HSLU Hochschule Luzern

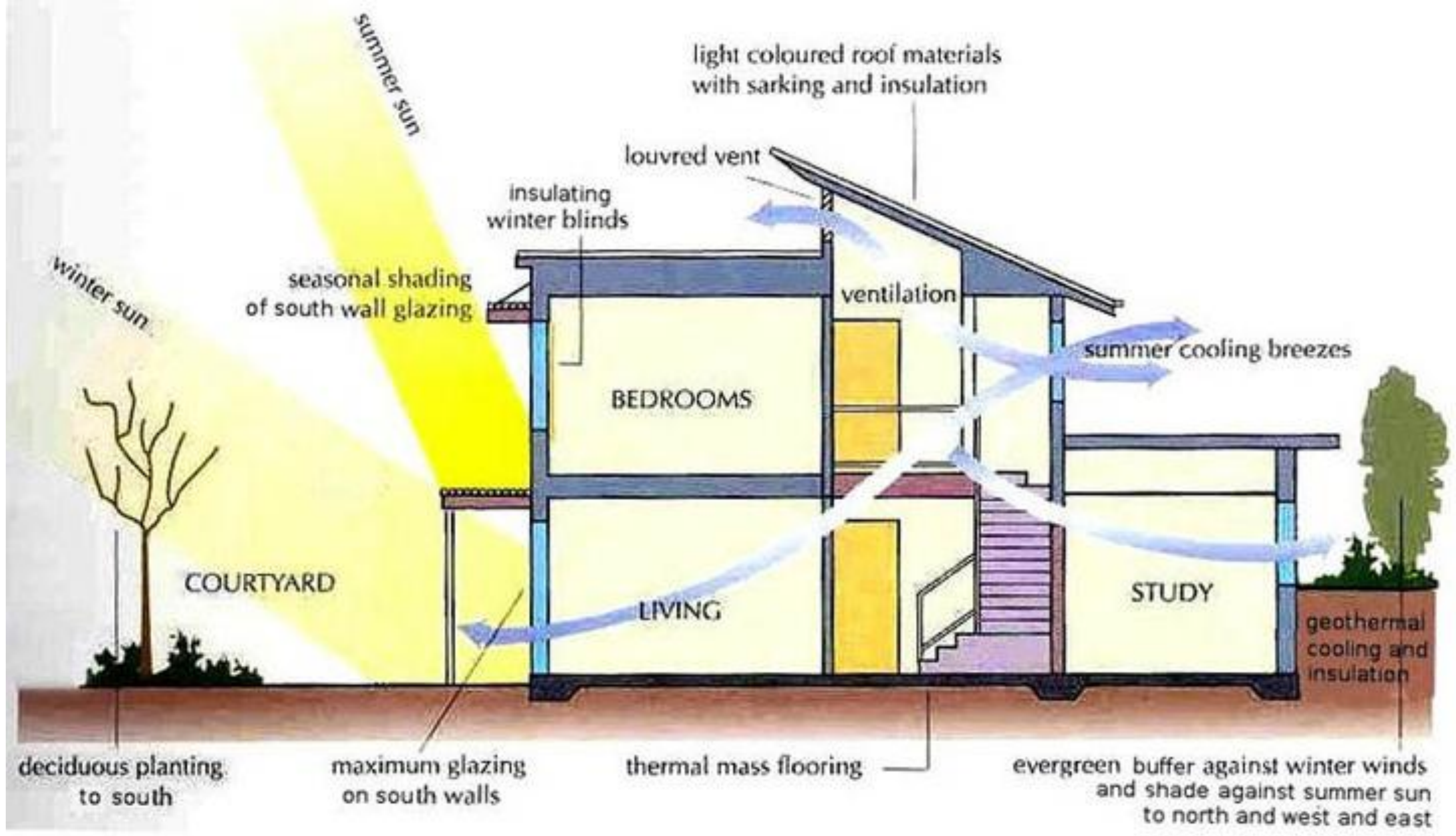
Technik & Architektur

Building Technology / Gebäudetechnik

Master of Science in Engineering

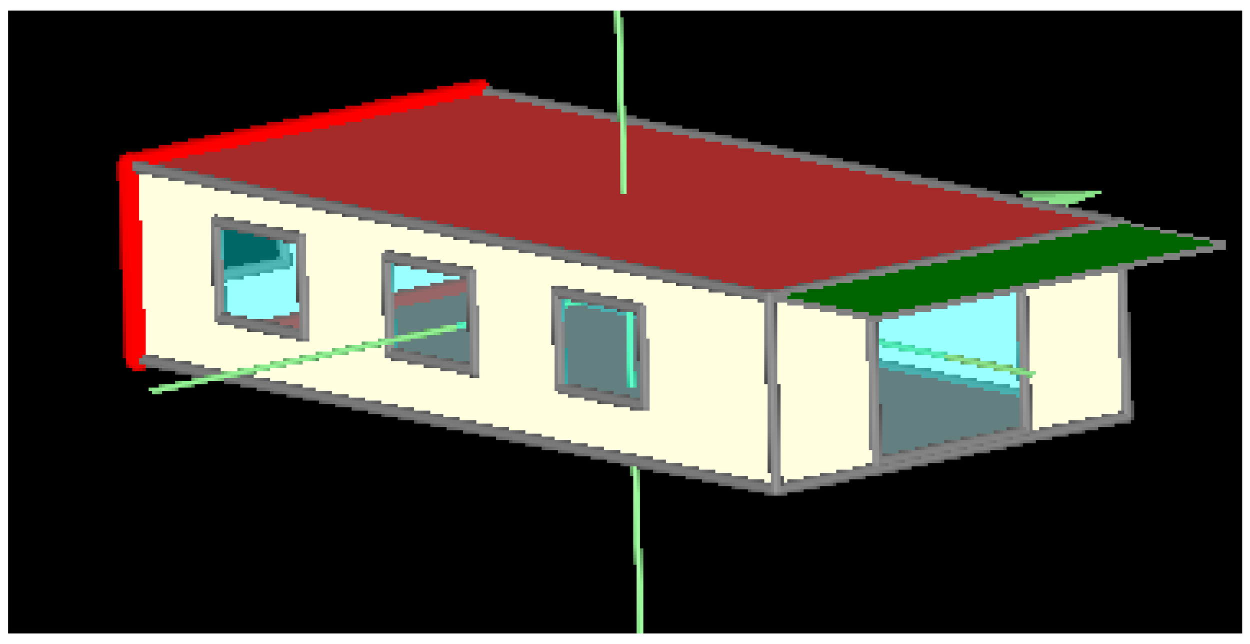
Parametric Analysis of Passive Design Strategies

Parametric Analysis of Thermal Comfort and Heating Energy Demand in Zurich Using Dynamic Building Simulation

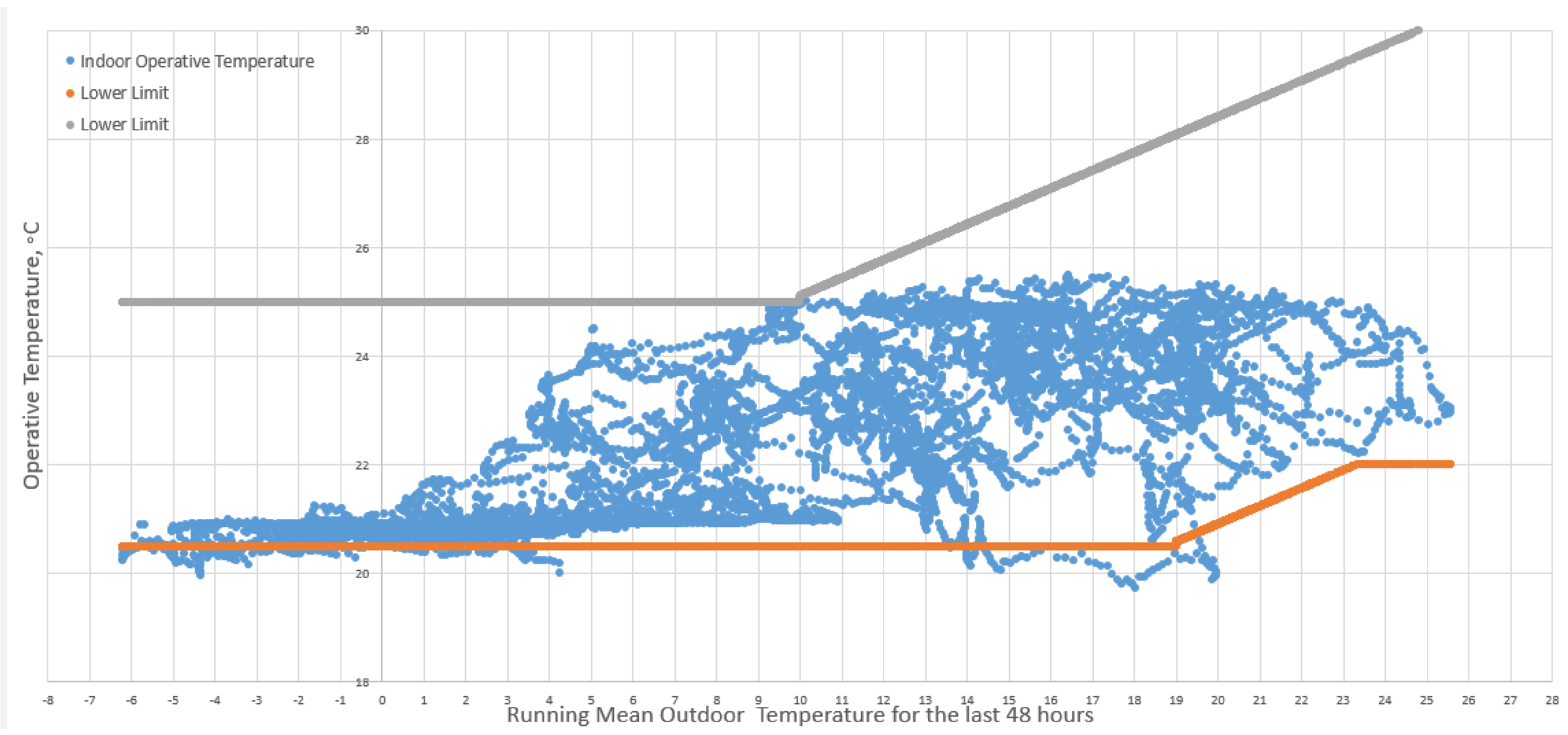


Passive Solar Design

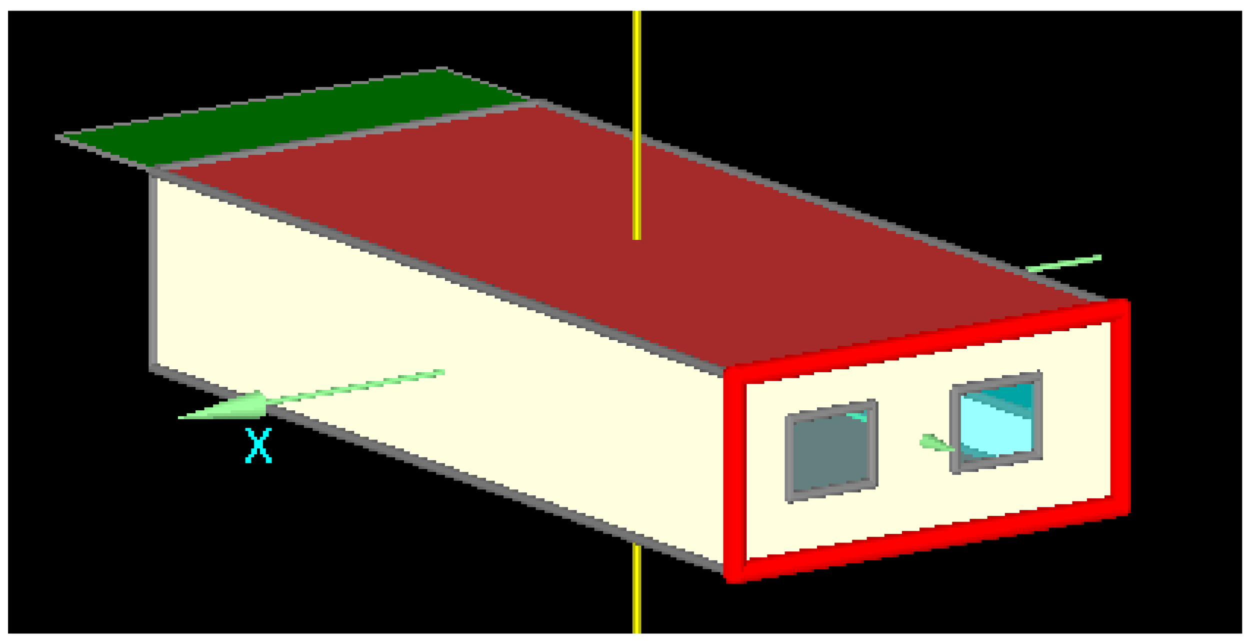
Source: Passive Solar Design | Inhabitat - Green Design, Innovation, Architecture, Green Building



reference case WUFI®Plus model



Adaptive thermal comfort assessment according to SIA 180



reference case WUFI®Plus model

Introduction

The building sector is responsible for a substantial share of global energy consumption and greenhouse gas emissions. In Switzerland, increasing thermal comfort expectations, stricter energy regulations, and projected climate change are creating new challenges for the design of residential buildings. While highly insulated building envelopes and efficient HVAC systems can reduce energy consumption, many buildings remain dependent on active systems to maintain comfortable indoor conditions.

Passive design strategies offer the potential to reduce thermal loads before mechanical intervention is required. However, the relative influence of passive measures remains highly dependent on local climatic conditions and building characteristics. Furthermore, the effectiveness of these strategies under future climate scenarios is not yet fully understood. Therefore, there is a need for systematic investigations that quantify the impact of passive design parameters on thermal comfort and energy performance in residential buildings.

Solution Concept

To address this challenge, a residential apartment building located in Zurich, Switzerland, was modelled using the dynamic building simulation software WUFI® Plus. A parametric simulation approach was adopted to evaluate the influence of key passive design parameters on indoor thermal comfort and annual heating energy demand.

Results

The simulation results demonstrated that passive design parameters significantly influence both indoor thermal comfort and building energy performance. Shading strategies and night-time ventilation proved particularly effective in reducing overheating risk and lowering indoor operative temperatures during warm periods. Window-to-wall ratio and façade orientation strongly affected solar gains and temperature distributions, highlighting the importance of façade design in passive buildings.

Conclusion

The findings demonstrate that optimized passive design can substantially improve thermal comfort while reducing operational energy demand in residential buildings. The study highlights that no single passive strategy provides optimal performance under all conditions; instead, the most effective solutions result from the integration of multiple design measures. Combining appropriate glazing design, external shading, night-time ventilation, and high-performance building envelopes produces the most robust thermal performance.

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