Optimizing Design for Conversion From Steam to Hot Water

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International District Energy Association

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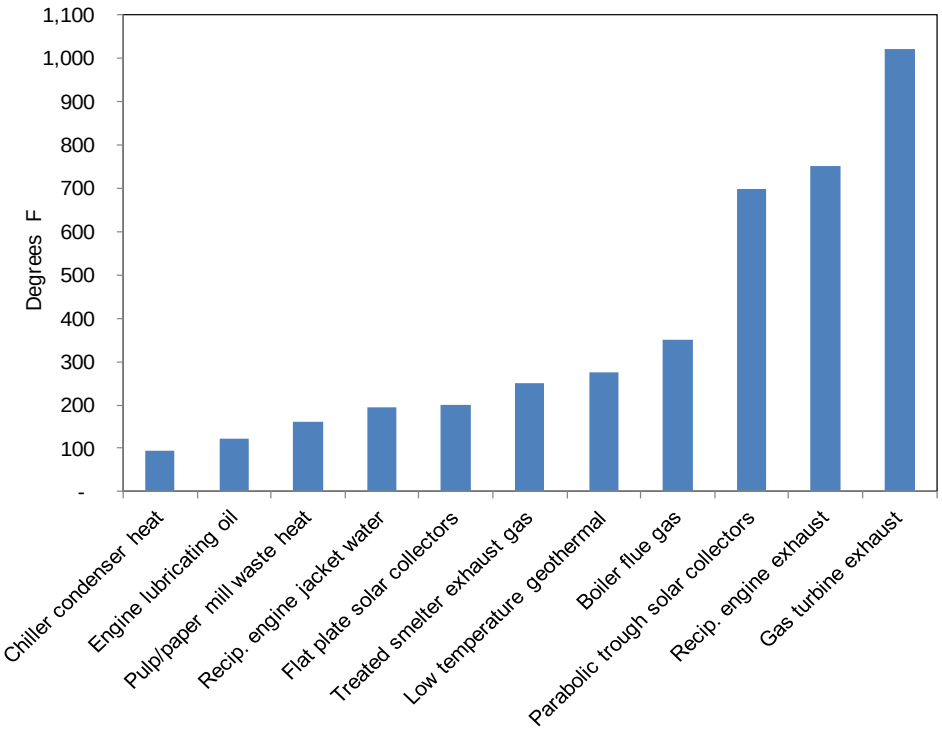
45 Years of Experience in Sustainable District Energy Systems

Agenda

- Why get into hot water?
- Design trade-offs
- District hot water temperatures
- Building conversion
- Heat sources
- Distribution piping
- Conversion phasing

Why Hot Water?

- Broad array of energy sources with lower temperature hot water
- Reduced heat losses
- Lower capital costs
  - Direct buried installation more practical
  - Lower piping and component material costs
  - Reduced expansion compensation requirements
  - No anchor blocks required in most cases



- Lower O&M costs
- Hot water is storable on a daily or seasonal basis

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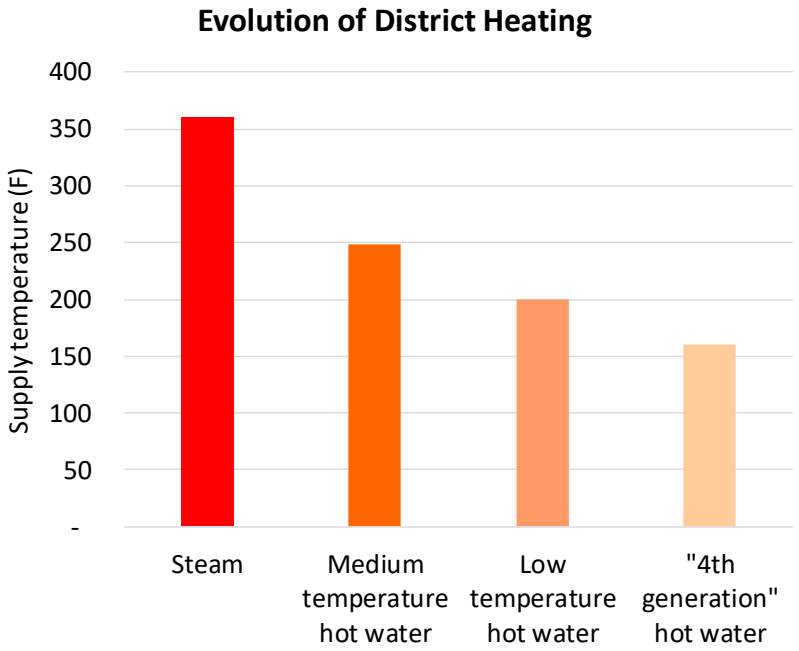
Hot Water Temperatures Coming Down

- Strong trend toward reducing hot water temperature
- “Generations” of district heating
  1. Steam
  2. Hot water peak supply temp >100°C (212°F)
  3. Hot water peak supply temp 80-100°C (176-212°F)
  4. Hot water peak supply temp <65-75°C (149-167°F)
- Legionella in DHW is a concern, particularly during summer



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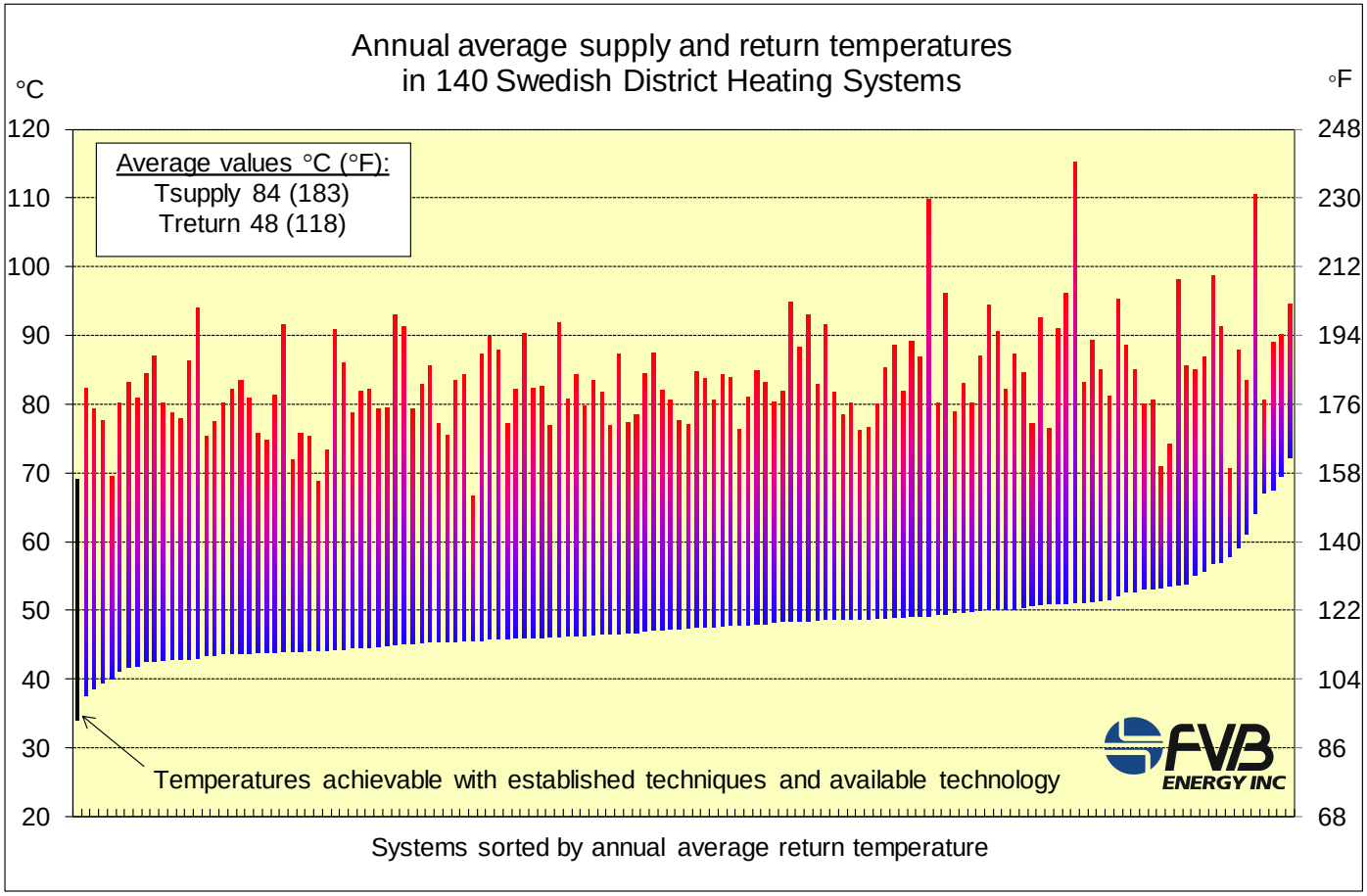
Hot Water Temperatures Coming Down

- Swedish DH system temps have been dropping
- Most systems are now in 3rd or 4th generation



What is steam to hot water conversion all about?

- *Pipe?*

What is steam to hot water conversion all about?

- *Plant?*

What is steam to hot water conversion all about?

- *Building systems?*

What is steam to hot water conversion all about?

- All three!

Design Trade-offs

- **Life-cycle analysis of cost trade-offs is critical!!**
- Assess the impact of alternative Hot Water District Heating (HWDH) supply and return temperatures on
  - Conversion of building systems
  - Dispatch of heat sources
  - Distribution piping materials
- Phased approach to hot water temperatures may facilitate capital cost reductions

District Hot Water Temperatures

Temperature scheme has impact on

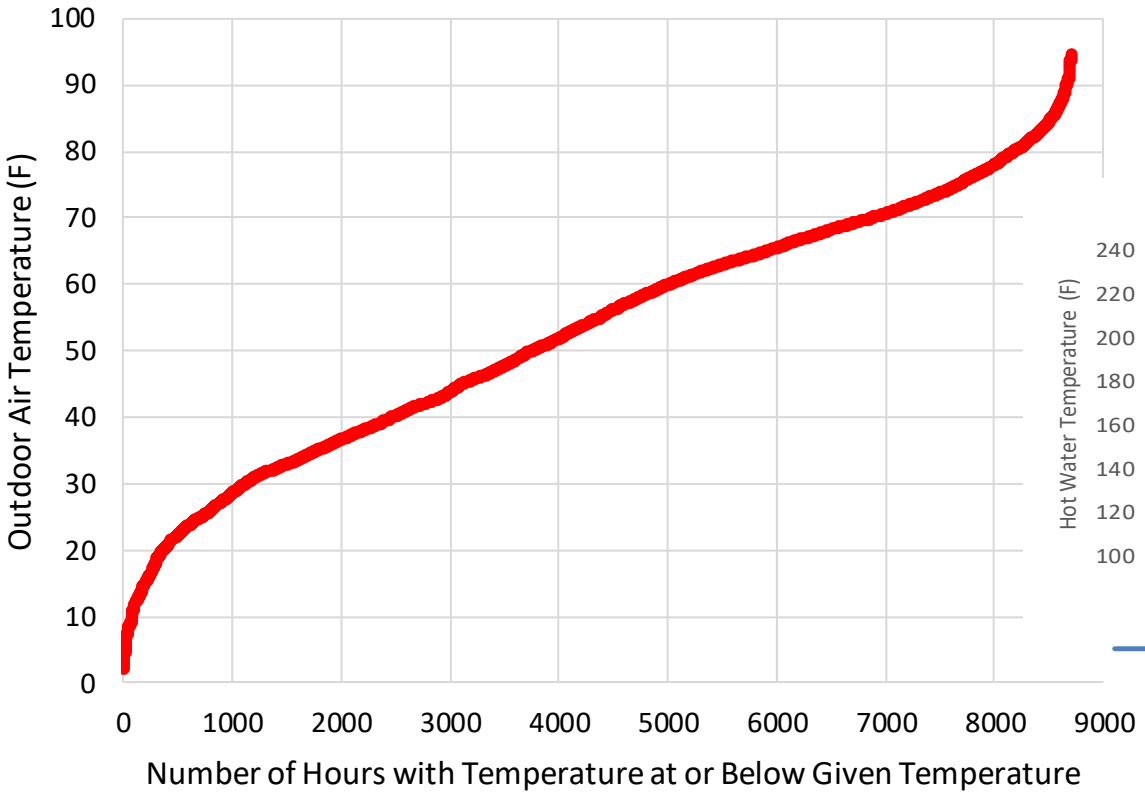
- Capital cost for
  - Building conversions
  - Distribution system
- Access to alternative energy sources, thereby affecting
  - Energy costs
  - Energy efficiency
  - Carbon emissions
- Distribution heat loss
- Pumping cost

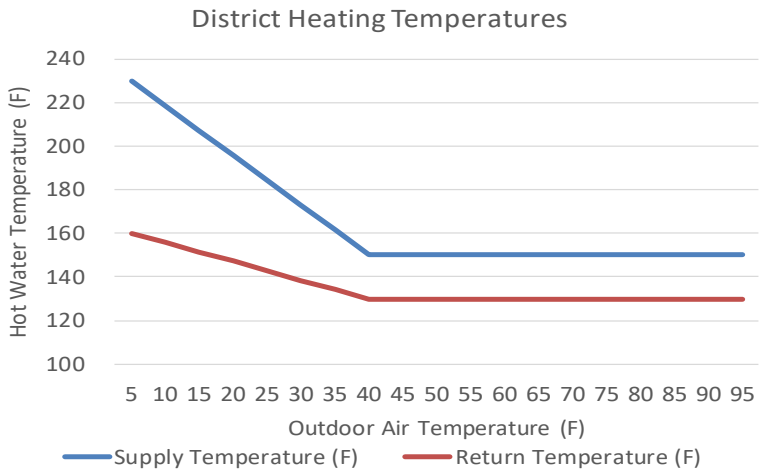
District Hot Water Temperatures

- **Both absolute temperatures and Delta T are important**
- Higher HWDH temperatures help reduce building conversion costs
- Lower HWDH temperatures
  - Enhance the ability to use low-temperature heat resources such as heat pumps
  - Lower distribution heat loss
  - Facilitate use of plastic piping (if not constrained due to pressure)
- Higher Delta T
  - Reduces distribution system capital costs
  - Facilitates lower operating costs for pumping

District Hot Water Temperatures

- Consider temperature duration curve in conjunction with potential HWDH reset schedule





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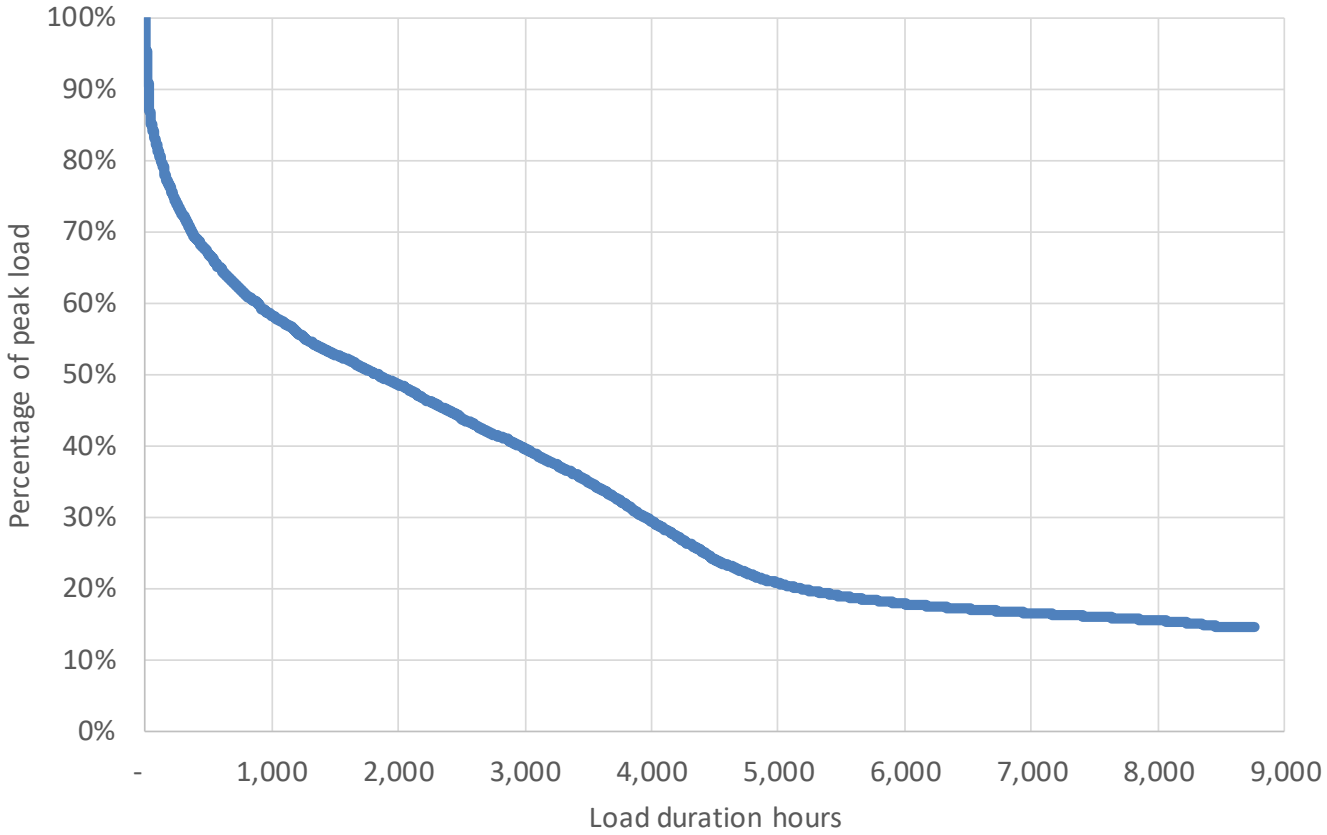
District Hot Water Temperatures

- Consider load duration curve. In example below:
  - 1,878 hours when load was more than 50% of peak
  - 136 hours when load was more than 80% of peak



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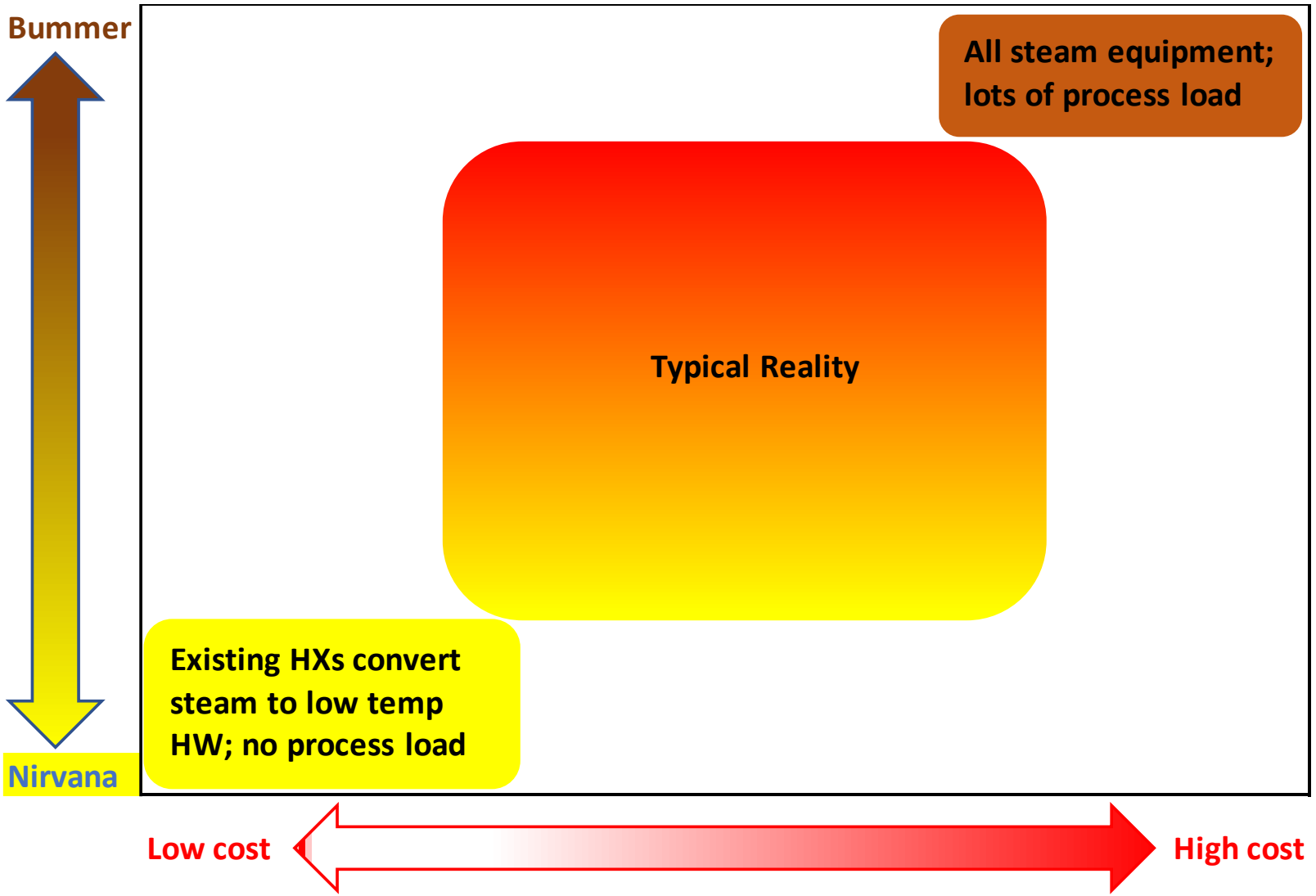
District Hot Water Temperatures

- Heat pumps operate at relatively low temperatures, and are most efficient at lower temperatures and with lower temperature lift
- HWDH supply temperature can be boosted for a relatively small number of annual hours
- Allows reduction in distribution pipe size/cost and facilitates a reduction in building conversion costs
- Trade-off is a marginal increase in energy costs, and elimination of the option of plastic pipe

Building Systems Conversion



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Building Systems

- What are the characteristics of the building systems?
  - Steam to hot water (HW) heat exchangers
  - Steam or HW perimeter heat
  - Steam or HW reheat coils
  - Steam pre-heat coils
  - Process loads
- Depending on HWDH temps, may be able to
  - Retrofit AHUs non-invasively
  - Reuse low pressure steam radiation

Heat Sources

- Local low-carbon energy resources vary significantly
- Climate affects the magnitude and balance of heating & cooling loads, and thus opportunities like chiller heat recovery & ground source heat pumps
- Thermal storage can help optimize use of low-carbon heat sources
- Local site availability and geologic conditions affect options for seasonal storage

Distribution System

- In assessing distribution piping material alternatives
  - Consider all mechanical and civil costs for procuring and installing piping, fittings and valves, and accommodating thermal expansion
  - Perform life cycle assessment accounting for long-term heat losses and maintenance costs
- With EN253 distribution system there is a wide range of pre-insulated fittings and valves
- System pressures are a potential constraining factor with plastic pipe such as PERT and PEX

Conversion Phasing

- Phasing by precinct of building conversion and installation of hot water distribution
- Phasing of district hot water temperatures may facilitate reduction of capex by taking advantage of:
  - Retrofit or replacement of buildings and/or building systems
  - Construction of new buildings designed for low temperatures
- Careful planning to minimize disruption to campus operations

Thanks for your attention!

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