HSLU Lucerne University of Applied Sciences and Arts

Engineering and Architecture
BSc. Energy and Environmental Systems Engineering
Bachelor-Thesis

Optimizing Passive Houses with Building Energy Simulation at Locations of Palma and Zurich

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1. Background, Challenge & Objectives

Background / Context
The importance of sustainable housing and energy efficiency is globally recognized due to escalating environmental challenges. The thermal performance of a building, influencing energy use, air quality, and comfort, is pivotal in this context. Palma de Mallorca and Zurich, with distinct climates, serve as ideal locations for comparing these aspects by studying the thermal behavior of two houses under varying conditions. This analysis can offer crucial insights into climate-responsive building design.

Challenge / Research Questions
The challenges underlying this research involve identifying and quantifying the effects of certain design and construction parameters on the thermal performance of residential buildings in different climates. Understanding the effects of various parameters and how do they influence the thermal behavior of houses and to what extent.

Objectives / Hypotheses
1. Determine the thermal performance of two simple houses in Palma de Mallorca and Zurich under base conditions and upon variation of specific parameters.
2. Analyze and compare the influence of changing parameters
3. Understand the extent to which climatic conditions in Palma de Mallorca and Zurich impact the effectiveness of various thermal performance strategies

2. Methodology / Materials

Methodology

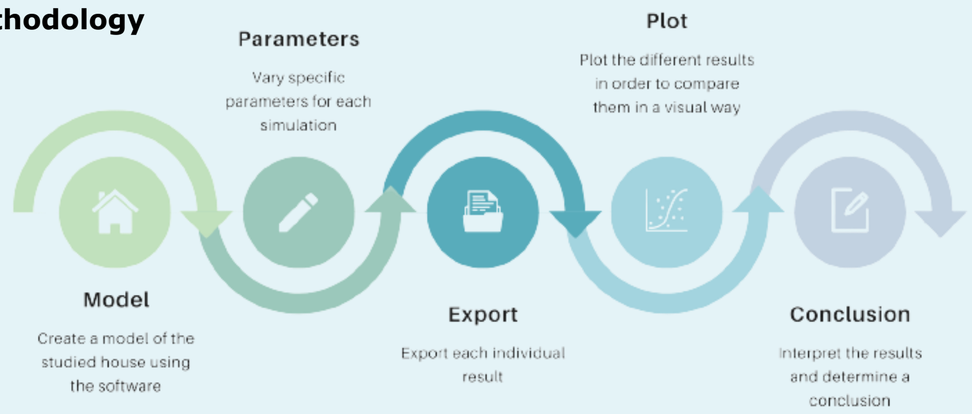

Figure 1: *Steps followed along the process*

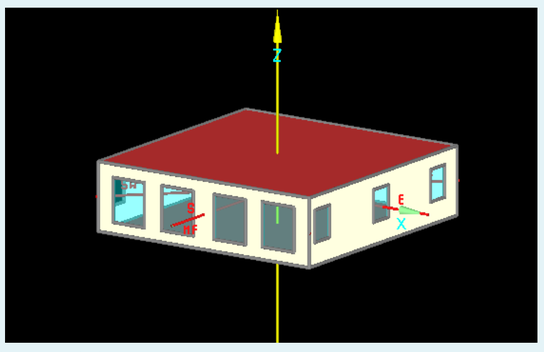

Figure 2: *WUFI ® Plus model*

Materials / Data / Tools
- WUFI ® Plus Software
- Excel
- Comparative analysis
- Normative and standarts for comfort
- Modelling programmes (for a 3D model)

3. Results / Solution / Recommendations

RESULTS 1:

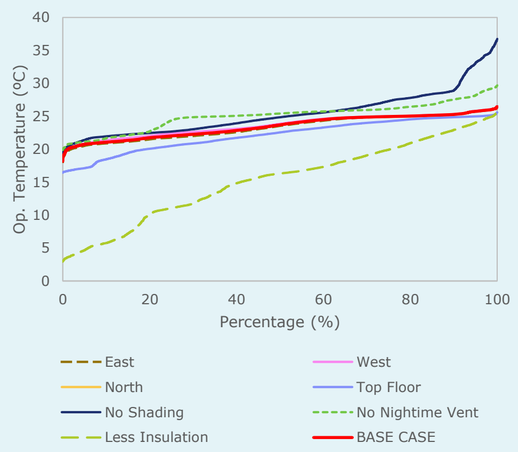

Figure 2*. Cumulative frequency of operative temperature in Zurich*

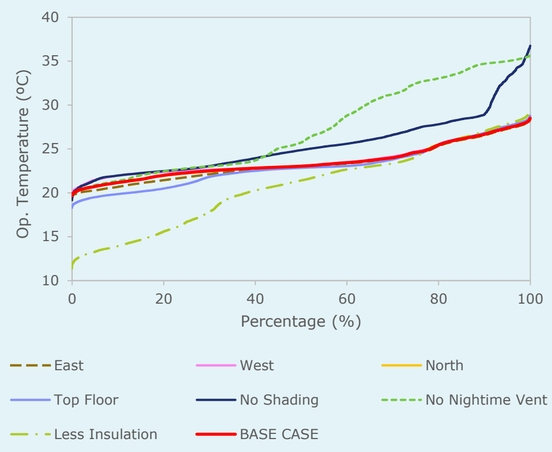

Figure 3*. Cumulative frequency of operative temperature in Palma de Mallorca*

RESULTS 2:

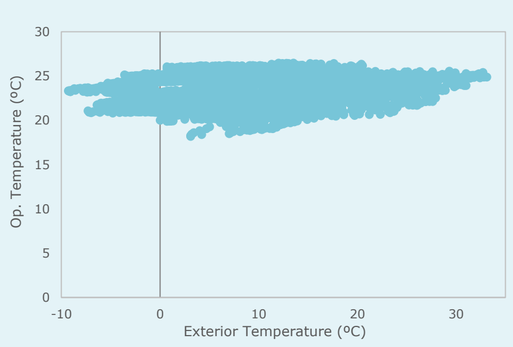

Figure 4*. Operative temperature VS. Exterior temperature in Zurich*

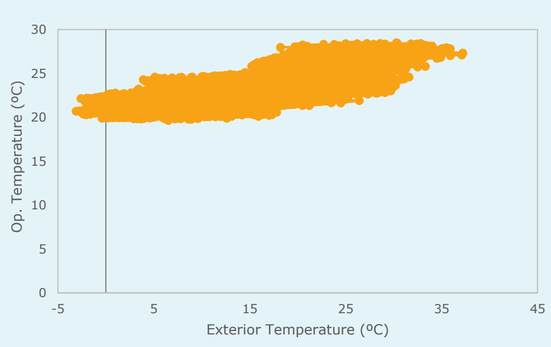

Figure 5*. Operative temperature VS. Exterior temperature in Palma de Mallorca*

4. Discussion, Conclusions & Outlook

Discussion & Conclusions
The base case simulations have indicated promising outcomes, evidencing the viability of achieving thermal comfort and energy efficiency in varying climatic conditions. The stability of the internal temperature within the prescribed limits, as a result of passive design principles, underscores their substantial contribution to enhancing living comfort. Furthermore, the parametric exploration revealed the key roles of window shading, insulation, and night ventilation in sustaining thermal comfort and reducing energy consumption. By embedding these insights into future architectural practices and policymaking, we can move closer to a more sustainable built environment.

Outlook
In light of future research, it would be advantageous to conduct an exhaustive examination of the individual parameters specific to each residence, which collectively delineate its energy performance.

Literature

- Manz, H., Micallef, D., Borg, S. P., & Buhagiar, V. (2018). A parametric building energy simulation case study on the potential and limitations of passive design in the Mediterranean climate of Malta. Sustainable Buildings, 3, 4. https://doi.org/10.1051/sbuild/2018004
- Samuelson, H., Claussnitzer, S., Goyal, A., Chen, Y., & Romo-Castillo, A. (2016). Parametric energy simulation in early design: High-rise residential buildings in urban contexts. Energy and Buildings, 117, 1-12. https://doi.org/10.1016/j.enbuild.2016.01.042

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