Analysis and Improvement of Building Energy System in Mechanical Ventilation and Air Conditioning (MVAC) System: A Case Study in Hong Kong

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Background

Hong Kong, known for its tall buildings and congested urban setting, has specific difficulties in managing energy use and maximizing building energy system performance, especially when it comes to MVAC system. These issues worsen the close-knit urban environment, which reduces the amount of natural ventilation and increases the need for energy-intensive cooling equipment.

Objectives

The primary objective is to evaluate the building's MVAC system type and investigate its patterns of energy use. The study identifies variations in energy use by comparing the energy usage among a number of years. In addition, appropriate modifications in energy usage are suggested to increase the building energy efficiency based on the systematic analysis.

Methodology

The project involves three stages.

Stage 1: The data is collected between 2021 and 2022, with an emphasis on the Energy Use Intensity (EUI), average monthly energy consumption of MVAC system, the MVAC system overall energy consumption, the energy consumption of the office and data center chiller plant, and the Coefficient of Performance (COP) of the chiller plant.

Stage 2: Analyze MVAC system EUI and compliance with Electrical and Mechanical Services Department (EMSD) benchmarks. Compare monthly energy consumption to identify significant months for energy usage. Assess energy usage of office and data center chiller plant. Evaluate chiller plant performance using COP and standards.

Stage 3: A thorough strategy to improve energy efficiency is devised using the information gathered from the assessment and conduct energy efficiency analysis:

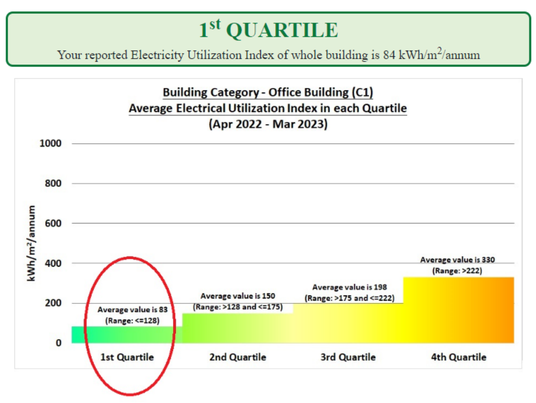
i) Upgrade equipment (chillers, fans, pumps, cooling towers) for energy efficiency;

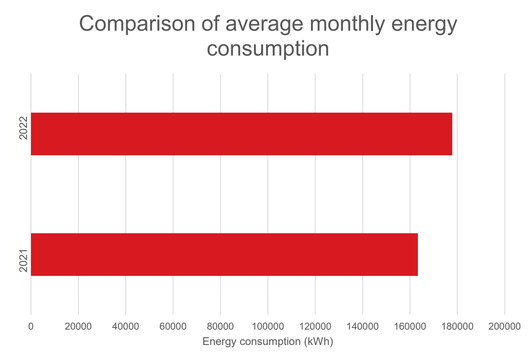
ii) Optimize control systems and algorithms, and implement smart technologies;

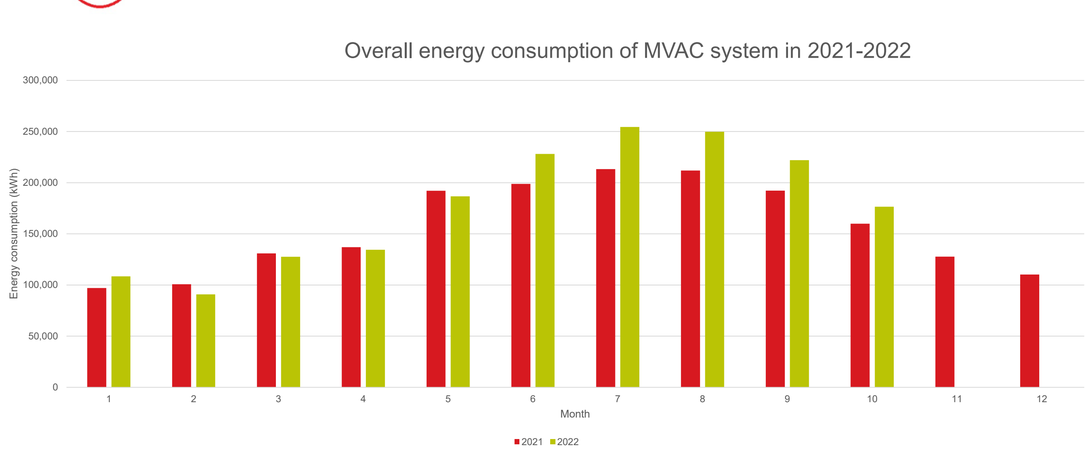
iii) Establish routine maintenance schedule for early problem detection, energy savings, and system longevity.

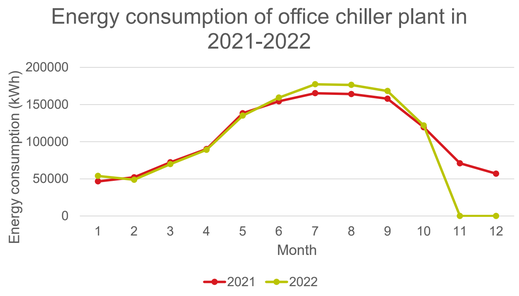
Findings

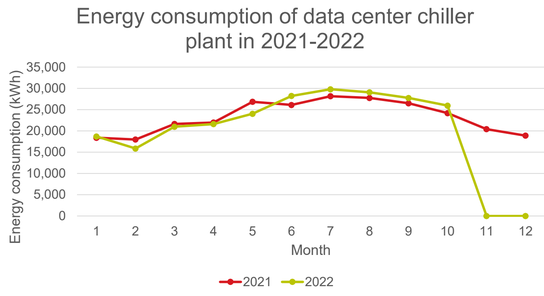
After detailed analysis and comparison, it is determined that the building's EUI of 2021 exceeded the benchmark first quartile average. During the summer and January, the MVAC system overall energy consumption was significantly higher, indicating issues with the chiller plant. Ultimately, the performance of the chiller plant was assessed by examining the COP, and it did not match the suggested level of performance.











Conclusion

To address the identified issues, recommendations are provided to improve energy efficiency by:

- Replacing centrifugal chillers with variable speed drives (VSD) chillers for better part load efficiency
- Replacing centrifugal pump with VSD pump for demand-matching and reduced energy waste
- Emphasizing routine maintenance
- Considering automatic control for chiller optimization to enhance system efficiency