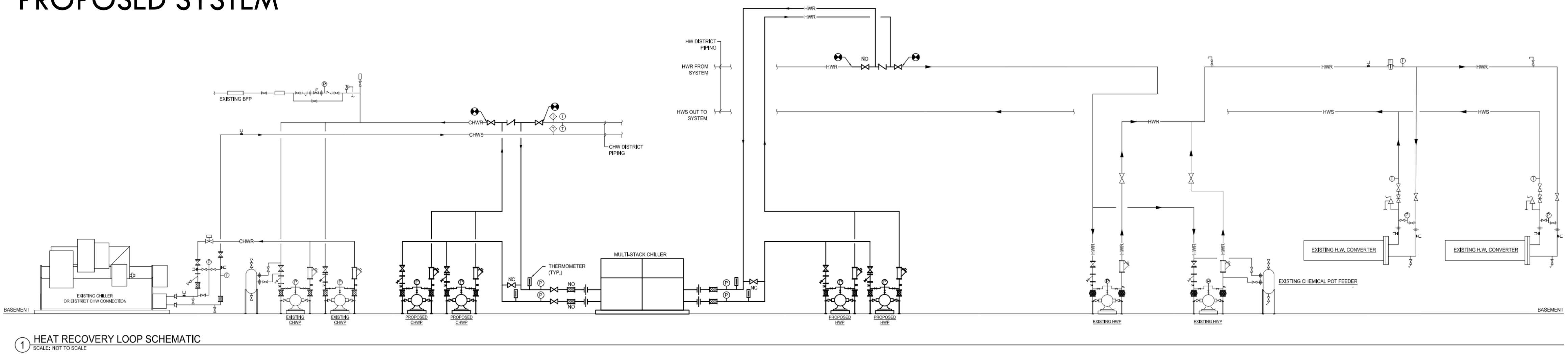
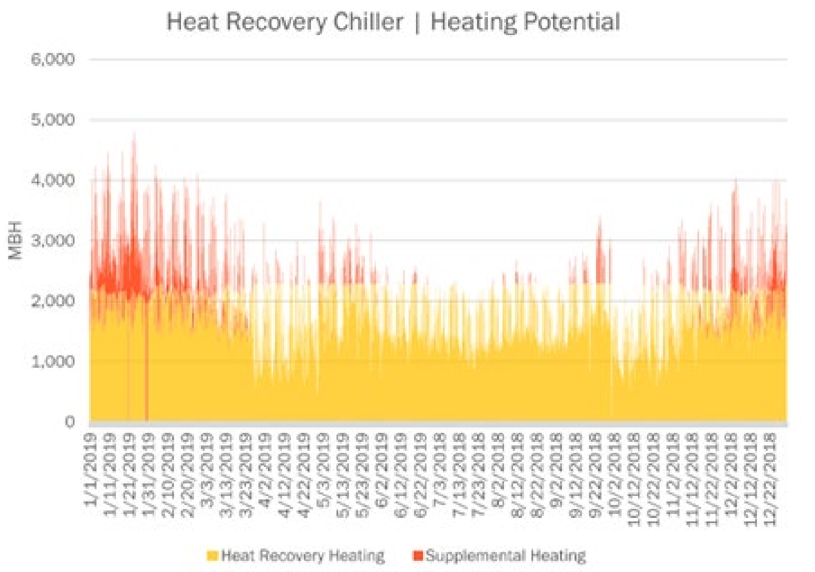
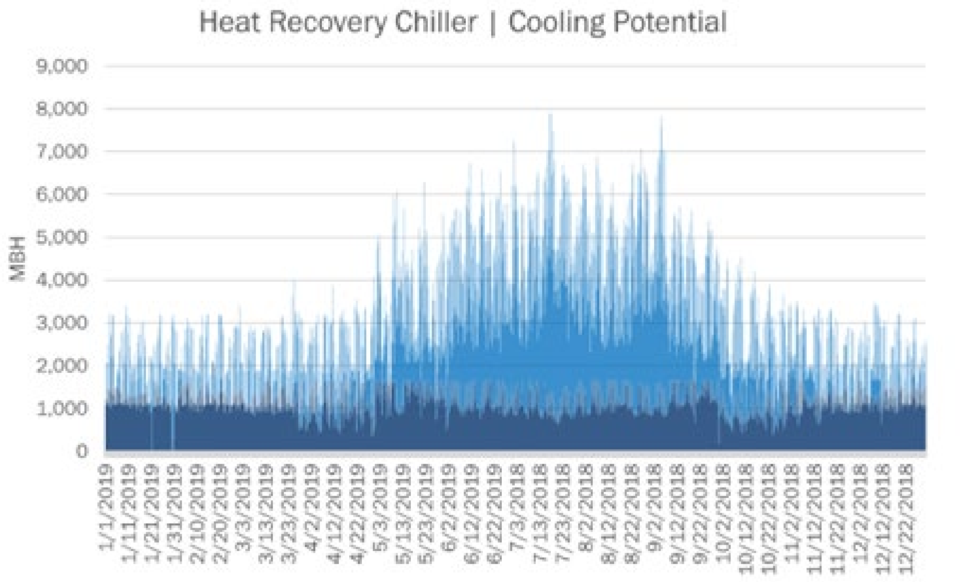
PROPOSED SYSTEM







Conclusion

- Recap of LTHW system benefits: energy efficiency, cost savings, and infrastructure modernization
- Emphasis on the need for thorough planning, financial analysis, and stakeholder engagement
- Encourage campuses/communities to consider LTHW conversion as a sustainable, financially responsible move

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Thank you.

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architecture | engineering | energy efficiency | construction management

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