Developing a benchmark model and characterization of nearly zero energy school buildings in Belgium

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ABSTRACT

The aim of this study is to develop a benchmark model for Belgian nearly zero energy schools (nZES) and Passive house (PH) schools . It reflects the cost, average energy consumption, indoor overheating hours and CO_2 concentration.

The collected surveyed data used as an input for Energy-Plus simulation model that is representative of buildings.

The calibration of the simulated model is by comparing the data found in the survey done on existing buildings with the simulation result.

KEYWORDS

Air quality, energy efficiency, sustainability, thermal comfort, wellbeing, monitoring and simulation

PROBLEM

Some certified passive schools that have been built in Flanders region of Belgium suffer from overheating and CO_2 concentration.

OBJECTIVES

- Typology analysis
- Conducting field survey and monitoring the Temperature, humidity, CO2 Concentration and end use energy patterns as well as energy cost
- Identifying occupancy schedule for investigated buildings
- Creation of an up to date benchmark model of nearly zero energy schools in Belgium
- Validating the simulation output by comparing the result with real set of data obtained from monitoring and surveys.

AUDIENCE

Building designers and engineers, educational administrates, students and teachers,

RESEARCH QUESTION

- Are nearly zero energy schools in Belgium suffer from overheating?
- Are they suffer from unhealthy level of CO_2 concentration in classes?
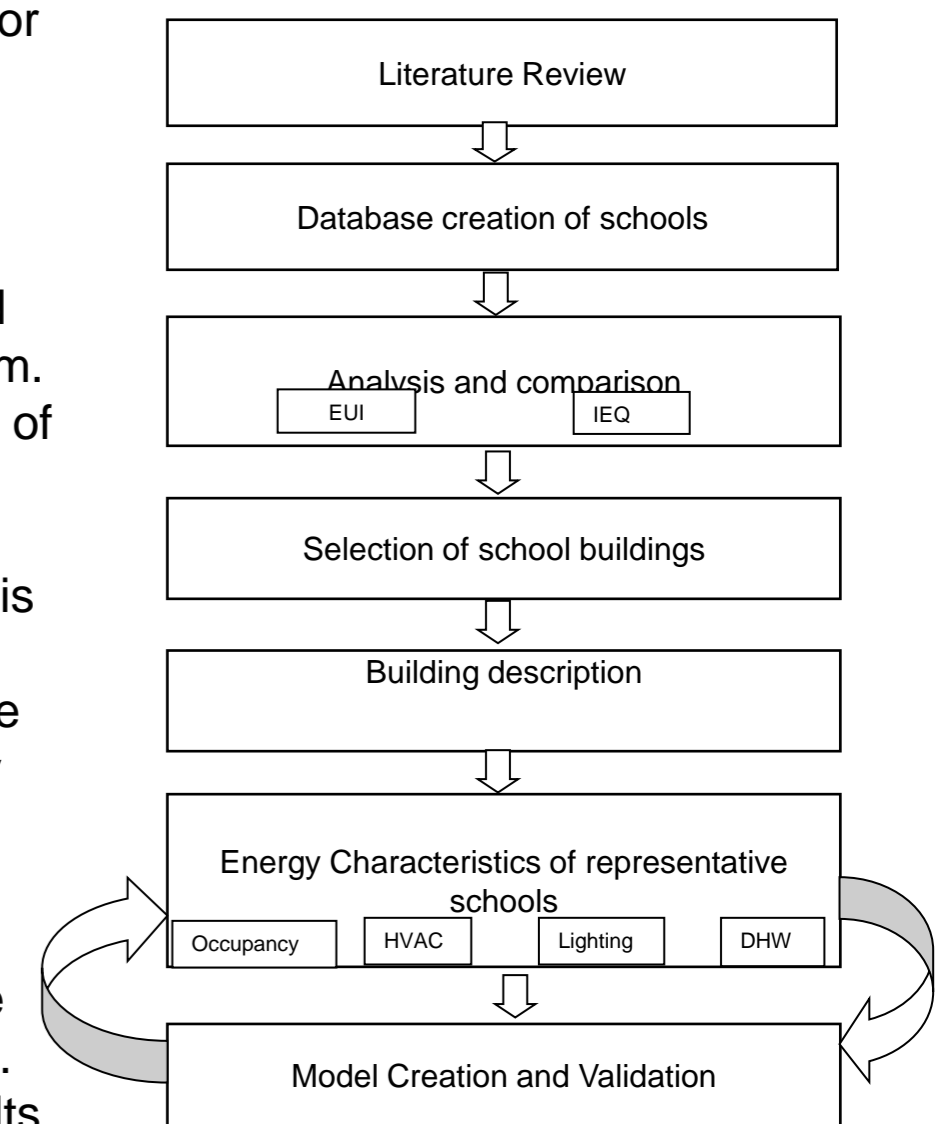- Does energy efficiency effect comfort?

ORIGINALITY

This study is distinct from previous similar studies because it is mainly focus on nearly zero energy schools built after year 2008.

This benchmarking is multi criteria including both energy intensity and indoor air quality
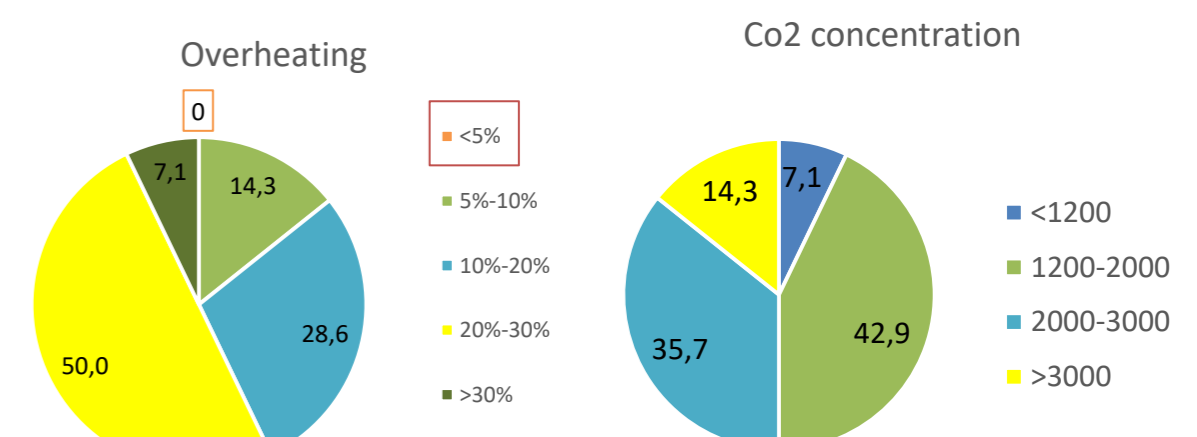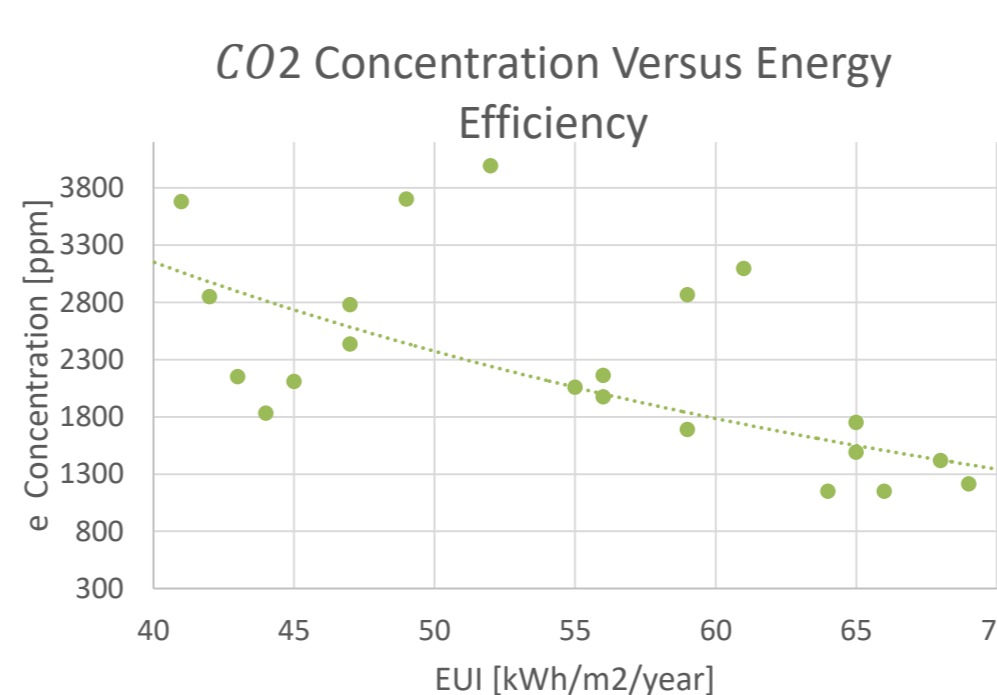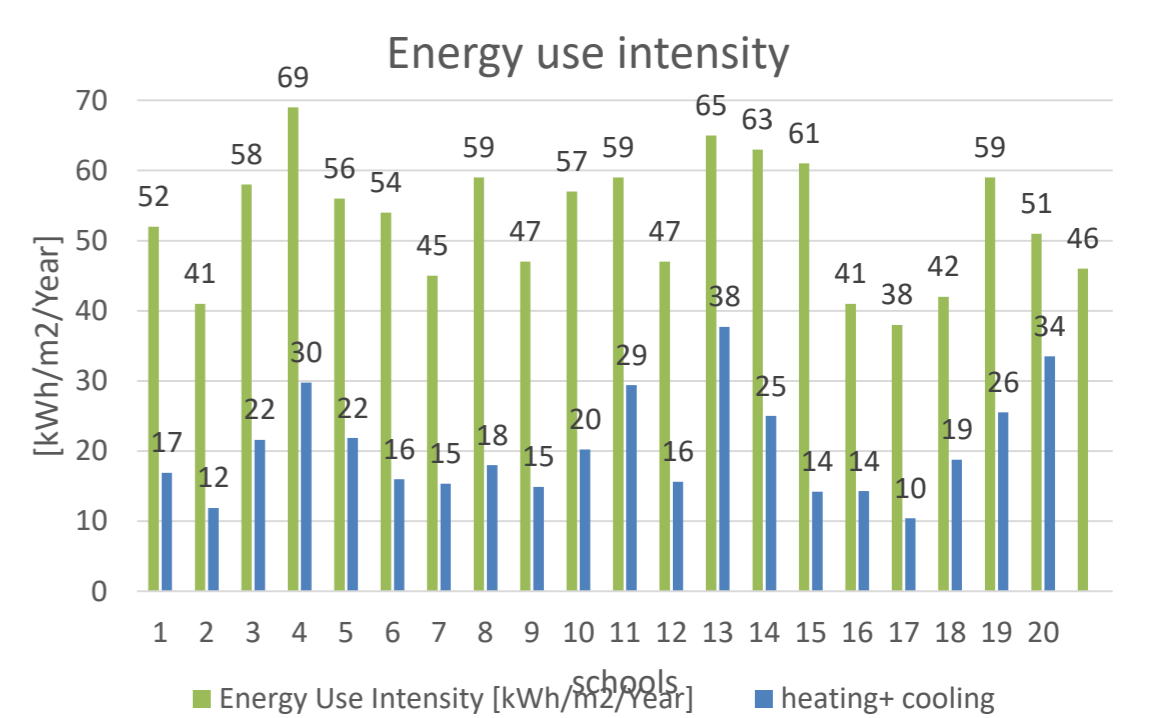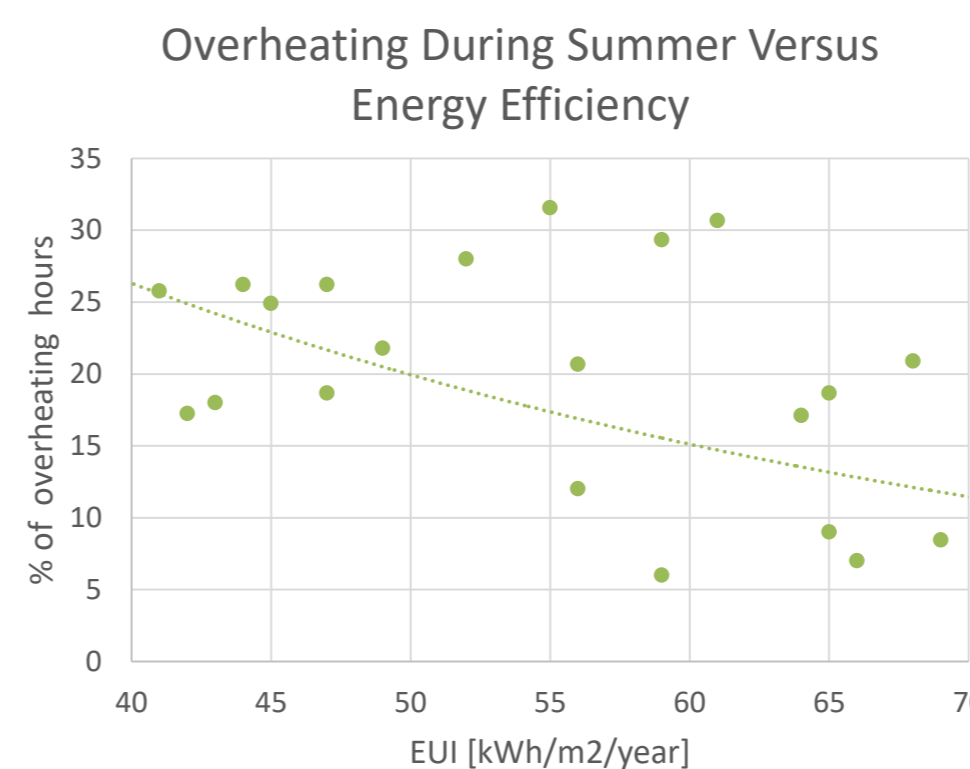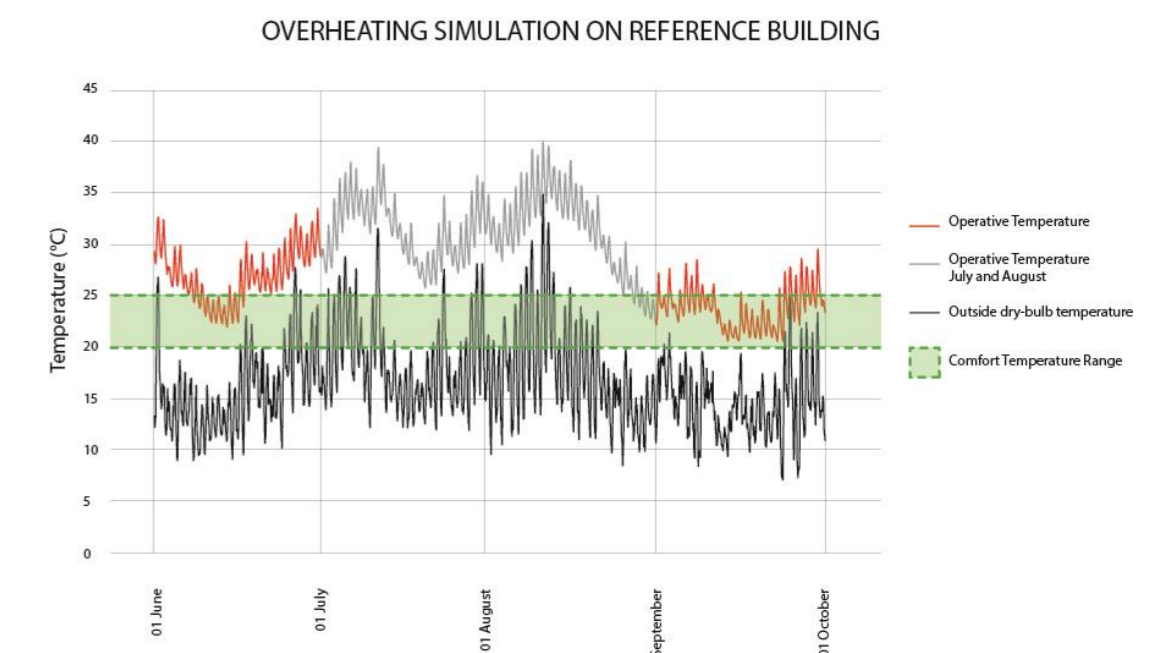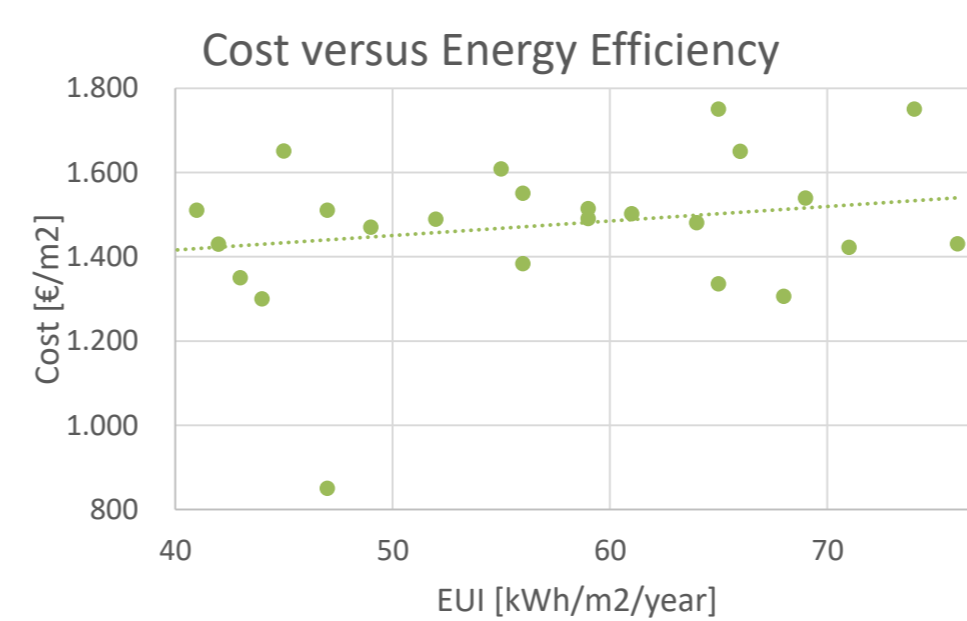
The case studies are built in Belgium. Therefore it is geographically distinct from other previous similar studies

METHODOLOGY

The first step is to review all literatures relevant and useful for the study. This step is followed by collecting data from a survey and making a database for schools. The survey plan included a description of a comprehensive set of building construction, equipment, energy use intensities, IEQ and dimensions. These data have been analyzed and compared to have general view about the statistics in nZESs in Belgium. Two building types have been selected based on age range of the students because the comfort preferences of children differs from adults. So the buildings have been grouped in two, one primaries and secondary schools. Typology analysis and average values of building characteristics and energy intensity led us to choose a benchmarks for each group. The characteristics of the school buildings have been defined by walk through survey and monitoring. CO_2 concentration, temperature and humidity inside classroom has been monitored using data loggers. Using processed data we created the benchmark models in DesignBuilder, we ran the simulations and calibrated the models using monitored data. Finally, the validation of the model is by comparing the results with real data.

Literature Review → Database creation of schools → Analysis and comparison (EUI, IEQ) → Selection of school buildings → Building description → Energy Characteristics of representative schools (Occupancy, HVAC, Lighting, DHW) → Model Creation and Validation

RESULTS

Cost versus Energy Efficiency

Overheating During Summer Versus Energy Efficiency

CO_2 Concentration Versus Energy Efficiency

OVERHEATING SIMULATION ON REFERENCE BUILDING

Energy use intensity

Overheating

Co2 concentration

CONCLUSION

- The passive schools in Flanders are suffering from overheating.
- Co2 concentration is high in the classes which is detrimental to the efficiency of the cognitive performance of the pupils.
- It is possible to improve the future school building design by evaluate existing buildings by doing post occupancy evaluation

RESOURCES

Attia, S., Evrard, A., & Gratia, E. (2012). Development of benchmark models for the Egyptian residential buildings sector. Applied Energy, 94, 270-284.
Zhang, D., Ortiz, M. A., & Bluyssen, P. M. (2019). Clustering of Dutch school children based on their preferences and needs of the IEQ in classrooms. Building and Environment, 147, 258-266.

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