22/26 Midwest: Net Zero Emission Strategy for Buildings

Background

The 22/26 office building [Figure 1], built in Austria in 2013, was designed to maintain a consistent internal temperature between 22 and 26 degrees Celsius with the use of natural ventilation controlled through an autonomous climate management system. The building's use of natural ventilation techniques, which transfer indoor and outdoor air, eliminated the need for conventional mechanical HVAC (Heating, Ventilation, and Air Conditioning) and improved the building's energy efficiency. Replicating this system globally would be beneficial for climate and sustainability initiatives. However, accounting for environmental variances across the globe makes this a challenging task, as no single building could efficiently meet the needs of every climate in the world. As such, implementations of the 22/26 net-zero concept will vary depending on the intended location of the system.

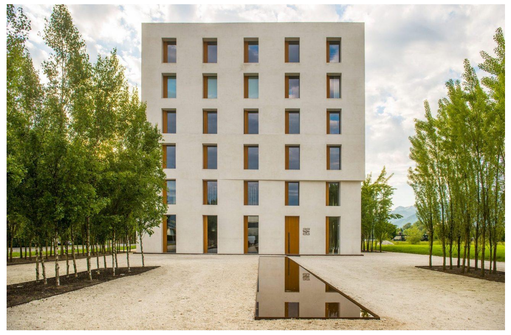

Figure 1: The original 22/26 project: the first realized building without any heating, cooling or mechanical ventilation in a cold climate

Objective

Our work aims to develop a prototype [Figure 2] of 22/26's climate management system that can be implemented in a carbon-neutral home tailored to the climate and prevailing construction techniques of the Midwestern United States.

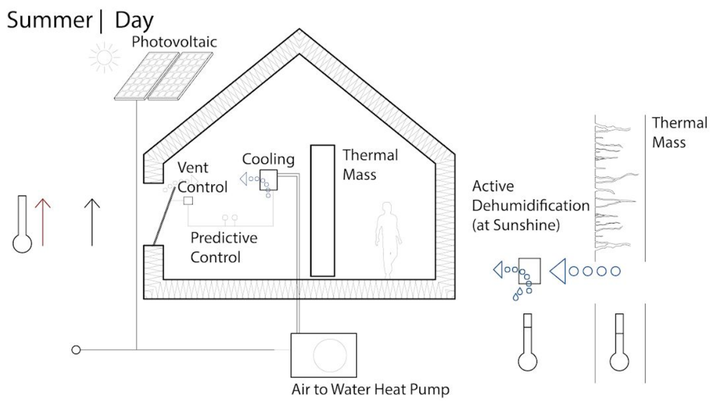

Figure 2: 22/26 Midwest Control Environment Concept Overview

Methods

Data Collection: A Raspberry Pi equipped with EE895 and DHT22 sensors collects temperature, CO_2, and humidity data. The external conditions and weather forecast are collected using an API.

System Communication: MQTT is a messaging protocol that allows machines to publish and subscribe data in order to simplify the communication process. As illustrated in Figure 3, using MQTT, data collected from individual room nodes is published to the central control unit. The air exchanger and window actuator system employ Raspberry Pis subscribed to the central control unit to receive the data and determine the adjustments required to regulate the internal temperature, humidity, and CO_2 levels to a comfortable level.

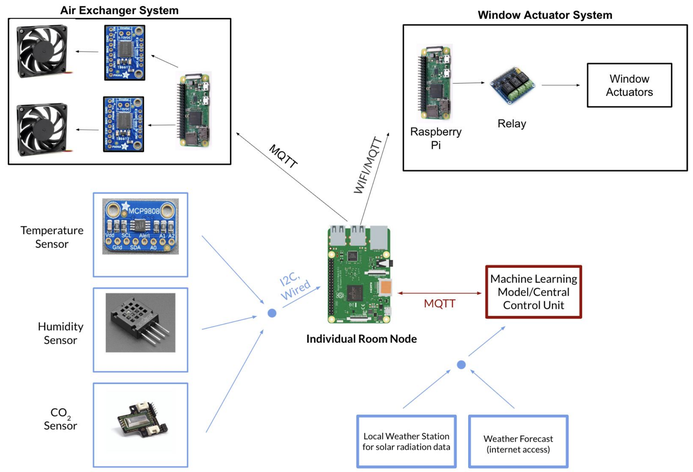

Figure 3: Overview of 22/26's system communication

Window Actuator: The Raspberry Pi in the window actuator system subscribes to the the central control unit, receiving real-time data from the node. The Raspberry Pi evaluates this data and operates a relay which adjusts the power supplied to the window actuator and controls the extension of the window opener. See Figure 4 below:

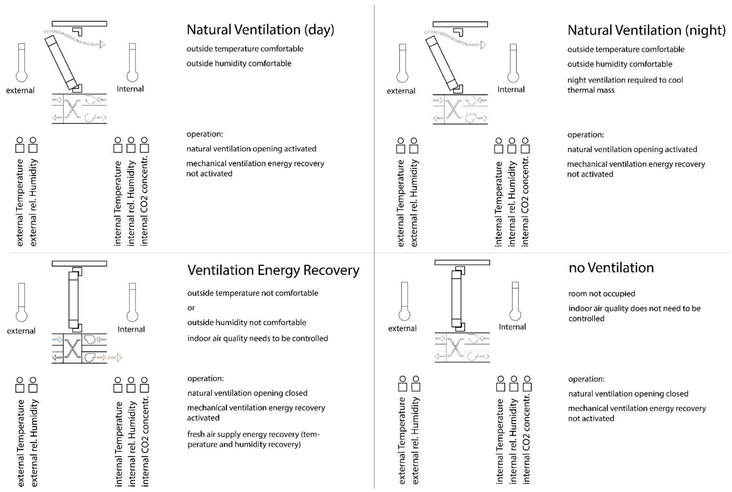

Figure 4: The decision process of the ventilation system

Expected Results / Conclusion

Our prototype has not yet been tested. Upon successful implementation, this prototype will effectively reduce the energy demand of the built environment in the Midwestern United States. In order to improve our system, time graphs of data collected by the sensors can be evaluated alongside records of commands made by the window actuator and air exchange system [Figure 5] to ensure that the prototype properly responds to changes in environmental conditions. Additionally, residents can provide feedback on the system's ability to regulate conditions and provide comfort and ease of use. The calibration of the sensors will also be evaluated to measure the prototype's long-term health.

Figure 5: The development of the ventilation unit

Future Research

Future research would entail a thorough testing of our current system. Following testing, the sustainability of our system would be determined by examining our system's life cycle and energy consumption. An analysis of the extent to which our system is cost-effective would also be necessary when considering the possible commercial implementation of our system. An investigation of residential architecture based in natural ventilation systems rather than traditional HVAC would also be necessary.

Acknowledgements

Junghans, L., & Widerin, P. (2017). Thermal comfort and indoor air quality of the "concept 22/26", a new high performance building standard. *Energy and Buildings*, *149*, 114–122. https://doi.org/10.1016/j.enbuild.2017.05.020

Daniel Liu, Taylor Nguyen, Colin Riker, Sanjit Vijay

MRADS

Shaniya Thomas[1], Kara Wong[2], Lars Junghans (PhD)[3]
College of Engineering[1], College of Literature, Science, and the Arts[2], Taubman College of Architecture and Urban Planning[3]

TAUBMAN COLLEGE