How Low Can You Go? Costs and Technical Considerations of Lower-Temperature Hot Water Building Conversion

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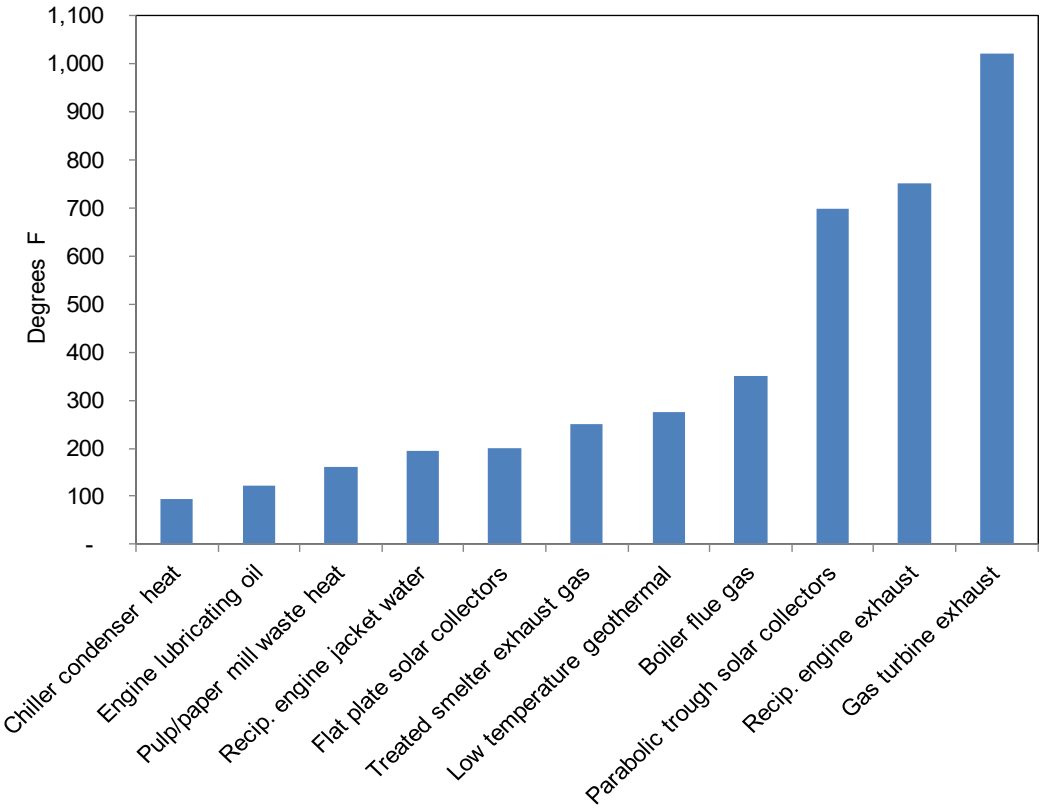
Agenda

- Why temperature matters
- District hot water temperatures coming down
- Design trade-offs
- Building conversion costs
- Conclusions

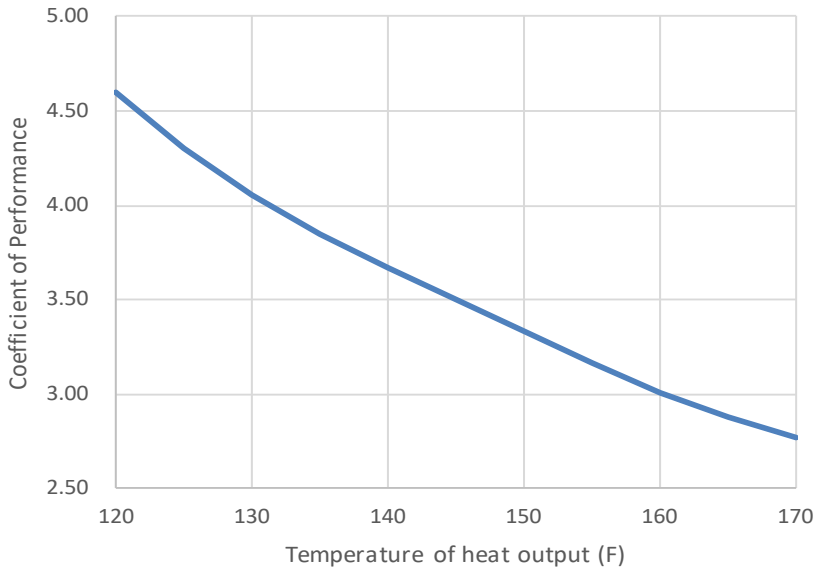
Why temperature matters

- Broader array of energy sources with lower temperature hot water
- Better heat pump COP at lower temperatures
- Reduced heat losses



Why temperature matters

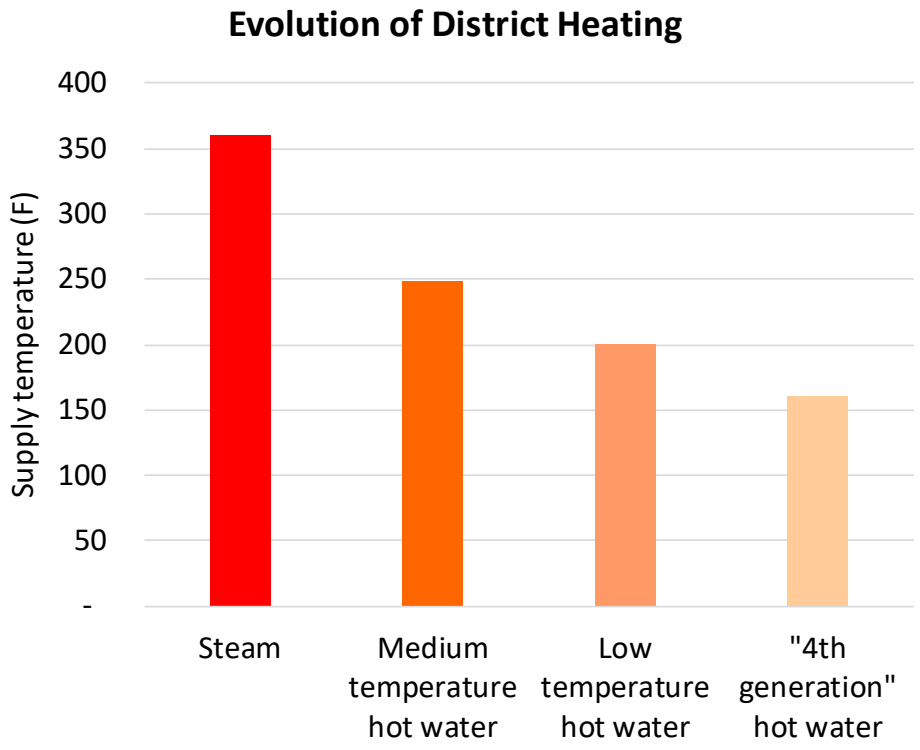
- COP is strongly affected by temperature “lift”.
- Generally, the maximum practical output temperature of a heat pump is about 170°F.
- Usually heat pump systems are designed for lower temperatures if possible.



- Graph shows representative values for the COP of a heat pump driven with a heat source of 50°F for a range of heat output temperatures.

Hot water temperatures coming down

- Strong trend toward reducing hot water temperature
- “Generations” of district heating



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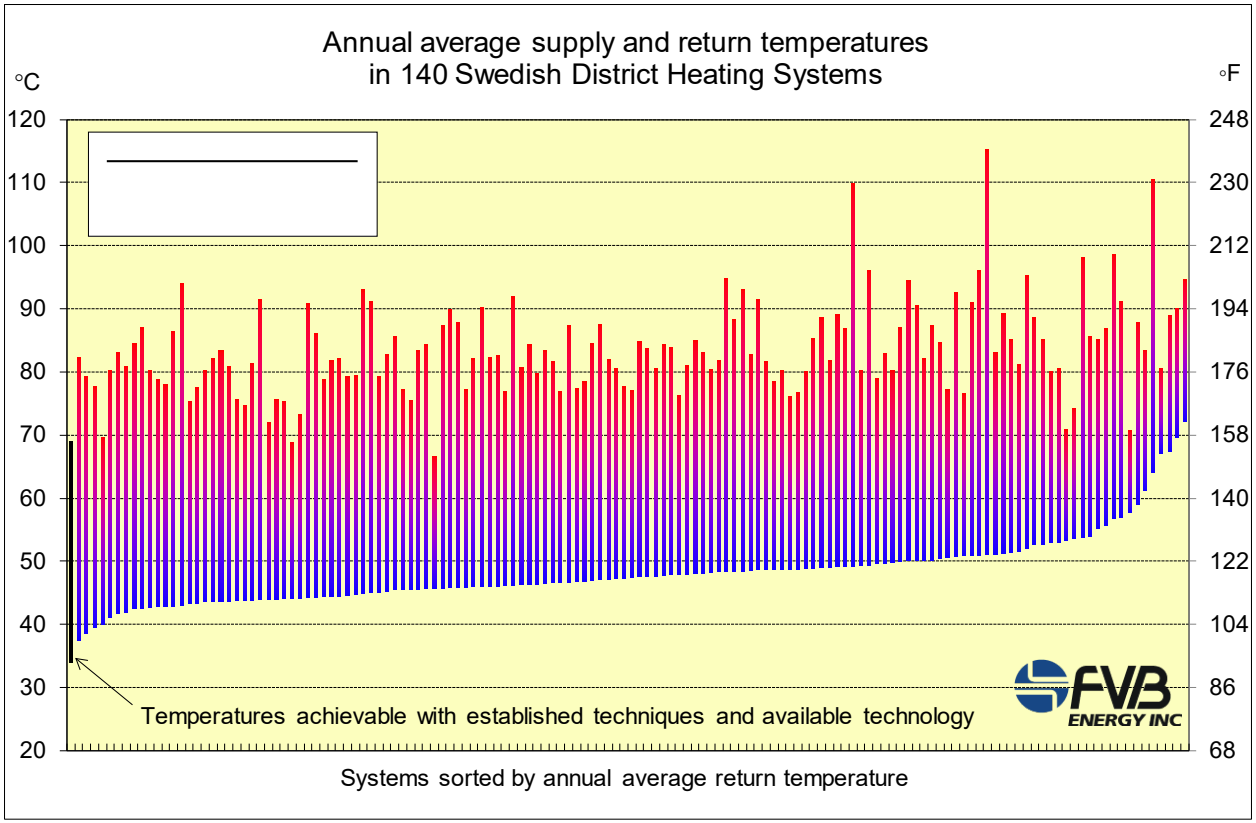
Hot water temperatures coming down

- Swedish DH system temps have been dropping
- Most systems are now in 3rd or 4th generation
- We are now moving to a next generation – 120°F or below



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It’s not just plants and pipes!

- Building conversion costs are often given insufficient scrutiny when a hot water temperature scheme is considered

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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

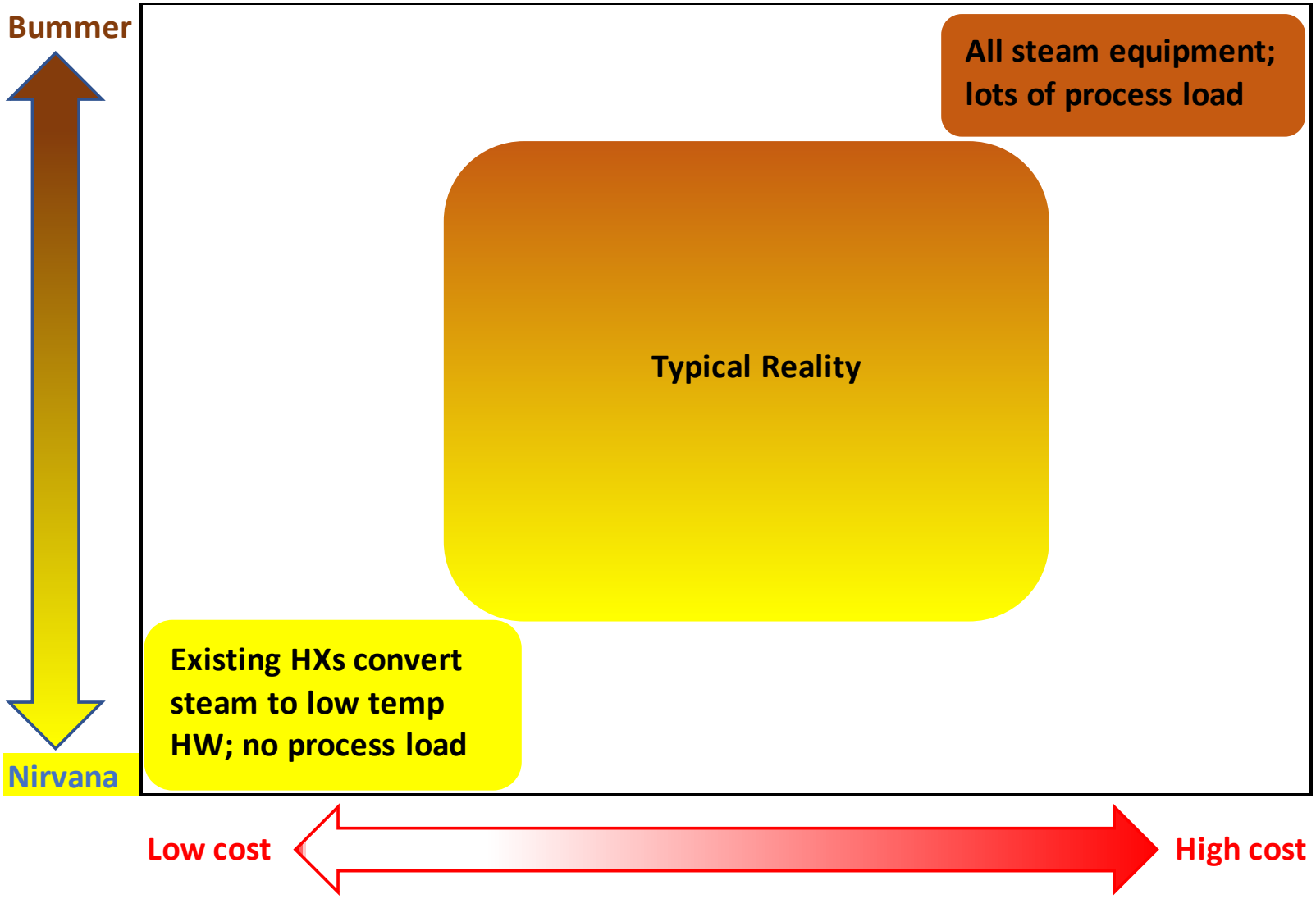
New buildings

- New buildings can and should be designed for temperatures of 120°F or lower.
- Special efforts are required to prevent Legionella problems if a supply temperature lower than 140°F is contemplated.

Retrofit of buildings

- Retrofit of existing buildings is more complex and more expensive.
- Typical North American building HVAC systems are designed for 180-200 °F.
- If lower temperatures are delivered to terminal equipment than the units were designed for, heat output capacity is reduced or “derated”.
- It is sometimes necessary to reduce heating requirements through envelope improvements (insulation of roofs and/or walls, window replacements, etc.).

Building systems conversion



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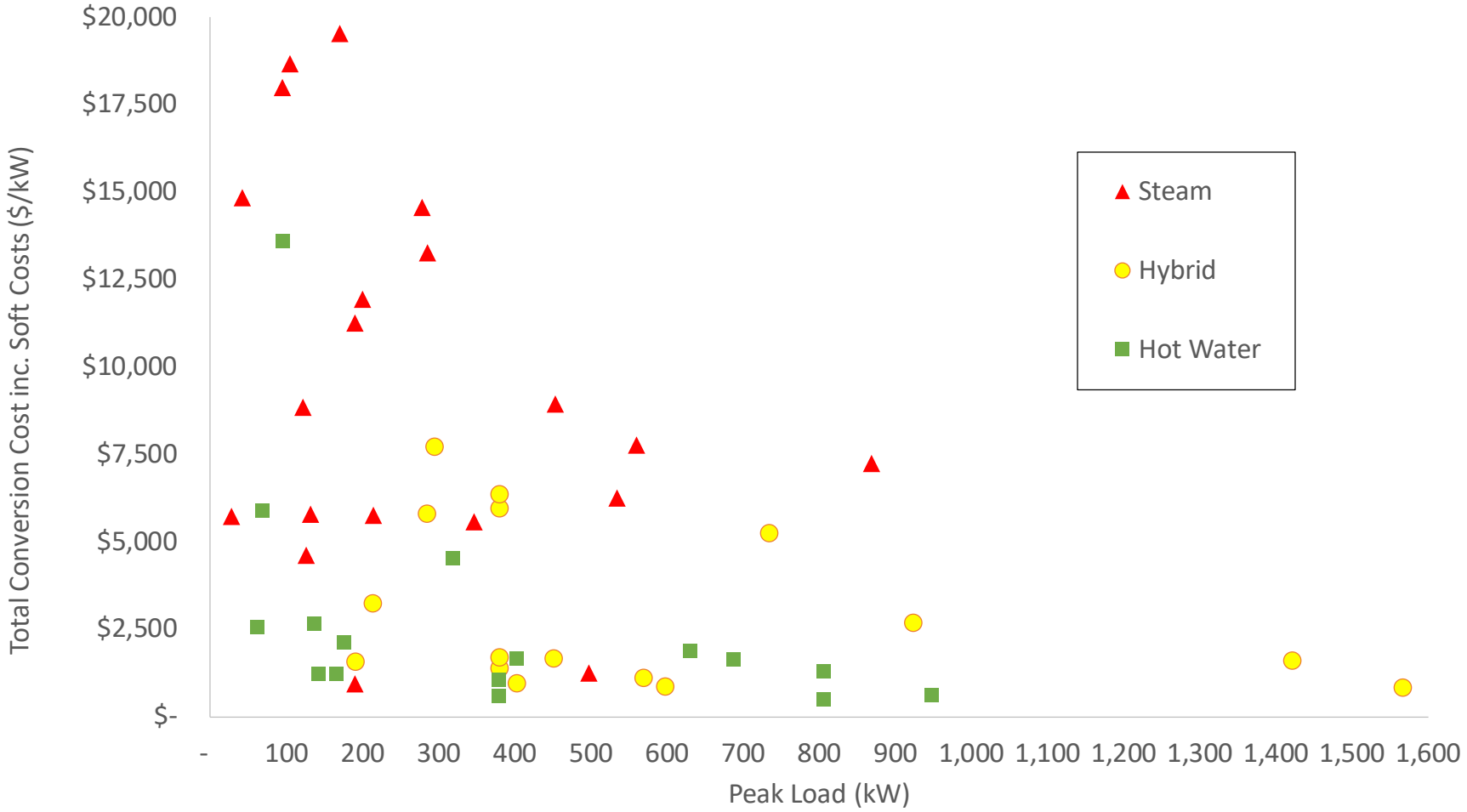
Building systems

- 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
- Useful to classify HVAC systems into
  - Steam
  - Hot water
  - Hybrid

Conversion costs

- Following data based on schematic designs for a range of campus and government buildings
- Significant scatter in data due to wide variation in building-specific circumstances
- Generalizations:
  - Smaller buildings are most costly per kW thermal load
  - Steam systems most costly
  - Hot water systems least costly
  - Hybrid systems in the middle

Example conversion costs by HVAC type vs load



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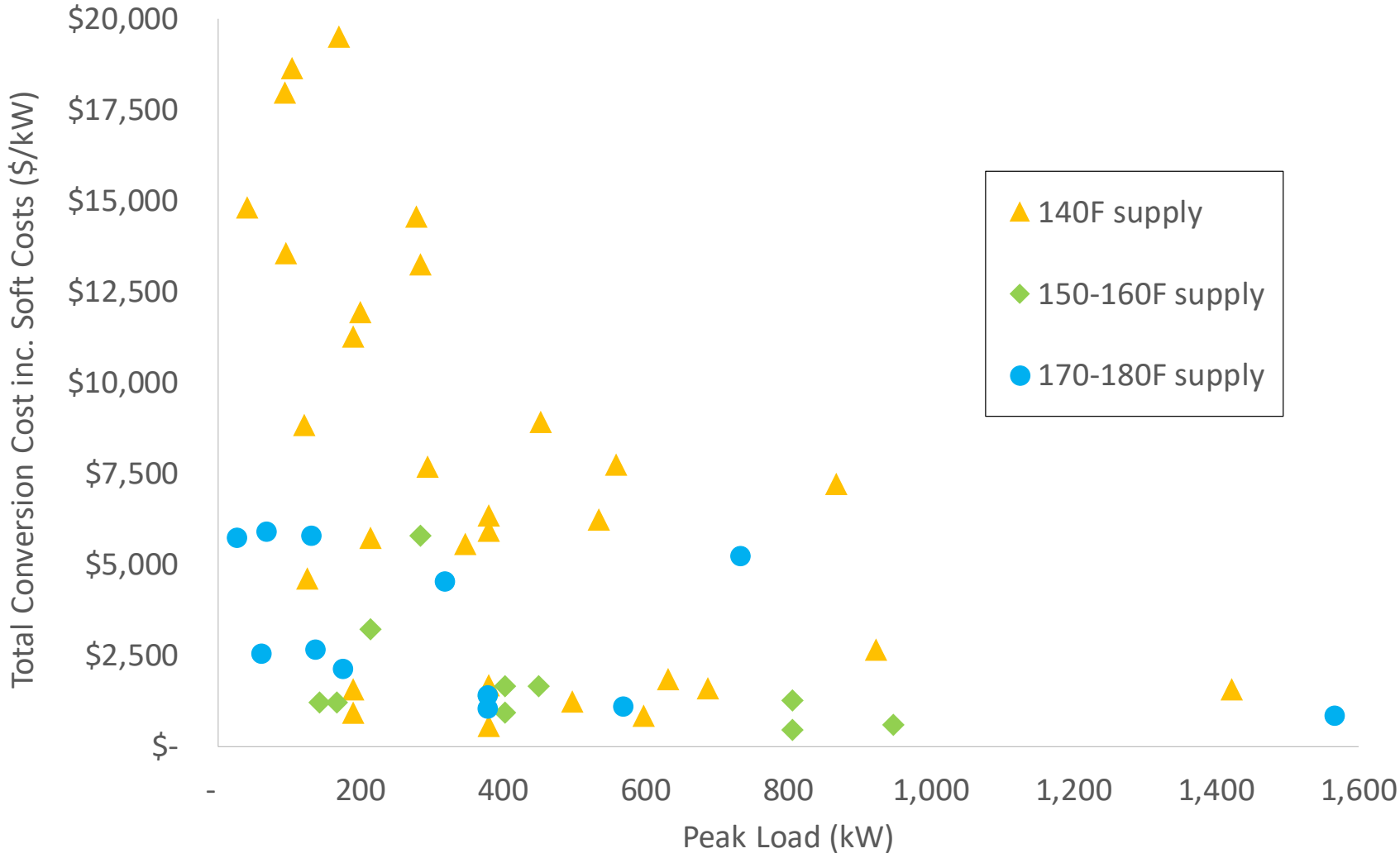
Conversion costs

- **Temperatures matter!**
- If client goal is cost-effectiveness and heat production is fuel-based, recommend minimizing terminal equipment replacement
- With existing steam systems, must often replace terminal equipment, so these systems can run on lower temperatures
- Existing hot water systems can be converted more cost-effectively if higher temperatures are acceptable
- Conversion costs are very building-specific

Example conversion costs by temperature vs load



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Conclusions

- How low can you go?
  - Technically, very low, considering space heating air temperature set points, with consideration of DHW issues
- Easier to optimize with new buildings
- Economics are driven by high heat transfer area surface area
- Retrofits present additional challenges and higher costs
- Optimization analysis must consider heat production, distribution system and building system design or retrofit

Conclusions

- Must also consider evolution or revolution
- Phasing district heating temperature reductions can take advantage of building renewal cycles
- Ultimately, most appropriate design depends on client goals
- In municipal settings, policy is critical

Thanks for your attention!

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