News Article for RISUD Strategic Focus Area (SFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Prof. Shengwei WANG	BEEE/PolyU
2.	**Name of SFA:**	Smart Energy Efficient and Grid-Responsive Buildings	
3.	**Project Title:**	Optimized Design and Optimal Control of Smart Buildings of Enhanced Grid Friendliness and Responsiveness	

4. **Final Report Progress/Achievement (***in layman's language, no more than two A4 pages. Photos are most welcome.***)**

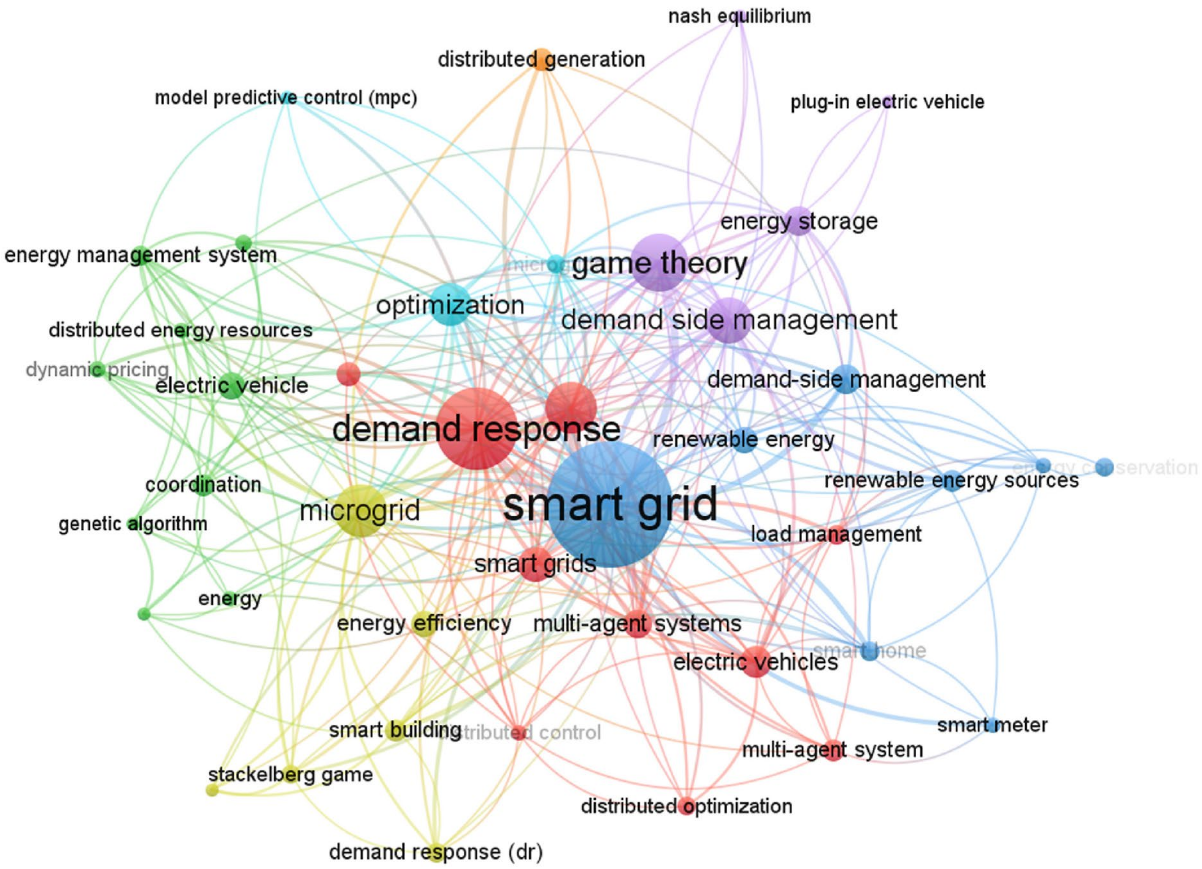

Fig. Connections of building demand response and smart grid with other hot research topics

The challenges faced by the power grid have increased in line with the growing demand of end-users and the growing penetration of renewable energy generation. To address the inefficient operation and the reliability problem which may occur in the power system, optimizing the design and control of smart buildings has been proven to be an effective approach in our research. With the grant support under RISUD Strategic Focus Area (SFA) Scheme, we have achieved fruitful outcomes that 30 papers have been published in journals with high impacts and received numerous citations. Our research works played a vanguard role in this research area, which achieved considerable progress in enhancing the friendliness and responsiveness of the smart buildings to the power grid. The project support allows us/RISUD to be a pioneer and a major contributor of high impacts on these research topics. Moreover, through inter-/multi-disciplinary collaboration between building energy (BEEE), smart grid (EE), and information technologies (COMP), a deeper understanding of the complex interactions between energy systems, smart grids, smart buildings, and advanced information technologies is established which fostered a more holistic approach to problem-solving and decision-making in achieving carbon neutrality. Here are some of the key research outcomes achieved:

- ✓ Development and investigation of/on the methodology, benefits, and feasibility to enhance the grid friendliness of buildings and overall energy efficiency of buildings-grid ecosystems;
- ✓ Development of the methodology and optimal design of grid-friendly and grid-responsive buildings; Quantitative analysis of building demand side energy flexibility (e.g., flexibility index and assessment, uncertainty in the aggregate energy flexibility).
- ✓ Development of big-data analysis methods and optimal control methods of building energy systems for enhancing the power flexibility of buildings in operation (e.g., Identification of simplified energy performance models, the hierarchical optimal control strategy for continuous building demand response); Data-driven models are developed to predict the variation of power use and indoor temperature for facilitating the provision of day-ahead demand response of buildings.
- ✓ Development of smart power demand management and building demand response control method commonly applicable to smart buildings. Typical on-site data from a super-high-rise commercial building are collected and used to illustrate the problems during demand management and demand response periods. The online optimal control issues, such as uneven cooling distribution and indoor comfort sacrifice during the fast demand response event, are effectively addressed considering the requirements of the power grid and building simultaneously.
- ✓ Development of frequency-response control methods (e.g., investigation on the dynamics, quality and impacts of the grid responsive strategies); Several optimal control strategies are developed for HVAC systems to provide frequency regulation service to power grids, such as a hierarchical control structure consisting of a regulation bidding controller and a power use following controller, a frequency disturbance compensation scheme based on the concept of "disturbance-observer-based control".
- ✓ Test and validation of frequency-response control methods on the laboratory test platform. The feasibility of using HVAC systems in providing fast demand response and frequency regulation is investigated experimentally and the dynamic characteristics (those associated with electrical and hydraulic responses) of variable-speed pumps are also tested and validated.