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Data Centers Cooling: On-Site Integration for Smart Energy System

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Abstract

It is estimated that data centres consume between 2% to 4% of the total electricity consumption worldwide. Around half of this consumption is used for the cooling of data centres. As data centres continue to expand rapidly, increasing cooling efficiency presents a significant hurdle towards their sustainable operation. Recently, many data centres started using Aquifer Thermal Energy Storage (ATES) technology to cool their data centres. The ATES consists of two deep boreholes, one used as hot storage and one used for cold storage. During summertime, cold is extracted from the ground to cool data centres, while during winter, storage is recharged using cold ambient air by means of free coolers. However, due to climate change, summers are becoming hotter than expected, and winters milder than anticipated. As a consequence, ATES is continuously imbalanced, and its economics is becoming infeasible. In order to counteract this occurrence, an on-site integration with heating demand was proposed in order to increase the total efficiency of the energy system. A mixed-integer optimization model was developed in order to calculate the optimal investments and operational behaviour. The model was applied for the case of medium-sized data centres located at Naviair, Danish airspace control. The results showed that two heat pumps need to be installed. The project's payback period was calculated to be 6.51 years, and the internal rate of return was 13%. Initial gas consumption used for heating was reduced by 76%. CO2 emissions dropped from 658 to 331 tons (49.6%). The results showed that there are low-hanging fruits regarding data centres operation that are located within urban areas. However, silo-thinking is currently a significant obstacle to the broader adoption of the proposed solution.