Reducing a building's carbon output can also lower costs

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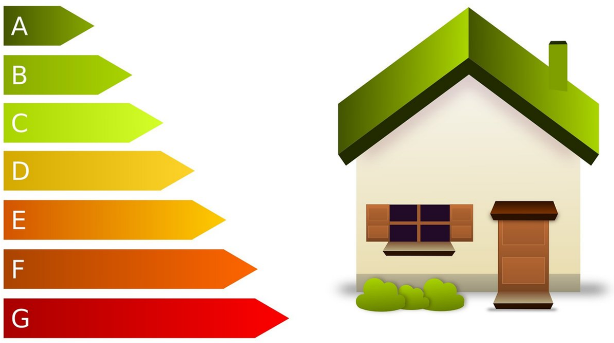

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Researchers from Concordia University's Department of Building, Civil and Environmental Engineering have found a way to significantly reduce carbon emissions produced by residential and non-residential buildings, while also cutting costs.

Heating, cooling, and powering hospitals, hotels, city halls, apartment complexes and other large buildings that share built energy systems makes for a complex and potentially costly climate-change problem.

Add to this the challenges posed by Canada's climate and size—especially in the Far North where remote communities are located considerable distances from the power grid.

In 2014, Canadian homes and buildings contributed nearly a fifth of Canada's total greenhouse gas emissions.

"It often feels like we have to choose between our financial constraints and using more energy-efficient measures," says Mohammad Sameti, a PhD candidate in Building Engineering at Concordia.

"But what our method shows is that we can efficiently integrate a given system to positively affect both."

To reduce overall energy consumption, Sameti and Fariborz Haghighat, professor in the Department of Building, Civil, and Environmental Engineering and Tier 1 Concordia Research Chair in Energy and Environment, developed a way to optimize the integration of multiple systems across multiple buildings.

They looked at a grid of eight residential buildings with a variety of characteristics, operating costs and technical constraints to arrive at an energy-efficient and cost-effective usage pattern. The researchers used hydro-powered heat pumps and lake cooling—which uses large bodies of naturally cold water as heat sinks—as renewable energy sources in their simulations.

After running all possible variations, the team found that by prioritizing the reduction of carbon emissions, they could cut costs by 75 per cent while also reducing emissions by 59 per cent.

However, when they prioritized overall costs instead, it resulted in savings of just 38 per cent, but carbon emissions were much higher. "To optimize cost, we had to prioritize systems that burn fossil fuels. These technologies are cheaper to install and operate than the renewable energy models, but offer no reduction in emissions," explains Sameti.

"Renewable energy sources used in the optimal simulation create a net-zero energy usage by the network, removing the need to rely on traditional heating and cooling technologies with higher emissions, and draw less power from the grid."

For Canada's northern communities, optimizing energy usage in this manner offers the chance to integrate technologies better suited to their remote locations far from the power grid and fossil-fuel supplies.

The researchers' findings were published in December by the journal *Applied Energy*.

The virtual model tested by Haghighat and Sameti considered multiple renewable and non-renewable energy sources.

They also had to consider issues within the grid—for example, the age of buildings or how their energy use can change at different times or during different seasons.

"Because of the complexity of the problem and the large number of decision variables involved, we needed to run all possible variables," said Haghighat.

They demonstrated that a significant reduction in carbon emissions is possible without changing all systems in all buildings in a grid—a process that has to happen slowly with periodic investment in new equipment.

As a result, their methodology can be applied as changes are made to a system over time.

This research aims to further lower both carbon emissions and overall costs by optimal integration and sizing of energy storage systems (both thermal and electrical) into the community. The ultimate goal will be the successful optimization of a net-zero energy district (nZED).

To make widespread adoption of their methods a reality, Sameti and Haghighat are hard at work on expanding its application to ever more complex networks.

More information: Mohammad Sameti et al, A two-level multi-objective optimization for simultaneous design and scheduling of a district energy system, *Applied Energy* (2017). DOI: 10.1016/j.apenergy.2017.09.046

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