AI-ASSISTED SMART AIR-CONDITIONING CONTROL

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COLLABORATION WITH:

ENGIE factory

NUHS National University Health System

PROJECT OBJECTIVES

This project aims to improve energy efficiency and indoor human comfort through the development of an AI-based smart building systems control solution in buildings employing building management systems (BMS). The AI-based solution is innovative as it departs from the conventional reactive control, and employs a predictive control strategy by synergising online machine learning and model predictive control for smart building energy management applications.

PROJECT SUMMARY

This project develops an AI-based smart control technology to tackle the major limitations in current BMS in managing air conditioning and mechanical ventilation (ACMV) energy, and indoor thermal comfort. Current BMS is based on conventional reactive control such as proportional–integral–derivative (PID) that is prone to overcooling/insufficient cooling issues, resulting in excessive energy consumption and discomfort. The proposed smart control employs an AI algorithm that learns building dynamics and thermal comfort, as well as makes use of information from indoor and outdoor conditions measured by various sensors to precisely predict the future building responses represented by the Predicted Mean Vote (PMV). The PMV is a sophisticated thermal comfort index that takes multiple environmental factors (e.g. indoor air temperature, humidity, mean radiant temperature) and individual factors (e.g. metabolic rate, clothing level) into consideration.

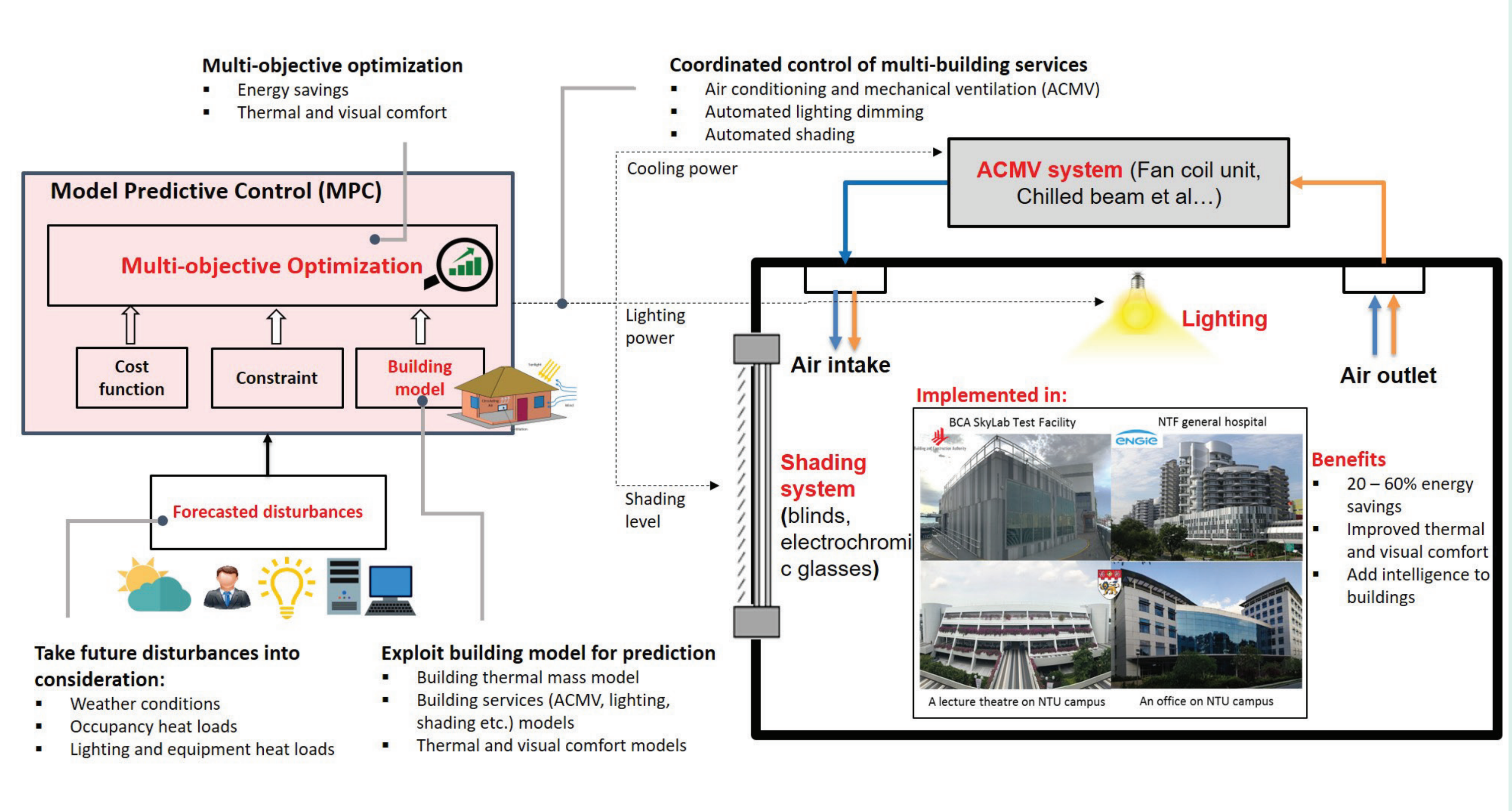
Based on the predictions, the system optimises the ACMV operation with a mathematical optimisation algorithm to save energy and improve indoor thermal comfort. The smart control is implemented in the facility management office of Ng Teng Fong General Hospital (NTFGH) to test-bed its control performance for ACMV. The technology allows users to change its optimisation objective between energy-saving-biased (more energy savings with comfortable indoor conditions) and thermal-comfort-biased (best thermal comfort with reduced energy saving) according to their needs.

With the online learning capability of the AI algorithm, the technology has the potential for rapid scale-up deployment at multi-zone and whole building levels. The technology has demonstrated the capability to control different ACMV equipment including fan coil unit, active chilled beam and air-handling unit, making it suitable for various buildings (e.g. offices, institutional, shopping malls, hotels, airport halls, etc.) equipped with these ACMV equipment to provide similar energy savings and improved comfort. The technology could work as a plug-in module to existing BMS as a supervisory layer through standard industry communication protocols (e.g. Modbus, Open Platform Communications). The technology could also work as a standalone BMS for buildings that are not equipped with existing BMS. Besides ACMV, the technology can also perform integrated control of ACMV, automated dimmable lighting and shading systems for achieving overall optimal energy efficiency and occupant's thermal and visual comfort.

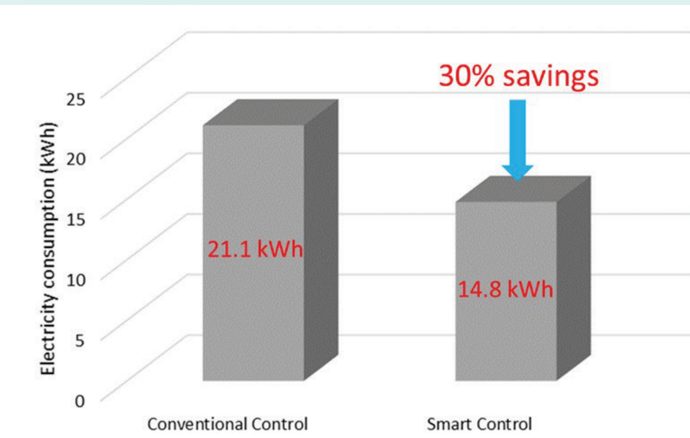
PROJECT OUTCOMES

- An AI-based smart ACMV control algorithm that has potential for scale-up deployment and multi-building-systems control (e.g. ACMV, heating, lighting, shading).
- 30% of energy saved on cooling for ACMV measured by a thermal energy meter installed on the chilled water pipes, which is equivalent to an annual electricity bill reduction of around S$150k for a typical office building with a gross floor area of 25,000 m^2
- Much improved thermal comfort represented by PMV as compared to conventional control measured in a real building.

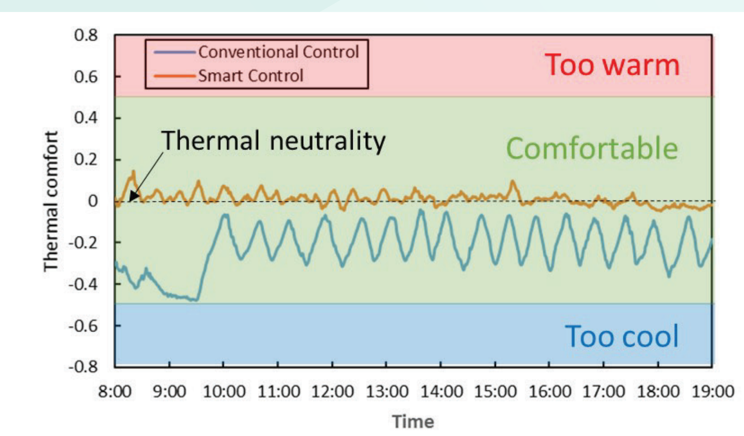
OVERVIEW OF PROPOSED AI-ASSISTED SMART CONTROL



TEST RESULTS IN NG TENG FONG GENERAL HOSPITAL



Energy Performance



Thermal Comfort (PMV) Performance

PART OF

YOUTH @SICW

ORGANISED BY

Energy Market Authority Smart Energy, Sustainable Future

20 Years and beyond

Powering Lives

PROJECT BY:

Yang Shiyu

Nithiakuhan Uthayakumar

Yeo Wei Jie