Energy Efficient Buildings Facilitated by Micro Grid

Xiaohong Guan[1,2], Zhanbo Xu[2], Qingshan Jia[1]

[1]Tsinghua University, [2]Xian Jiaotong University

According to the U.S. Department of Energy, about 40% of total energy is consumed on buildings in industrialized countries, among which 68% is electricity. Recently research shows that 20%~30% of building energy consumption can be saved with optimized operation and management without changing building structure and hardware configuration of energy supply system significantly. Therefore, there is a huge potential for building energy savings through efficient operation.

Micro smart grid technology provides a desirable infrastructure for energy efficient buildings. In additional to the power source from the grid, a micro grid for buildings may contain autonomous power generators possibly CHP, renewable energy resources such as PV solar cells, power storage devices and system loads including HVAC systems, lighting equipment, IT data centers, etc. The first step for energy efficient operation is to establish the profiles for varieties of loads. In order to accomplish this task, a cyber-physical network as the basis of a micro grid is needed with many low-cost micro sensors possibly wireless deployed for measuring comfort conditions such as temperature, humility, lighting, air quality, etc. and occupant locations and movements. Auto-meters are also needed for reliable acquisition of power consumption data. With the necessary information collected, dynamic load profiles can be established.

With support of a micro grid, energy efficient operation is synergetic task that needs coordinated scheduling and control of the HVAC system, lighting, renewable energy sources, power storages, etc. with possible thermal load management by controlling fresh air, automatic window shading, room illumination, etc. In our research individualized comfort model is established to identify the individual requirements in the building in order to serve individual occupants in an energy efficient way to avoid or alleviate the energy wasting caused by conflicting demands. Occupant localization and movement tracking through wireless sensor network, RFID and CCD videos are considered and performed for power saving lighting control.

Based on the model of dynamic energy flow in a building, an optimization based strategy is developed for integrated scheduling and operation with flexible thermal loads, light demand and CHP generation, PV solar cells and power storages to minimize energy consumption and costs across a time horizon. Building energy and cost savings are realized through effective management of flexible loads coordinated with renewable and CHP generation and power storages under time varying or dynamic pricing in a micro grid.

Simulation and testing are performed based on a practical test-bed campus building. The results show that significant energy savings are achievable with the optimization based strategy.

978-1-4244-6551-4/10/$26.00 ©2010 IEEE