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On The Role of Thermal Storage for Demand Response in Building Clusters

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Extended Abstract

Climate action plans worldwide mostly rely on increasing the share of renewables and electrification of heating systems in urban areas. The intermittent nature of renewable sources imposes various challenges on users and grid operators due to the variability of energy supply, including grid congestion and overload or renewable curtailment. In addition, the electrification of heating systems will lead to extra pressure on the grid, especially during peak hours, with significant load variation during the day. Hence, a transition in the perception of electricity availability is necessary for the robust integration of renewable sources into the electricity grid and electrification of the building heating sector. The "production-on-demand" approach, where electricity is unlimited, should be replaced by the idea of "consumption-on-demand," where managing the users' demand helps minimize the stress on the grid in periods of low renewable electricity generation or high demands. Flexible operation of energy systems is a solution to the mentioned challenges as it enables demand-side management and, thereby, demand response based on the requirements of the surrounding grids, narrowing the gap between the users' demand and supply from renewable sources or the grid.

Thermal energy storage and central heating networks have proven to be promising solutions to support demand response (DR) efforts in the heating sector. Implementing thermal storage of excess renewable energy as heat or cold allows to release it when needed to offset peak demand. Centralized heating or cooling systems with district heating or cooling networks enable the central management of heat and cold supply, distribution, and consumption in a given area, making it easier to balance energy demand and supply during peak periods. This study assesses how thermal storage can be beneficial in demand response in a cluster of buildings on the downtown campus of Concordia University, Montreal. The university plans to be carbon-neutral by 2040, and the electrification of the heating system is part of its climate action plan. A new heating system with heat pumps and thermal storage to serve a cluster of buildings is designed, and optimal control is proposed to maximize the system's energy flexibility.