DC Number	DC9
Title of the PhD Project	Stable and scalable control algorithms for managing energy flexibility in thermal networks
Keywords	Thermal networks, (model) predictive control, distributed control
Recruitment organisation	Flemish Institute for Technological Research (VITO), EnergyVille
Supervisors names and contacts	Tijs Van Oevelen (tijs.vanoevelen@vito.be)
Scientific context and objectives	This PhD project focuses on the operational optimization of district heating and cooling (DHC) system performance through energy flexibility management. DHC systems have considerable opportunities for integration of renewable heat sources and recycling of excess heat from industry. Furthermore, these systems have a lot of affordable energy flexibility potential due to the presence of thermal energy storage in buffer tanks, piping and connected buildings. This energy flexibility can also be offered to connected electricity networks to also support their operation. Wide-scale real-time optimization of DHC system operation faces several technical challenges: 1. The thermal-hydraulic nature of DHC systems leads inherently to non-linear mathematical models and non-convex optimization problems. This makes the stability and reliability of numerical solvers far from trivial. 2. The numerical complexity of control algorithms scales with the number of assets that needs to be controlled, as well as with the prediction horizon. Control of large-scale DHC systems incorporating long-term thermal storage technologies is therefore not feasible with current methods. 3. Replication of smart control approaches from pilots to commercial applications needs streamlined approaches for DHC system characterization. This is complicated by the diversity of thermal network configurations and hydronic installations, and the frequent lack of necessary information and/or sensor data. VITO is taking a leading role in the development of smart energy systems control methods. The DC will join the Thermal Energy Systems team at VITO and work in close collaboration with several R&D colleagues active in DHC systems and management of energy flexibility.
Required skills	• A M.Sc. degree in engineering, preferably with a focus on control engineering, energy engineering, optimization methods - alternatively you have a comparable qualification. • Sound knowledge of control engineering and/or thermal energy technology and/or optimization methods. • Experience in Python or at least one relevant programming language (preferably C++, Matlab or Julia), and relevant packages for numerical solvers/data analysis/optimization. • Interest in applied research work in the fields of control and analysis of sustainable and intelligent energy systems. • Ability to work scientifically, independence, take initiative, flexibility, teamwork and communication skills. • Creative, problem-solving, results-driven and can meet quality output with stringent deadlines. • Eager to disseminate your research results by scientific publication or communications at conferences. • Desire for professional and personal development. • Very good knowledge of English, both oral and written. Dutch proficiency is a plus.
References	[1] T. Van Oevelen, T. Neven, A. Brès, R.-R. Schmidt, D. Vanhoudt, « Testing and evaluation of a smart controller for reducing peak loads and return temperatures in district heating networks, » Smart Energy, vol. 10, pp. 100105, 2023. [2] T. Van Oevelen, D. Vanhoudt, C. Johansson, E. Smulders, « Testing and performance evaluation of the STORM controller in two demonstration sites, » Energy, vol. 197, pp. 117177, 2020.

This project has received funding from the European Union's
Horizon Europe Framework Programme (HORIZON) under the GA n. 101120278 - DENSE