OBJECTIVE AND SIGNIFICANCE: The objective of this multi-year project is to understand energy performance and operation of net zero energy, mixed mode buildings in tropical climate and to use the buildings as real-world research facilities for the study of energy efficient building features and control strategies. The specific objectives of the current work are to measure and evaluate indoor air quality, particularly CO₂, in manually operated mixed mode buildings. High levels of CO₂ can cause drowsiness, absenteeism, and poorer student performance.

BACKGROUND: Two unique energy efficient, net zero energy buildings constructed on the University of Hawai‘i at Mānoa campus serve as platforms for energy, comfort, and controls strategy research. Since 2016, HNEI has been extensively monitoring these mixed-mode Project FROG structures to gain insight into their performance.

The buildings were designed to be naturally ventilated with openable windows that allows air to flow through the room. On-Demand HVAC control prevents the room from being air conditioned continuously at night or when classroom capacity factor is below 60% during the day. With the adjustable ceiling fans, the mixed mode buildings are comfortable for most of the year without the air conditioning running. The buildings are also outfitted with photovoltaic systems that generate more power than they consume.

The current research focuses on observing and characterizing CO₂ levels in the mixed mode buildings and understanding the influence of window operation. As part of this project, HNEI developed a sensor providing the building occupants real-time feedback on CO₂ levels, including a cue to take action to increase fresh air.

From an energy perspective, these buildings serve as models for energy efficient construction with highly insulated roof and walls, high performance low E glazing, ceiling fans, LED lighting with daylight controls, and orientation to prevent solar heat gain through the windows.

In addition, the research platforms serve as beta test sites for innovative controls and sensor research experiments including:

- Real time CO₂ indicators
- Automated ceiling fan controls
- Innovative occupancy sensing device
- Unique hi-res energy monitoring system
- Unique power quality monitoring system
- Deployed a thermal comfort perception kiosk

PROJECT STATUS/RESULTS: The Project FROG buildings continue to serve as functioning classrooms for both high school and university classes. In this ongoing project, we observed that CO₂ levels can exceed recommended levels, occasionally by a factor of two. User awareness and training are imperative to properly operate in the mixed mode. Building decisions are made every day by the instructors that impact the indoor air quality of a mixed mode building. Operation of windows, ceiling fans, and air conditioning are judiciously used to create healthy indoor air quality.

This project will be completed in December 2020.

Funding Source: Office of Naval Research

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ADDITIONAL PROJECT RELATED LINKS

TECHNICAL REPORTS:
1. Net Zero Energy Test Platform Performance Comprehensive Analysis, MKThink, March 2016

PAPERS AND PROCEEDINGS:

PRESENTATIONS: