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FEASIBILITY ANALYSIS OF DISTRICT COOLING TECHNOLOGIES IN COLD CLIMATE: A COMPARITIVE STUDY

Sreenath SUKUMARAN^{1*}, Siim Erik PUGAL², Sylvester OFILI³, Tanel KIRS⁴
Anna VOLKOVA^{5*}

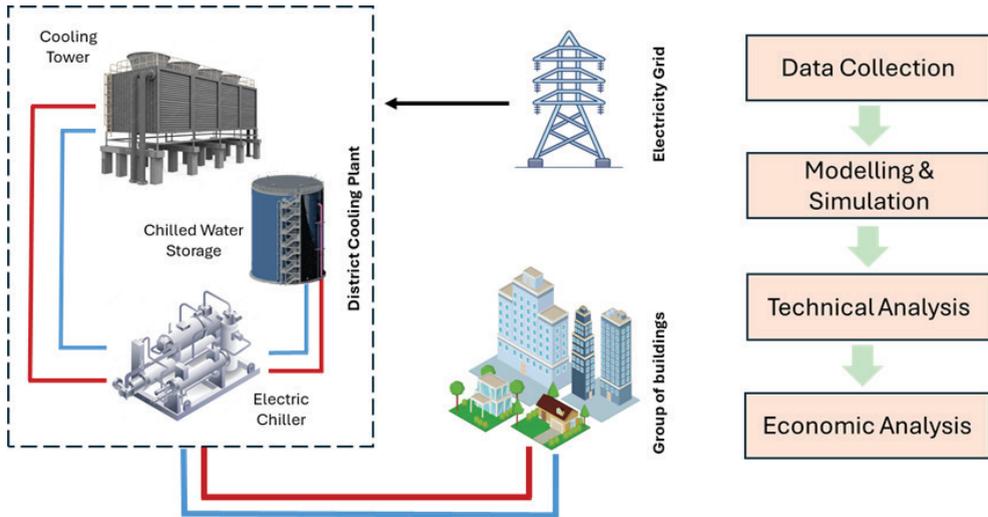
¹⁻⁵ Department of Energy Technology, Tallinn University of Technology, Akadeemia tee 3, 19086, Estonia

⁴ District Cooling Department, AS Utilitas Tallinn, Estonia

* **Corresponding author.** Email address: sreenath.sukumaran@taltech.ee

Abstract – Climate change-induced heat waves are becoming increasingly frequent in Europe, thereby affecting people's health, comfort and productivity. Hot summers and population growth have escalated the space cooling demand of urban energy landscapes, even in cold climates. It is in direct correlation with the increased demand for residential air-conditioning units and individual heat pumps. A relatively new technology, District Cooling (DC) is seen as an alternative to individual cooling solutions. Typical DC system consists of a centralized cooling plant that serves the cooling demand of multiple buildings by circulating chilled water through underground pipes. In some European cities, DC systems are competing with individual cooling solutions due to their ability to scale down carbon emissions and promote energy efficiency. However, these DC systems suffer from techno-economic challenges such as high investment costs and electricity cost fluctuation. In this scenario, the integration of energy storage technology with DC systems presents a promising solution through peak shifting, load sharing, energy savings etc. Chilled water energy storage is one of the widely considered technologies in the DC industry. Though some studies are reported in literature, the potential of thermal energy storage for DC applications is not fully explored. The feasibility of space cooling systems is influenced by location dependent factors such as climatic conditions, load profile and economic parameters. The aim of the study is to investigate the feasibility of district cooling technologies in cold climates from customer's perspective. Based on preliminary results, it is observed that the district cooling plant coupled with chilled water storage has the lowest levelized cost of cooling (53.35 EUR/MWh) as compared to typical DC system and on-site electric chillers. This finding is highly influenced by the inputs and assumptions considered by the user. The current study also involves Modelica-based modelling of main components, simulation of developed models to assess the system performance and estimation of economic competitiveness of system configurations. It is expected that these findings shed light on the design and planning of the proposed system, thereby strengthening its widespread application across northern European cities.

Keywords – Cold storage; levelized cost; district energy; energy planning; energy storage; Modelica; system modelling; performance analysis; space cooling; sustainable energy



Pictorial representation of the proposed system and research methodology

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