Heating Quebec's schools can be easier and cheaper thanks to a new study

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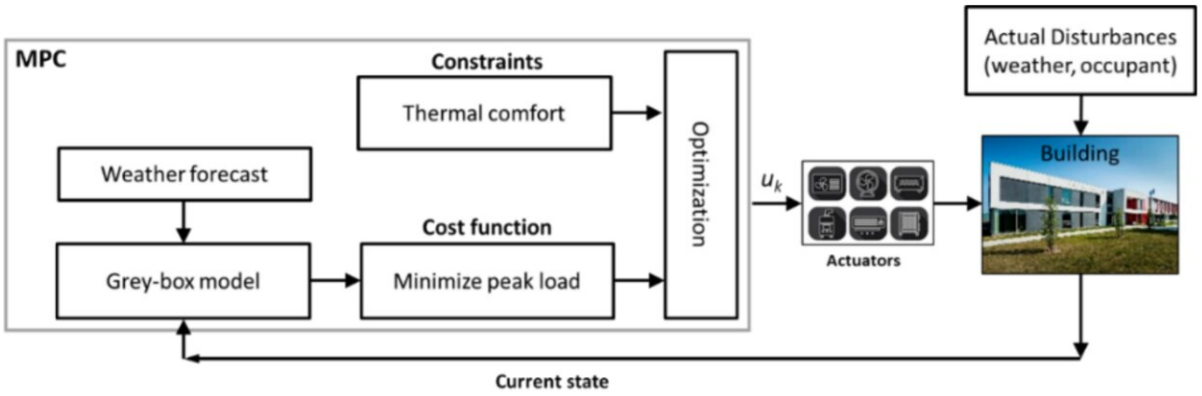

Diagram of the model predictive control. Credit: *Journal of Physics: Conference Series* (2023). DOI: 10.1088/1742-6596/2654/1/012099

A new system to heat Quebec schools during cold winter months could help keep students more comfortable, improve the amount of solar-heated clean ventilation, and save school boards a bundle.

The energy-flexible approach is designed by researchers at Concordia's Centre for Zero Energy Buildings Studies and the University of Sherbrooke. The system uses model predictive control strategies to heat school buildings and increase the amount of solar-heated clean air during off-peak hours. The method is designed to both ease the strain on Hydro-Quebec's electricity grid during peak hours—6 to 9 a.m. and 4 to 8

p.m.—and avoid paying the higher rates the utility charges during those times.

"There are more than five million students in 15,000 schools across Canada. We have to consider thermal comfort and indoor air quality while also paying attention to energy consumption," says Navid Morovat, a Ph.D. candidate in the Department of Building, Civil and Environmental Engineering (BCEE) at the Gina Cody School of Engineering and Computer Science.

The researchers used a Montreal-area school as a case study. Using measured sensor data installed in the school, weather station data, class occupancy, class size, and other measurements related to the building's age and design, along with dynamic Hydro energy rates, they were able to predict electricity consumption within a window of several hours to a few days. This provided them with ways to examine and optimize energy use patterns.

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"This way, instead of relying on a traditional reactive controller like a thermostat, we can program the school's HVAC system to turn on several hours before the school opens. This approach allows us to let the building gradually warm to the temperature required, as well as to exchange the air supply inside," says Morovat.

"Based on daily weather predictions and the number of people inside the building, we can increase the setpoint temperature before it is needed. This means that children arrive at a school that is already at the thermal comfort level they need and with air that is fresh. As an extra bonus, the school's electricity bill is reduced."

BCEE Professor Andreas Athienitis and José A. Candanedo of the University of Sherbrooke co-authored the paper. It was first presented at the 13th Nordic Symposium on Building Physics in Aalborg, Denmark last year.

Adaptable model

The authors say their system greatly improves on conventional control methods by reducing the building's peak hour power consumption by up to 100 percent, all while maintaining acceptable comfort conditions.

Morovat says the system can easily be transferred between schools and even among different kinds of buildings, given accurate data. It can also be used to power air conditioning in warmer conditions.

The project is a collaboration with Hydro-Quebec under a Natural Sciences Engineering Research Council of Canada and Hydro-Quebec Industrial chair held by Athienitis. The research strengthens Concordia's position as a leader in the electrification of society and as an institution that prepares its students for tomorrow's workforce.

Athienitis also chairs the scientific committee and Theme 1 of Concordia's Volt-Age research program. The program, which is supported by the Canada First Research Excellence Fund, focuses on electrifying society to achieve resilient and decarbonized communities.

"This collaboration helps us know what the industry will be asking of us in the future," Morovat says. "We are doing exactly what the industry is looking for. And as a student, it is helpful to get feedback from the industry, confirming that our research is practical and moving in the right direction."

Athienitis adds that highly novel research in this area helps the university

launch the Volt-Age world-leading research program.

Morovat also would like to acknowledge the financial support received from Fonds de recherche du Québec—Nature and Technologies (FRQNT) in the form of a doctoral research scholarship.

The paper is published in the *Journal of Physics: Conference Series*.

More information: N Morovat et al, Model predictive control for demand response in all-electric school buildings, *Journal of Physics: Conference Series* (2023). DOI: 10.1088/1742-6596/2654/1/012099