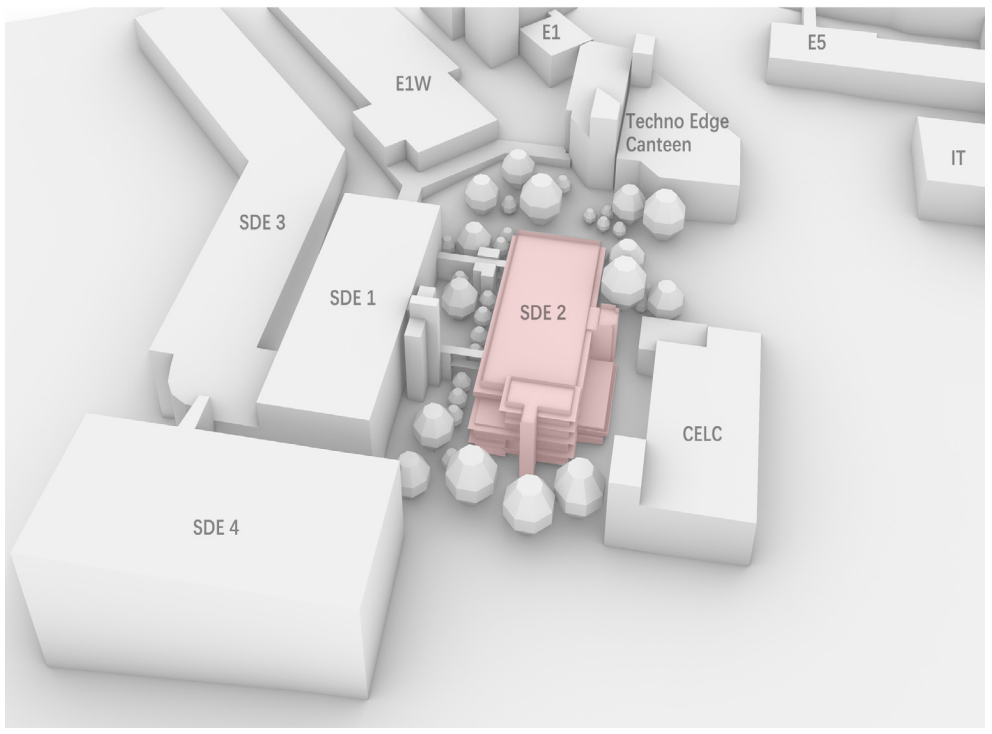
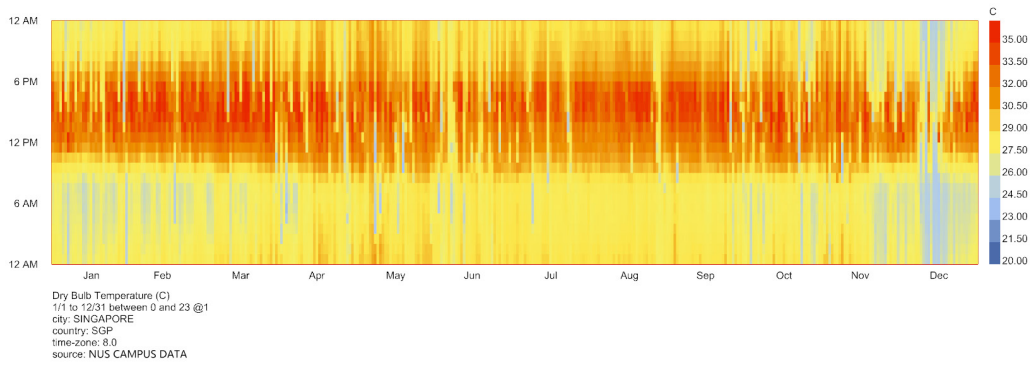
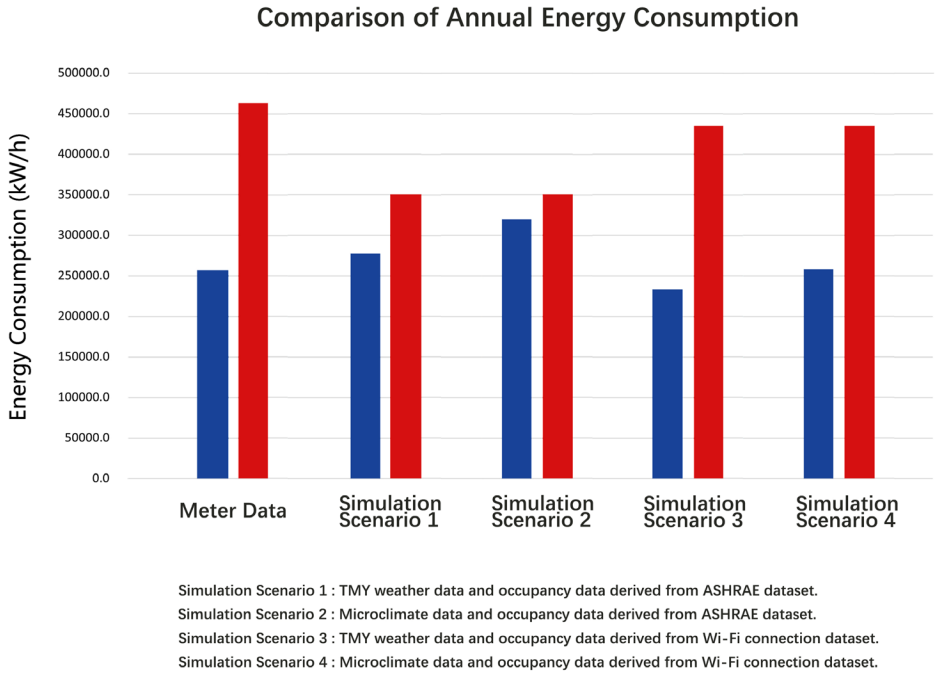
Rethinking Building Energy Simulation for District Scales: Microclimate and Occupancy

This study focuses on aspects often overlooked in previous building energy simulation research: microclimate and occupancy. Given the Urban Heat Island (UHI) effects, microclimate data might diverge from Typical Meteorological Year (TMY) data, potentially resulting in unexpected cooling or heating loads in building energy simulations. Occupancy patterns exert direct influence on the operation of appliances such as air-conditioning units, fans, laptops, and more.

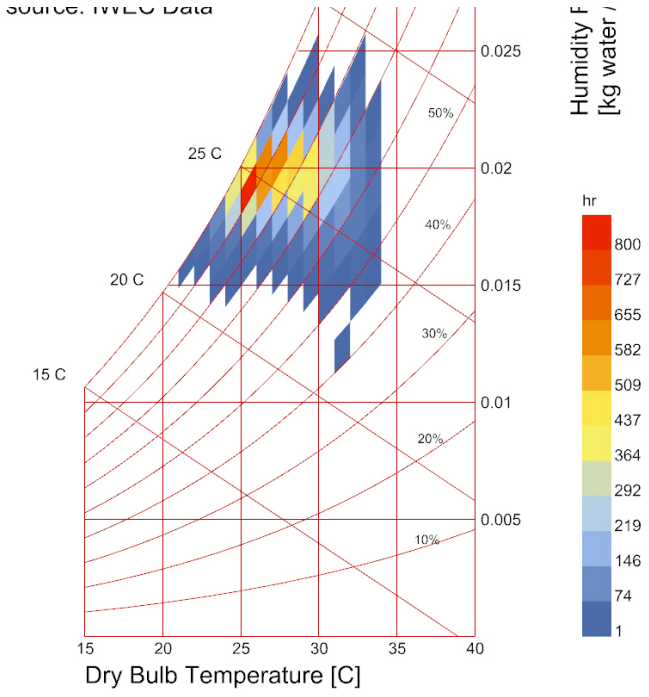
For this investigation, an educational building within the National University of Singapore campus was chosen as a case study. Four simulation scenarios were devised, each involving distinct combinations of occupancy and weather data. Occupancy data were sourced from both the ASHRAE dataset and the Wi-Fi connection data of the building. Weather data encompassed both TMY data and microclimate data obtained from nearby weather stations. Simulations were conducted using the Honeybee and Ladybug plugins for Grasshopper.

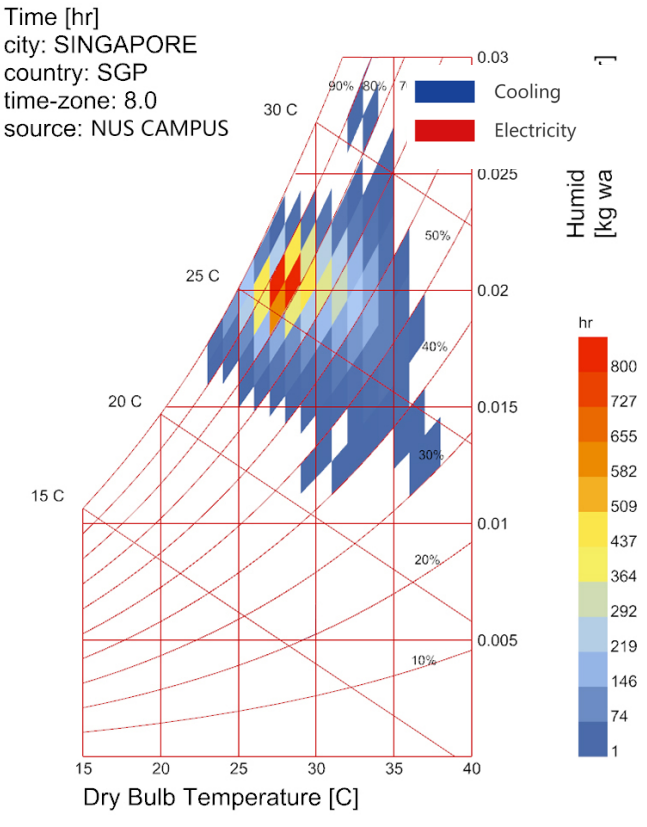


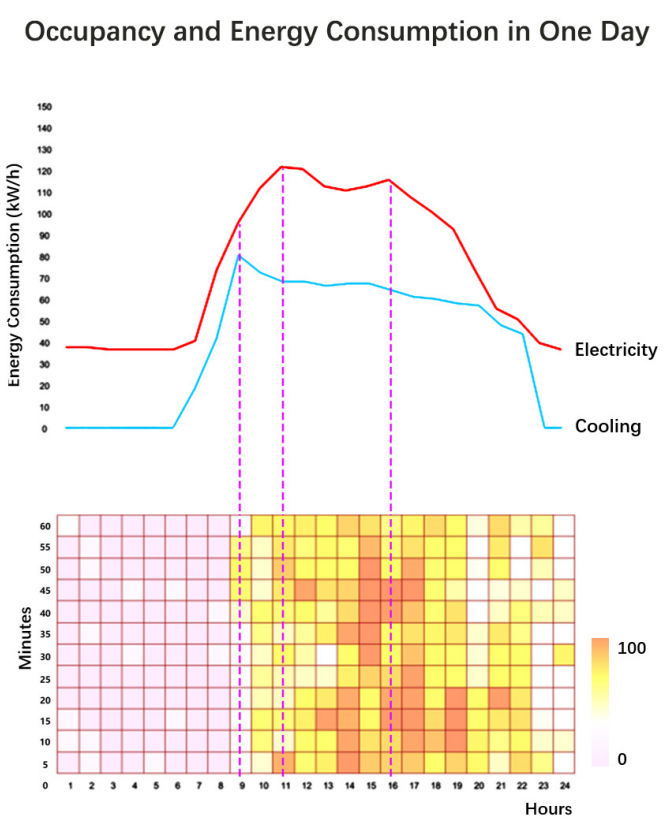




Simulation Scenario 1 : TMY weather data and occupancy data derived from ASHRAE dataset.
Simulation Scenario 2 : Microclimate data and occupancy data derived from ASHRAE dataset.
Simulation Scenario 3 : TMY weather data and occupancy data derived from Wi-Fi connection dataset.
Simulation Scenario 4 : Microclimate data and occupancy data derived from Wi-Fi connection dataset.







Simple statistical analysis was employed to compare actual energy consumption against simulation results. Outcomes reveal the considerable influence of microclimate and occupancy on building energy consumption, underscoring the need for precise urban building energy modelling.