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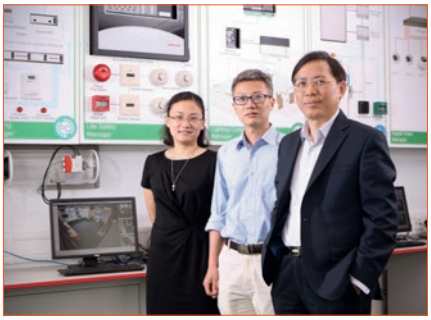
News Bite on PolyU's Innovation

Life-cycle Smart Optimisation and Diagnostics Solutions for Buildings

Saving up to 40% energy consumption in central air conditioning

In Hong Kong, 90% of the electricity is consumed by buildings, and in commercial and industrial buildings, over half of the energy consumed is used on central air conditioning. However, improper design, operation and control of air conditioning systems have led to poor energy efficiency and massive waste of electricity. In light of this, researchers from the Department of Building Services Engineering provide consultancy services to formulate optimisation solutions for commercial and industrial buildings, effectively reducing up to 40% of energy consumption in central air conditioning.

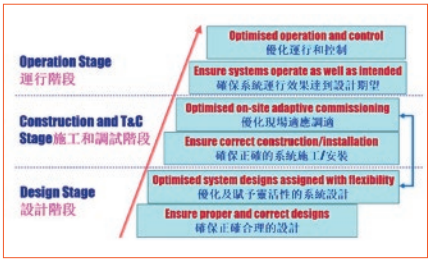


Prof. Shengwei Wang (right) and his research team

To save electricity is to save not only money, but also the environment. Over 60% of electricity in the world is generated by burning non-renewable fossil fuels such as coal and oil[1] that emit harmful fumes and greenhouse gases in the process. In Hong Kong, over 90% of electricity is used by buildings, and central air conditioning accounts for more than 50% of total energy consumption in commercial and industrial buildings. However, the poor efficiency of air conditioning systems due to improper or obsolete design, operation, control and maintenance means that much of the energy is wasted. To boost the overall energy efficiency of commercial and industrial buildings, Prof. Shengwei Wang of the Department of Building Services Engineering led a research team to formulate all-round optimisation strategies that enhance energy performance of air conditioning systems. They also provide optimisation solutions on air conditioning to various buildings through consultancy services, saving as much as 40% of energy consumption.

Life-cycle optimisation

Prof. Wang and his team take a holistic approach to the optimisation of air conditioning efficiency. They call it life-cycle optimisation in which every stage, from design via construction to operation, is examined thoroughly to ensure performance. "In the design stage, we pick the most suitable energy-efficient technologies. Then we optimise the air conditioning system by simulating and predicting the load and working conditions including their probability distributions while integrating and connecting with different building services, so



Schematic of the systematic approach of life-cycle smart optimisation and diagnostics solutions for buildings

as to have a highest chance of meeting the demand with minimum energy consumption," explained Prof. Wang.

Adaptive commissioning

In the construction stage, the team employs a new concept known as adaptive commissioning. Traditionally, the design of a central air conditioning system is tuned to certain specific conditions or balance points, but the actual system characteristics may differ significantly. Prof. Wang thus includes different operation options in his design solutions to allow flexibility. "For example, instead of building one bigger pump of 100% required capacity in each of two cooling towers, we build three smaller pumps that add up to the same capacity instead. That gives the leeway of running one to three pumps according to the actual need. When the water-loop hydraulic resistance is low, we may operate two small pumps only to save energy."

Fault diagnostics

In the operation stage, the team look at different operation modes of the systems and how they affect energy consumption, in a view to fulfil the same cooling demand with less energy. Another important measure at this stage is fault diagnosis. "Components may fail over time leading to performance degradation. Components may also need to be cleaned or tuned up from time to time. Thus, we must devise a system to check where the fault is when the air conditioning system is not performing optimally, and to fix the problem as soon as possible," Prof. Wang said.

In newer information-super-rich buildings with built-in IoT sensors and building automation systems that collect bulk volume of data every day, the team would deploy big data analytics to effectively locate the problem. But even in older information-poor buildings where very little data is available, the team may still be able to deeply analyse energy use on building-level to find out the pain points that lead to wastage.

Saving up to 40% of energy

Prof. Wang's team provide air conditioning consultancy services and optimisation solutions to various buildings, such as underground facilities, factories, hotels, and commercial and office complexes. Their solutions have garnered encouraging results, saving 15 to 40% of energy consumption in those buildings. In a high-rise commercial complex in Hong Kong, the optimisation and continuous commissioning efforts have achieved an annual saving of over 10 million kWh of electricity, translated into more than HK$10 million of savings in electricity bill each year.

"In Hong Kong, electricity bill for major electricity users depends on both the amount of power used and the maximum demand. By just cutting back on the maximum demand by 10 to 20% for three to five hours a month alone, the electricity bill can be brought down by 3 to 5%. Better still, our solutions save electricity cost and contribute to power grid stability by using energy stored in buildings and shutting down part of the cooling plant for a short period of time, without sacrificing the comfort of users," Prof. Wang explained.

[1] *BP Statistical Review of World Energy. 2019. Retrieved from https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf*