Scalable Control for District Heating & Cooling Networks

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District Heating and Cooling Networks (DHCNs) are central to the transition toward net-zero CO2 energy systems, yet their increasing complexity, driven by the integration of geothermal sources, solar thermal storage, prosumers, and large-scale thermal buffers, makes their efficient operation a challenging problem. Traditional modeling and control approaches are often suboptimal and do not scale to these heterogeneous, networked, and multi-time-scale systems. Unlocking the potential of future DHCNs requires advanced, model-based strategies and suitable models that balance physical accuracy with computational tractability. Their modeling-for-control employs tools and techniques of physics-based thermal-hydraulic descriptions, algebraic graph theory, and modern system identification. The real-time operation of DHCNs naturally points to Model Predictive Control (MPC) as the most promising solution. Nonetheless, applying MPC to large nonlinear thermal networks remains intractable due to bidirectional flows, high-dimensional dynamics, and scalability constraints. This talk will outline the opportunities offered by next-generation DHCNs, discuss the modeling and control grand challenges, and highlight our recent progress toward scalable MPC schemes aimed at making these networks smart, efficient, and reliable.