MODELING THE TECHNICAL AND ECONOMIC FEASIBILITY OF DISTRICT COOLING NETWORKS UNDER SCENARIOS OF INCREASING COOLING DEMAND

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Overview

The rising tendency of the European Cooling demand urges the need to plan and implement decarbonization pathways for the cooling sector. District cooling, which until now has not been a common energy carrier in the cooling industry, unlike its counterpart in heating, could show improved feasibility and possibility for sustainable supply considering the rise in the cooling demand. The paper aims to develop a methodology to identify potential areas for district cooling networks and analyze the sensitivity of technical and economic parameters on the network's overall feasibility and coverage.

Methods

We formulate the district cooling feasibility model that aims to maximize the coverage of the district cooling area with its cost constrained against decentral solutions at the local and national levels. The results are presented at their present version on a hectare cell (100 X 100 m) resolution.
The model comprises three components.

- Anchor Definition
- Transport grid model
- Distribution gird model

Grid cells with certain demand density exceedance are defined as the anchor customers (non-residential consumers with consistent demand) around which the network centers [1]
The transportation grid model deals with the supply side, considering different free cooling sources. Based on the temperature requirements of both supply and demand, potential transportation pipe size and pressure requirements are calculated for each pair. All anchors within technically feasible distance from a source are defined as the feasible anchor.
The distribution grid model further calculates the feasibility of expansion of the grid around these anchors. This is based on the grid expansion ceiling (calculated in comparison to individual supply [2]), demand, and cooling floor area (in reference to [3] for heating). The final output is a map showing a cluster of cells, each representing a potentially feasible district cooling network.

Results

The result of the geospatial model is a map illustrating a cluster of hectare cells with feasibility for district cooling. The sensitivity of the coverage area is assessed against demand density in different scenarios, consumer demand temperatures, and available supply source temperatures.
At its current version the model was tested for the case of Vienna. The model identified potential locations for district cooling in the city. We also analyzed the sensitivity of these identified areas against electricity prices and the costs of competitive individual cooling supply solutions. The model showed the system efficiency to be a highly influencing factor in determining potential locations. Further detailed analysis of results is still under evaluation.
We envision to further improving the model by looking into the integration of the connection rates less than 100% within a cell, as well as consideration of existing grid and the feasibility of its expansion. In addition, the possibility of intermingled use with district heating will be assessed with the use of the heat from the return pipe of the heating network as waste heat. As a follow-up of this conference contribution, we intend to further improve the spatial granularity of the model to either a building block or a building level to provide more detail for actual network pipe design. The model will be designed to be applicable without geographical restrictions.

Conclusions

Considering the cooling demand will be a crucial component of the energy demand over the long and short run, the model aims to provide a means of assessment for identifying sustainable supply solutions. We envision the model to promote district cooling and support additional renewable energy generation integration into the energy mix.

References

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