CONSTRUCTION INDUSTRY COUNCIL 建造業議會	*Project Title:*	Retrofitting existing building (energy efficiency) – a quantitative approach
	Principal Investigator:	Dr Tin Tai CHOW
	Project ID:	CICR/05/14
	Research Institution:	City University of Hong Kong
	Subject Area:	Environment and Sustainability

Objective

- To identify the existing office buildings in which the retrofitting energy saving technologies can be made available for field measurements;
- To carry out quality insitu studies on the selected energy systems and to evaluate the effectiveness and the implementation difficulties; and
- To quantify and generalise the long-term system performance and cost benefits.

Background

More focus is now placed on the international protocols on the reduced reliance on fossil fuels as a result of the increase in awareness of climate change and scarcity of natural resources. In Hong Kong, the building sector consumes over 90% of the territory-wide electricity generation, of which 66% are consumed in the commercial sector. Offices, retail shops and restaurants are identified as the key energy consumers within the commercial sector. The Hong Kong Green Building Council (HKGBC) has proposed a holistic approach based on the demand-side management conception. The HK3030 campaign was officially launched in year 2013, targeting at a reduction of building energy consumption by 30% in Hong Kong by the year 2030, using the 2005 consumption level as the baseline.

In order to promote the wider application of energy efficiency measures in the coming years, the building industry of Hong Kong was in need of reliable field measured data and convincing technical information to demonstrate the engineering practicality, energy saving potential, as well as cost benefits. Such an evaluation of merits was best done by the third independent party rather than by the equipment supplier or the building owner. A stage by stage research study along this direction was carried out.

Methodology

Selection of Feasible Retrofit Technologies

Potential retrofitting technologies applicable to this subtropical modern city were identified in view of their energy saving potential and practicality, in particular for high-rise and high-density urban environment. As the major energy, consumption items for office buildings were the air-conditioning and lighting installations, more attentions had been placed to these systems.

Case Identification and Assessment

The same retrofitting technology when adopted in different buildings may have different levels of performance satisfaction and cost saving. The case selection would depend on the system availability during the project period, and the opportunity of acquiring quality performance data set. Priority was to be given to those systems available for measurements before and after the retrofitting. The development of mutual trust between the properties management team and the research team became important in order to generate a case study report with high quality. Only the attitude of the research team in the studied case, which was considered reliable, was included in the report.

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Brief description of the retrofitting work

1. Building description (building type, age, location, number of stories, etc.)
2. System description (before and after the retrofitting completed with illustrating diagrams where applicable)
3. Energy performance analysis (methodology, field measurements, mathematical analysis)
4. Cost analysis (evaluating assumptions, cost-benefit analysis)
5. Technology evaluation (technical difficulties encountered, appropriateness of the retrofitting scale, design optimization, etc.)
6. Overall remarks

Results and Findings

Through the case assessment processes, it was found that both the percentage energy saving (PES) and simple payback period (SPP) varied widely among different technologies and even different cases of the same technology. Besides, the trends of the PES and SPP could be substantially different. This could be attributed to the different information involved in the two parameters. PES only reflected the energy saving percentage but not the amount of energy reduced which SPP was more correlated to. Another important factor which affected the SPP was the initial cost of the retrofitting work. This could fluctuate substantially from case to case and from time to time. The marketing strategies of the suppliers and the contractors could influence the initial cost to a great extent.

Based on the assessment results, four energy saving technologies were considered most promising, namely the use of variable-speed primary chiller pump station, the addition of CO_2 sensor to reduce fresh air rate, the replacement of light tubes by T5 or LED fixtures and the addition of heat pump to domestic hot water supply. Various factors were found to affect the performances of the energy saving technologies in different aspects and to different extents, which the building owners/facility management should pay more attention to in the planning of respective energy retrofitting work, namely the security of system operation, scale of retrofitting work, consolidation of work, extent and ease of work, impact on maintenance load, selection of supplier/contractors for the retrofitting work, interference from users and appropriateness of system settings.

Recommendations

To further promote the implementation of energy saving technologies, more incentive schemes can be offered to the building owners, to help improve the economic merits of the energy saving technologies. Meanwhile, tighter statutory requirements on building systems energy efficiencies/consumptions can be enforced which can shift the building owners' focus from the economic performances to the technical performances of the energy saving technologies. Public awareness is also important as human behavior is often a very significant factor, which affects the success of respective energy saving technologies.