Study proposes a predictive home energy management system with customizable bidirectional real-time pricing mechanism

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With a continuous rise in the global population, energy consumption and its associated environmental and economic costs are also increasing.

One effective approach to manage these rising costs is by promoting the use of smart home appliances, leveraging Internet of Things (IoT) technologies to connect devices within a single network. This connectivity can enable users to monitor and control their real-time power consumption via home energy management systems (HEMS). Energy providers can, in turn, utilize HEMS to gauge residential demand response (DR) and adjust the power consumption of residential customers in response to grid demand.

Efforts to promote residential DR, such as by offering monetary incentives under the real-time pricing (RTP) model, have historically struggled to foster lasting behavioral change among consumers. This challenge stems from unidirectional electricity pricing mechanisms, which diminish consumer engagement in residential DR activities.

To address these issues, Professor Mun Kyeom Kim and Hyung Joon Kim, a doctoral candidate from Chung-Ang University, recently conducted a study published in the *IEEE Internet of Things Journal*. Their study proposes a predictive home energy management system (PHEMS).

Prof. Mun Kyeom Kim led the study, introducing a customized bidirectional real-time pricing (CBi-RTP) mechanism integrated with an advanced price forecasting model. These innovations provide compelling reasons for consumers to participate actively in residential DR efforts.

The CBi-RTP system empowers end-users by allowing them to influence their hourly RTPs through managing their transferred power and household appliance usage. Moreover, PHEMS incorporates a deep-learning-based forecasting model and optimization strategy to analyze spatial-temporal variations inherent in RTP implementations. This capability ensures robust and cost-effective operation for residential users by adapting to irregularities as they arise.

Experimental results from the study demonstrate that the PHEMS model not only enhances user comfort but also surpasses previous models in accuracy of forecasting, peak reduction, and cost savings. Despite its superior performance, the researchers acknowledge room for further development.

Prof. Mun Kyeom Kim notes, "The main challenge with our predictive home energy management system lies in accurately determining the baseline load for calculating hourly shifted power. Future research will focus on enhancing the reliability of PHEMS through improved baseline load calculation methods tailored to specific end-users."

More information: Hyung Joon Kim et al, New Customized Bidirectional Real-Time Pricing Mechanism for Demand Response in Predictive Home Energy Management System, *IEEE Internet of Things Journal* (2024). DOI: 10.1109/JIOT.2024.3381606

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