Energy efficiency characterization of post-World War Belgian residential buildings

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ABSTRACT

The aim of this study is to develop an energy performance data set characterizing the Belgian post-World War II residential building stock and two building performance simulation benchmark models in EnergyPlus as a base of the development of targeted renovation strategies. The study reports the results of a field survey conducted on 355 detached houses built between 1945 and 1990. An analysis of monthly energy consumption is carried out for the occupancy period of 2015-2019. The simulated results are checked and validated with the monitored data and owner's bills.

KEYWORDS

Energy audit, Reference building, Building typology, Multi-zonal dynamic simulation, Energy use intensity

PROBLEM

In Belgium, residential sector is responsible for 14% of total greenhouse gas emissions. Moreover, the Belgian housing stock has the characteristic of being a very old stock, with 75% of the buildings that were built before 1980, without any environmental requirements. It constitutes therefore a stock under renovation pressure and rarely has any heritage value. The park therefore needs to be characterized in order to evaluate the renovation potential for reducing significantly the greenhouse gas emissions by undertaking targeted renovation strategies.

OBJECTIVES

- Visit and carry out field surveys and energy audits on selected 355 houses built between 1945 and 1990;
- Develop a general database and an energy performance data set for these houses;
- Identify 2 representative typologies and create 2 reference building performance simulation benchmark models with EnergyPlus;
- Calibrate and validate the model by comparing the simulated results with real consumptions and public statistics;
- Propose general renovation strategies.

AUDIENCE

PEB review committees (3), Building engineering and sustainable development offices, Building owners, Energy companies.

RESEARCH QUESTIONS

What are the most representative typologies of post-World War residential houses in Belgium? What are their energy and material characteristics? Do these houses have a real potential for renovation in order to reduce their energy consumption?

ORIGINALITY

- The study is based on a real reference model taking into account the real behaviour of a sample of 355 houses and not only statistics nor experts' assumptions as usually done;
- The study combines the occupant's behaviour and the building characteristics deeply to create the most representative model;
- Field study and not theoretical: very large investment in data collection.

METHODOLOGY
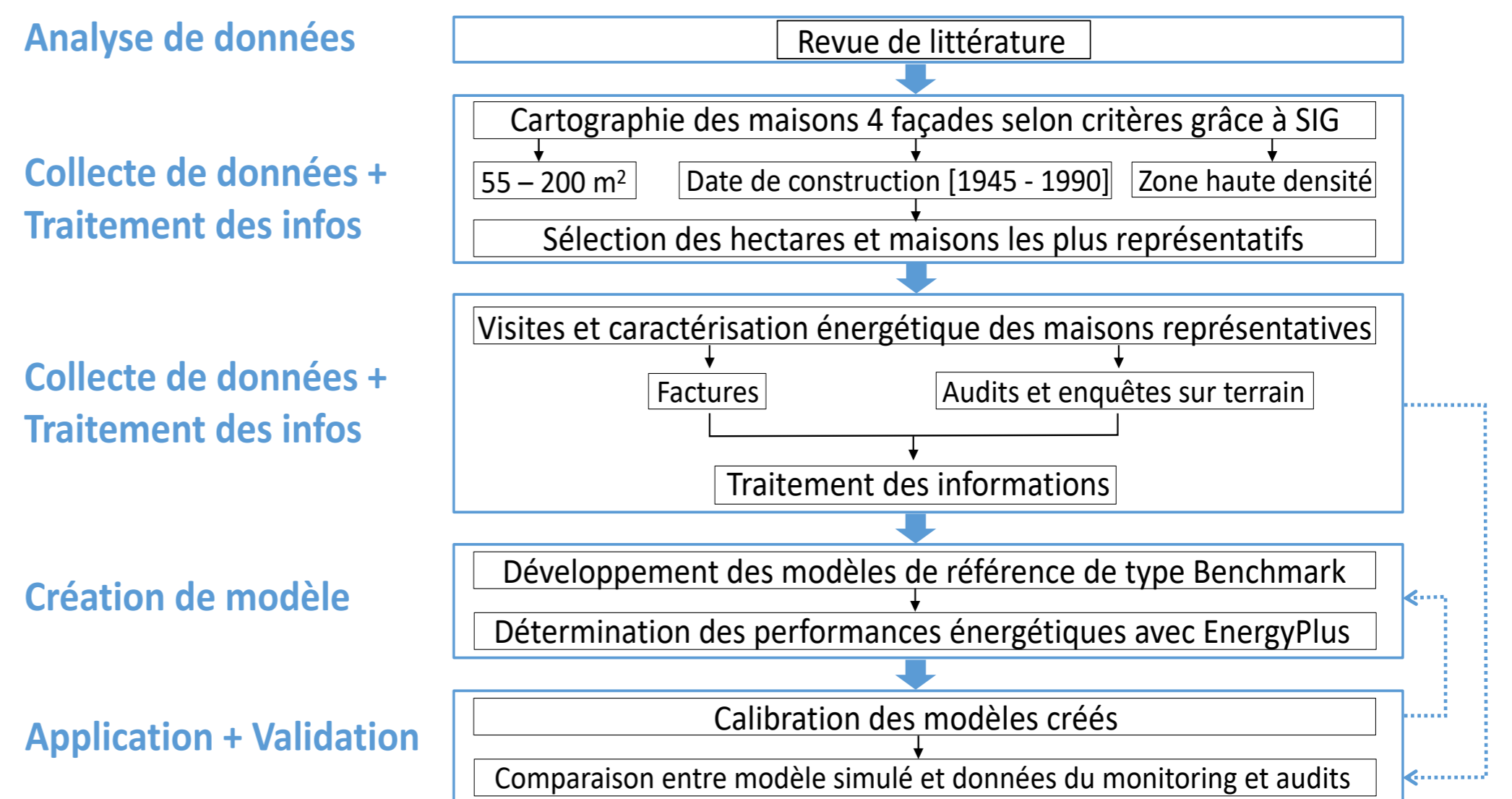
RESULTS
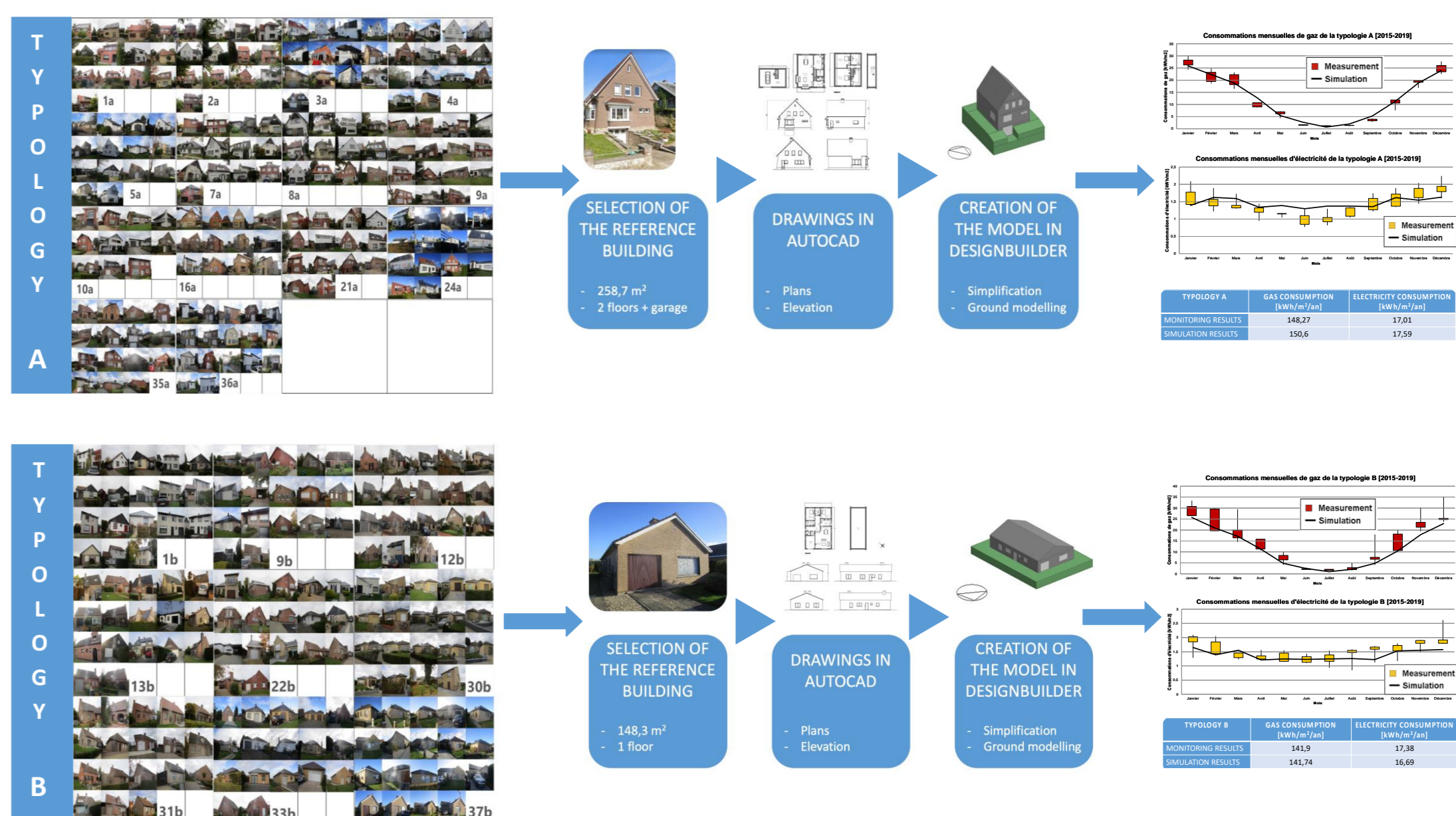
CONCLUSION

- The results show that both typologies representing the building stock of houses built between 1945 and 1990 in Belgium are characterized by a very low energy efficiency and need to be renovated;
- The main reasons of this low energy performance are: Building facades and roofs are almost always uninsulated and have very poor airtightness. The windows are made of poorly performing double glazing and old wood frames. Renewable energy systems are mostly absent and gas heating and domestic hot water systems have a low coefficient of performance. The houses have no cooling system;
- Observations also revealed that this old building stock has a very significant potential for renovation in the near future. The most influential factor in the decision to carry out a major renovation has been identified as the transfer of ownership and the average age of the owners for both typologies is 72,5.

MAJOR REFERENCES

Attia, S., Evrard, A., & Gratia, E. (2012). Development of benchmark models for the Egyptian residential buildings sector. *Applied Energy*, pp. 270-284.

Attia, S., Shadmanfar, N., & Ricci, F. (2020). Developing two benchmark models for nearly zero energy schools. *Applied Energy*,

Cyx, W., Renders, N., Van Holm, M., & Verbeke, S. (2011). *IEE TABULA - Typology Approach for Building Stock Energy Assessment.*

SPW-DGO4 Département de l'Energie et du Bâtiment durable. (2013). *CO-ZEB*

Van de Voorde, S. (2015). *Post-war building materials in housing 1945-1975.* Brussels: Vrije Universiteit Brussel

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