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Ushering in a new age of urban energy efficiency with smart buildings

Buildings utilizing artificial intelligence promise to reduce energy consumption through better control and optimization

As artificial intelligence (AI) is applied to urban energy systems to improve the distribution and efficient use of electricity, the surface has only begun to be scratched in terms of the possibilities opened by introducing AI into smart buildings.

A collaborative effort by researchers at Kyushu University and Duke University now provides valuable insight into the various AI-based modeling approaches being applied in smart buildings and the benefits that are materializing along with identifying challenges remaining for advancing this critical technology.

“Simultaneously improving energy efficiency, comfort level, and safety is a priority around the globe, and AI is perfectly suited to achieving this,” says Hooman Farzaneh, associate professor at Kyushu University’s Faculty of Engineering Sciences and collaborator on the study.

Farzaneh and his team from the Interdisciplinary Graduate School of Engineering Sciences (IGES) in collaboration with Dr. Adrian Bejan, J. A. Jones Distinguished Professor at Duke University and the developer of the constructal law, reviewed over 150 papers to evaluate the current state of the technology.

The inclusion of technologies such as sensors, communication networks, and cloud computing in smart buildings is leading to rapid advances in building management systems (BMS) and demand response programs (DRPs), and the researchers identified 14 common machine learning algorithms being used in energy systems to exploit this data for improving resource utilization.

As urban areas see an increase in the use of renewable, weather-dependent energy sources, such AI systems are particularly promising for implementing measures based on factors like weather forecasts to ensure a stable supply of electricity.

Multiple case studies highlight successes that have already been achieved, such as substantial energy savings by using AI in ventilation control strategies. However, a next critical step is going beyond buildings that are independently operated to those that work together.

“The much greater benefits lie ahead as we build on this foundation and when smart buildings are integrated with AI into connected communities that interact in real time through the power and water grids,” write the researchers in their paper.

One example is connecting the heat pumps of several smart buildings to a single heat exchanger

loop, thereby achieving even larger gains in efficiency.

As advances are made regarding the technological aspects of smart buildings, the researchers emphasize that major challenges also remain on another front: policy.

“AI promises many great benefits, but it still raises concern among skeptics about possible threats it could pose to humans. Thus, a major challenge going forward is the development of policies governing human–AI issues to ensure that all future developments in AI are trustworthy, human-centered systems,” explains Farzaneh.

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For more information about this research, see “Artificial intelligence evolution in smart buildings for energy efficiency,” Hooman Farzaneh, Ladan Malehmirchegini, Adrian Bejan, and Precious P. Daka, *Applied Sciences* (2021). https://doi.org/10.3390/app11020763

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