Low Carbon and Competitive? The Economics of Ultra-Low-Temperature District Heating and Cooling (ULTDHC) Networks

Michael Taylor (taylorm33@cardiff.ac.uk) and Dr Meysam Qadrdan, Cardiff University

Background

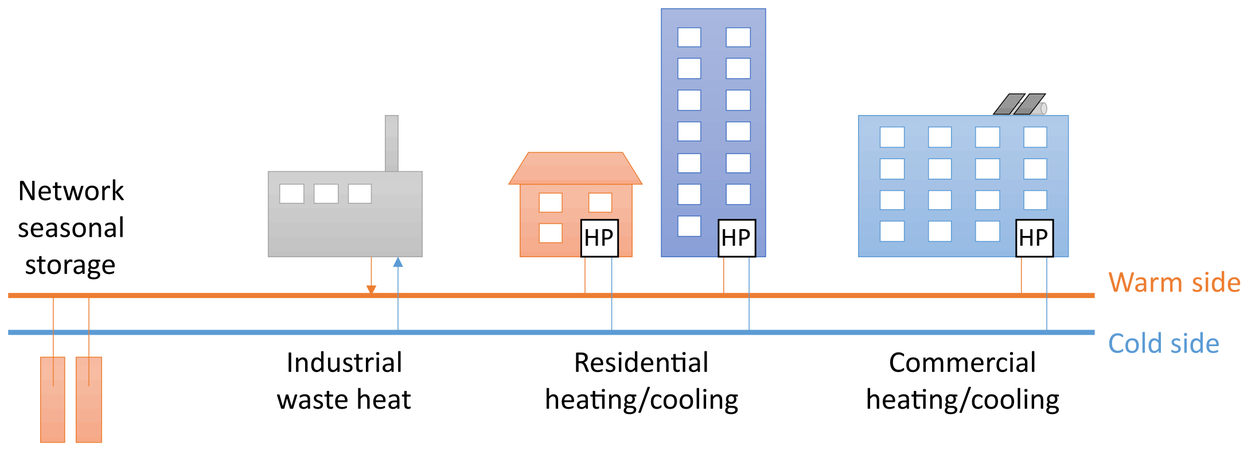
- ULTDHC networks allow sharing of heat between customers requiring heating or cooling.
- Building integrated heat pumps supply heating or cooling at the required temperature.

Benefits:

- Utilisation of low-grade waste or renewable heat.
- Access to cheap seasonal storage.
- High heat pump coefficient of performance.

Challenges:

- High costs to install network pipes.
- Historically low fuel prices favour gas boilers.

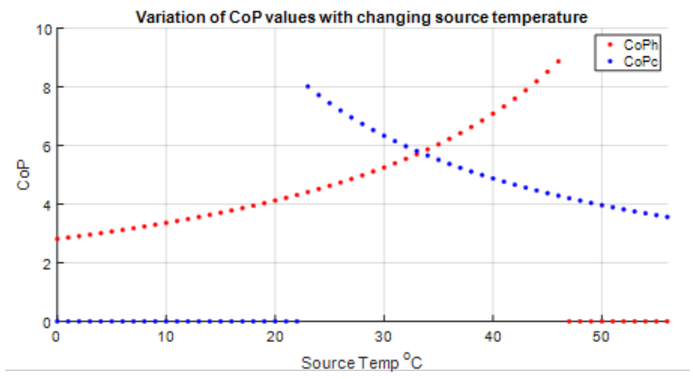


Research Question

Can ULTDHC networks compete with established standalone technologies for the provision of heating and cooling, both now and in the future?

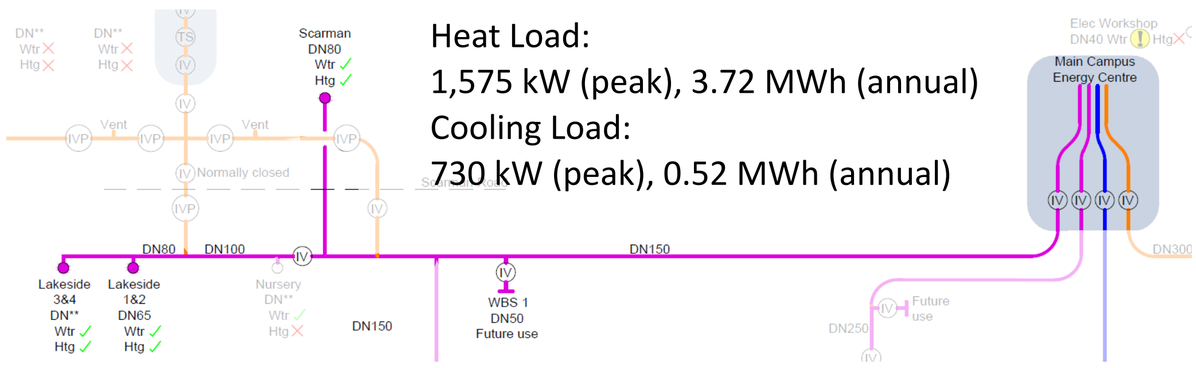
Methodology

- Annual ULTDHC network operation was simulated using quasi-steady-state simulation.
- Heat pump coefficient of performance was calculated for every half hourly period.
- The levelised cost of heating and cooling (LCOHC) was determined for each technology.
- Discount rate of 4% over a 50 year period.

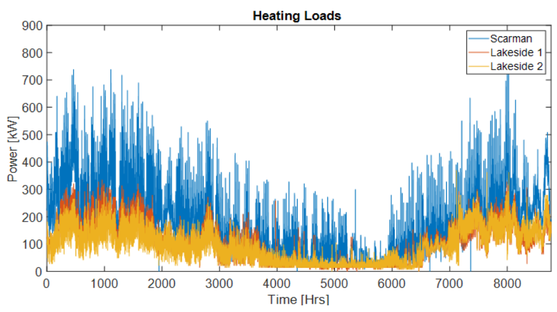


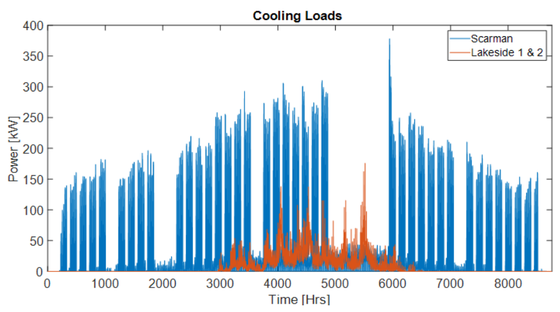
Case Study

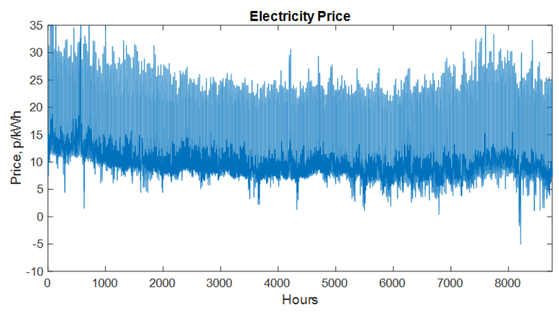
- Warwick campus heat network section connecting academic and residential buildings.
- Three configurations: ULTDHC network, gas boilers + chillers and air-source heat pumps (ASHPs) + chillers.
- Cooling loads scaled to lower heating to cooling ratio.
- Variable electricity price tariff (Agile Octopus in 2019).
- Gas prices 4 p/kWh (low) and 8 p/kWh (high).

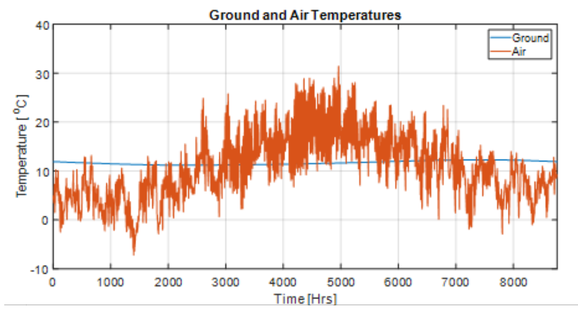


Heat Load:
1,575 kW (peak), 3.72 MWh (annual)
Cooling Load:
730 kW (peak), 0.52 MWh (annual)



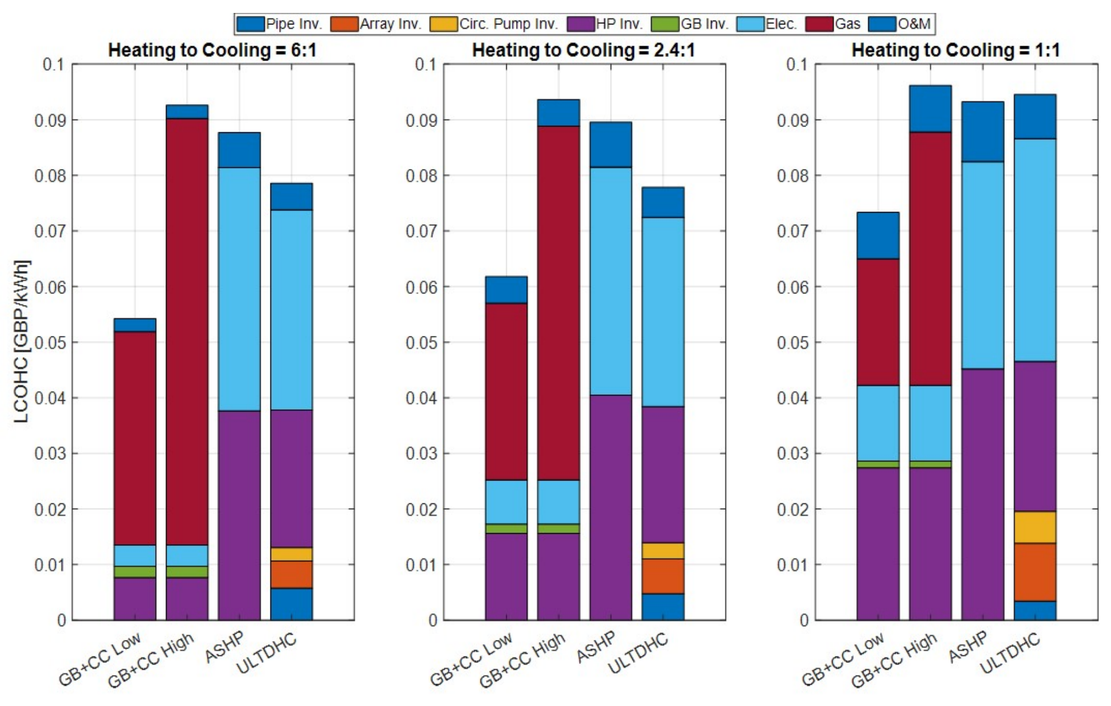






Results

- Increases in gas price favour electrified heating and cooling options with initial investment costs.
- Equipment costs for ULTDHC networks are comparable to standalone ASHPs + chillers due to improved CoP values.
- High levels of cooling in winter favours standalone chillers which benefit from low air temperatures.



Conclusions

- ULTDHC networks are a competitive option if gas prices remain at current levels.
- The LCOHC can be reduced in ULTDHC networks by increasing cooling loads for an optimal heating to cooling load ratio.

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