# Zero Energy Lightweight Construction Households for Urban Densification


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## Research Information


### Keywords
Roof Stacking, Lightweight Construction, Urban Densification, Zero-Energy


### Introduction / Context
Belgium, like many European Countries, has a serious challenge in the housing sector. The Federal planning bureau estimates the increase of the population by one million inhabitants by 2030, which represent 600,000 additional family requiring accesses to new housing facilities [1]. There is a significant housing shortage for individual, single parent families, seniors and students. Population ageing (mainly due to increase life expectancy) combined with a constant grow rate of individuals living in collective households, leads to a substantial increase of demand of collective households [2]. Furthermore, the stringent European performance environmental regulations for the building sector require that by 2020, all new construction are zero or nearly zero energy, (equivalent to 15 kWh/m2/year), with 60% efficient on-site coverage by renewable energy. The shortage of vacant land and the increasing energy performance requirements is pushing the idea of urban densification and zero energy construction households.

### Question / Goal
The goal of this research is to increase urban density, expand cost-effective housing opportunities and provide leadership to accelerate the transformation towards a low carbon community. The focus aim is to demonstrate validated design prototypes and products of different zero energy, timber frame construction systems and composite components.

### Hypothesis / Methodology
The research project passes by five main steps corresponding to five different work packages (figure 2). The first step focuses on the classification and characterization process of the existing building stock. The aim is to identify the potential densification opportunity and roof stacking in Liege (figure 3) . Then, a multi-criteria requirement will be set to identify the target performance needed by the newly built additional floors to meet the passive house standards and building regulations in Liege. That step is followed by the selection of one case study and a prototype development. Once the design is approved, simulation and multi-criteria optimization will be conducted to the prototype to achieve the highest performance in terms of energy, emissions and structure. Lastly, a 3D model for the final prototype will be built and construction joints will be tested.

### Conclusion
This research addresses the potential of roof stacking in the city of Liege as a sustainable approach for urban densification and reducing carbon emissions. This research presents a state of the art the integration of roof stacking, lightweight construction and zero energy building (figure 4). A validated prototype will be presented to inform and support the decision making for policy makers, municipalities, developers, and architects and building engineers in Belgium.

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## References


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[3] Attia, S. (2015). Overview and recommendation on urban densification potential in Liege, Belgium. Proceedings of International conference on high-quality retrofit and redensification with timber construction systems, Ökosan 15 Conference, 17-19 June 2015
[4] INS. (2015). Belgian Federal Government Statistic. Retrieved from statbel.fgov.be/en/statistics/figures/



**Fig. 1:** Depicting an imaginary for densification in the city of Liege

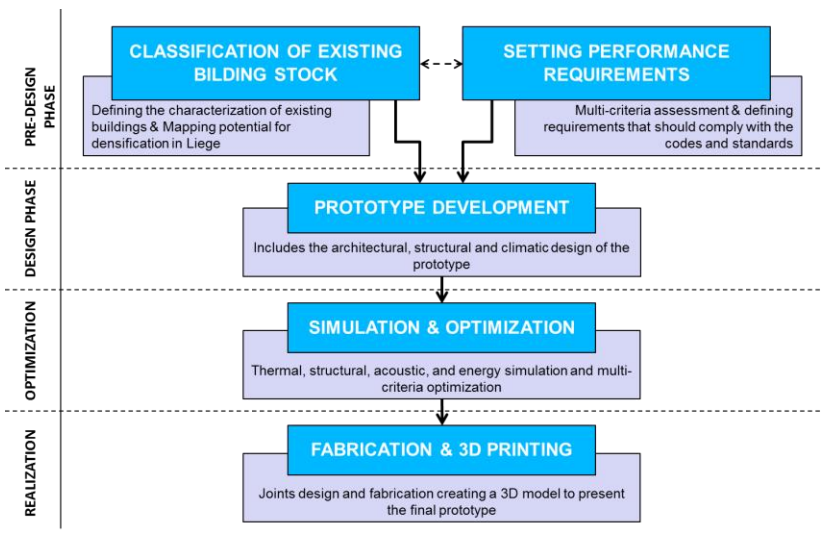


**Fig. 2:** Research Project methodology (Author)

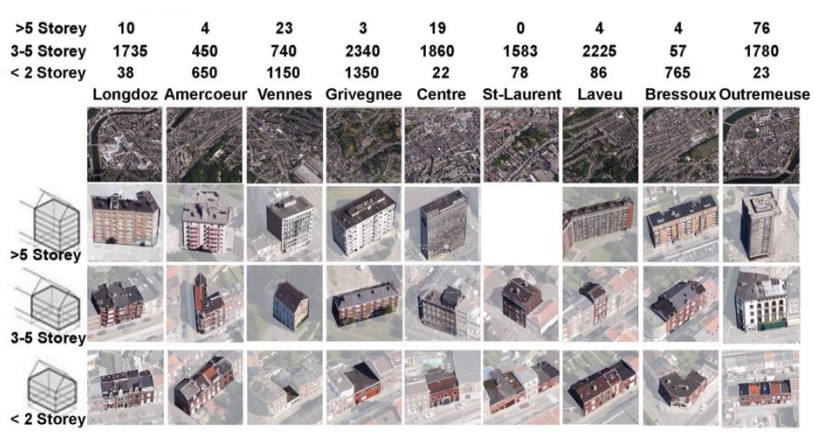


**Fig. 3:** Residential buildings classification in 9 of Liege's' neighborhoods [3,4]

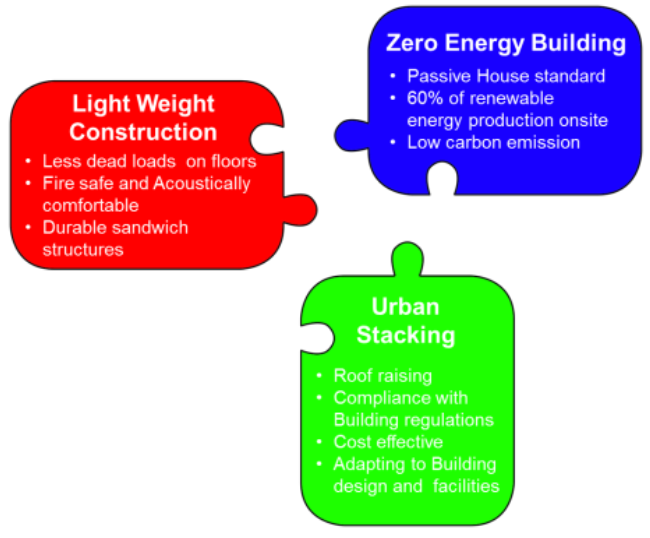


**Fig. 4:** State-of-the-Art integration of Urban stacking, lightweight construction and zero energy building (Author)