Proceedings World Geothermal Congress 2026, Calgary, Canada, June 8—11, 2026

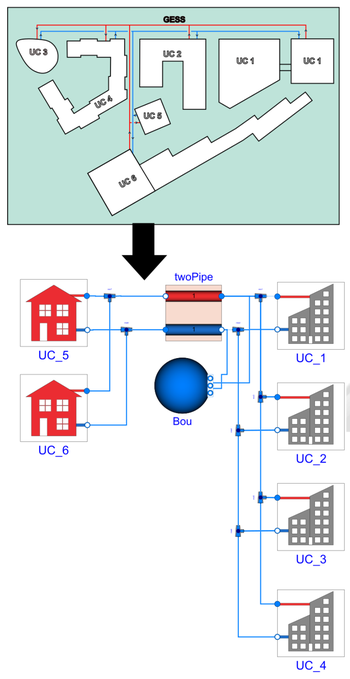
Modelling the impact of building composition on the system performance of shallow geothermal district network

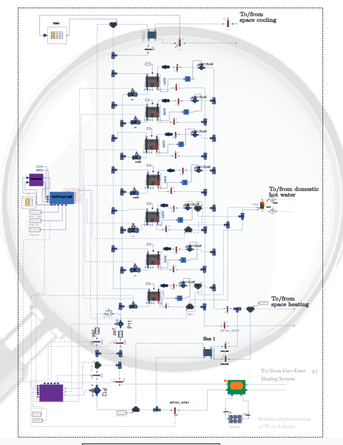
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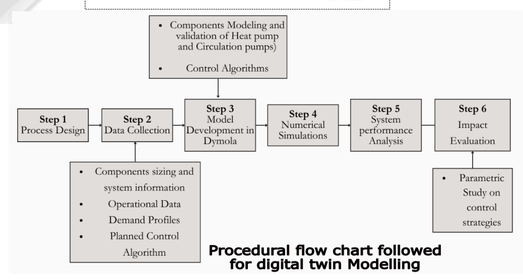
INTRODUCTION

Energy community and sectoral coupling of energy resources are regarded as feasible solutions to attain energy security and climate neutrality in the built environment. Studies indicate that a fifth-generation district heating and cooling network provides a platform for utilizing, and cross-sectoral integration of local thermal resources and electrical networks. In this research, through a detailed digital twin of a community based on Malmö, Sweden, we examined the effect of various building compositions on system performance and energy balance of a low-temperature district heating and cooling network. The main features of the studied community include six decentralized substations, each equipped with heat pumps and a shallow geothermal borefield, all connected by a unidirectional two-pipe network. The modelling and development of the digital twin were carried out in Modelica using the Dymola interface. Different combinations of office buildings, residential apartments, and shopping complexes were incorporated into the model to simulate the real-life scenario of the community.

METHODS







Procedural flow chart followed for digital twin Modelling

RESULT

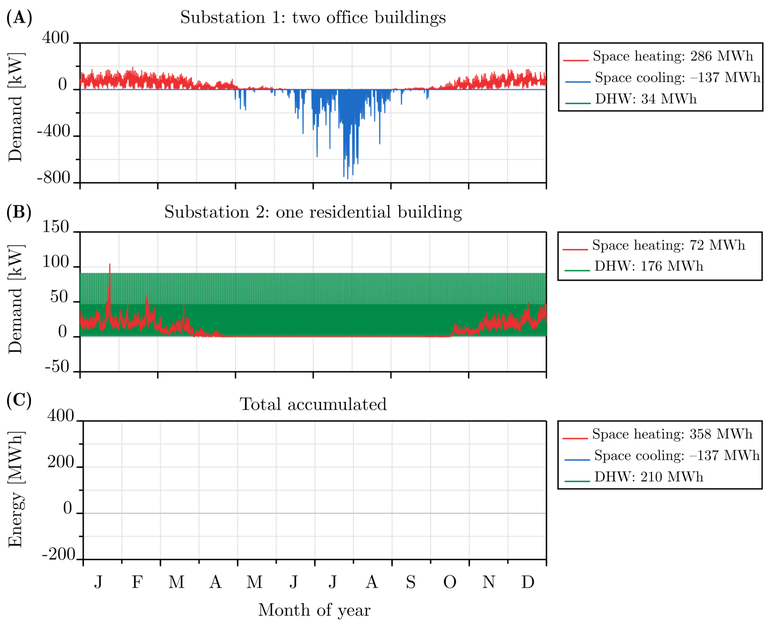


Figure 1 Thermal demand profile of substations at Embassy of sharing

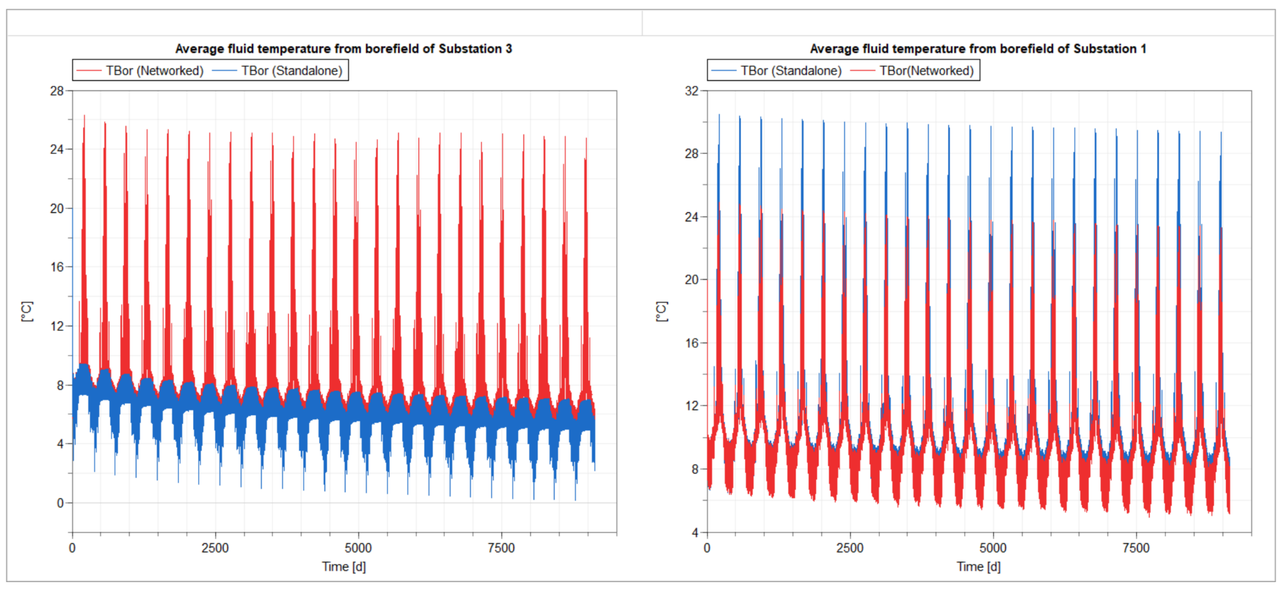


Figure 2 Average fluid temperature from two borefields of substations

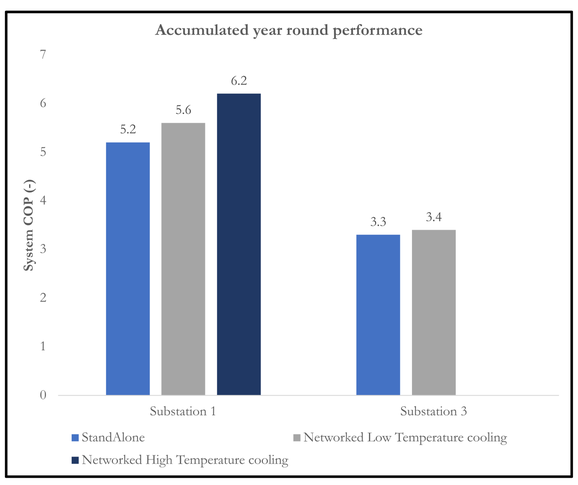


Figure 3 Year round coefficient of performance of two substations

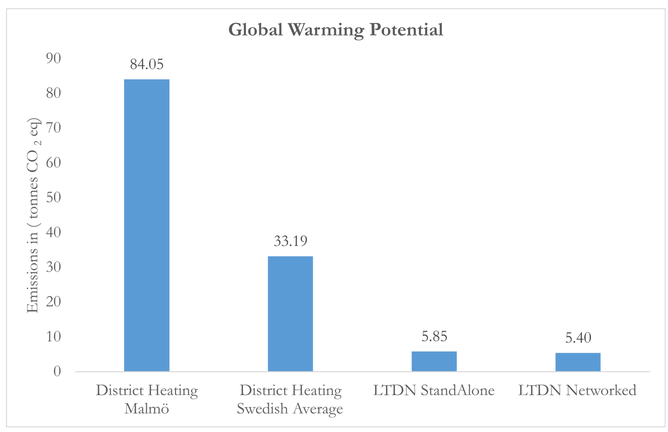


Figure 4 Operational emissions of studied low temperature network

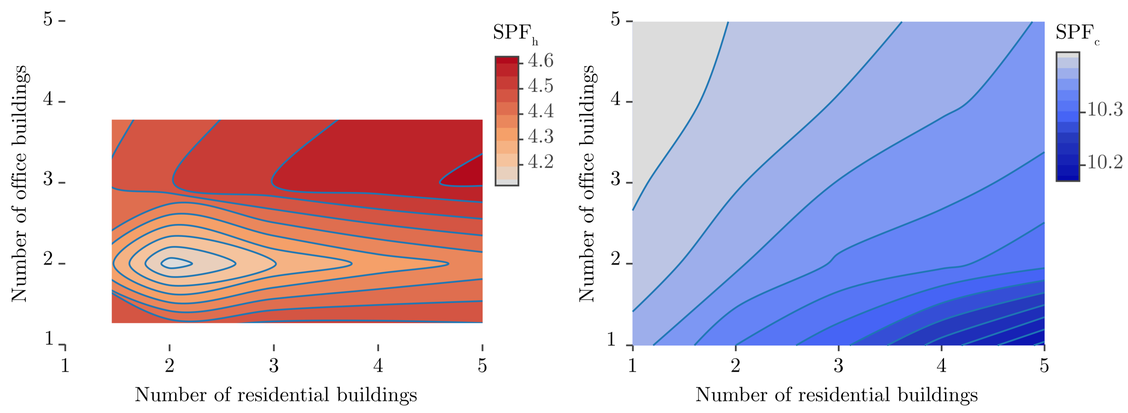


Figure 5 Effect of building composition on overall system performance

DISCUSSION

- Networked operation of mix of buildings with opposing thermal needs creates a scenario with higher fluid temperature for building with heating demand and reasonably lower fluid temperature for building with cooling demand. This enhances COP of heat pumps at both substations creating a win-win scenario.
- The studied buildings had similar thermal load profile which resulted into a small period where energy sharing between could be realised. Owing to this, conclusive results on the effects of different building mix was not drawn out of this study.
- Low temperature district heating and cooling networks coupled with shallow geothermal energy source has a great potential to decarbonize the urban heating and cooling through sectoral coupling and seasonal energy storage which is shown through this study.

CONCLUSION

- Networked operation of substations enhances overall system performance
- System coefficient of performance enhances by approximately 1 unit with appropriate control strategy
- Electrical energy consumed by heat pumps in such low temperature district network can be reduced by approximately 14 %
- Operation emissions from such geothermal networks is only 7% of the emissions compared to alternative district heating solutions available at the vicinity of studied community.
- Higher number of buildings with cooling demands and lower number of buildings with heating demands showed potential for enhanced energy sharing.

Acknowledgements

This research was financially supported by the Swedish Energy Agency (Energimyndigheten) through the project: “Energidelning inom Embassy of Sharing - system, function and comfort” with grant number [P2021-00180], and through the international project “The Change” with grant number [P2022-01051]. Additionally, this research was also funded by the European Regional Development Fund, through Interreg ÖKS, for the project titled “COOLGEOHEAT II”.