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A systematic approach to sustainable urban densification using prefabricated timber-based attic extension modules

Stefan Jaksch[a], Angelika Franke[a,]*, Doris Österreicher[b], Martin Treberspurg[b]

[a]*alpS GmbH, Grabenweg 68, 6020 Innsbruck, Austria*
[b]*University of Natural Resources and Life Sciences, Gregor-Mendel-Straße 33, 1180 Wien, Austria*

Abstract

Urban agglomerations are growing rapidly worldwide. Building additional living quarters has to be complemented by refurbishment and urban densification actions. In this context, attic extensions offer a high potential to increase urban density. At the same time, modern refurbishment projects have to improve the living comfort and energy efficiency of our buildings.
The objective of the research project 'Attic Adapt 2050' is the development of a low cost, lightweight attic-extension-system, applicable to a great number of buildings of the same construction type. Its primary goal is the creation of a timber-based, industrially prefabricated system with integrated renewable energy components and a highly efficient thermal envelope. Vienna's social housing buildings from the 1950s – 70s provide both an uniform building typology and low density – offering a high potential for ecological and economical urban development.
Due to the typological design of post-war residential buildings, the described system can be adapted to many similar building types across Europe. It thus provides a suitable and low cost solution for highly efficient refurbishment and densification in Vienna – and elsewhere.

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Keywords: Refurbishment; Urban densification; Prefabrication; Post-war residential buildings; energy efficiency

* Corresponding author. Tel.: +431-47654-87532 ;
E-mail address: angelika.franke@boku.ac.at

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1. Introduction

The growing population in our cities requires additional living space. Lots for new buildings are not always available or cannot cover the overall need – therefore new strategies for urban densification are essential as well. Attic extensions offer a great potential in this context: creating additional housing space while taking advantage of existing infrastructure. In many European capitals, attic extensions are particularly well established in refurbishments of late 19th century buildings in privileged city locations, where high real estate prices have made them attractive for investors. However, the densification potential of buildings from other construction periods has not yet been fully recognized. In Vienna, the city's social housing buildings from the post-war era seem especially suited for a systematic densification approach, due to their low housing density and standardized layout schemes.

As refurbishments of social housing buildings are typically carried out under inhabited conditions, minimizing disturbances for residents is a key requirement for successful refurbishment actions. By using a high degree of prefabrication, highest standards of quality as well as the abbreviation of the construction process to a minimum can be ensured. The prefabricated modules also enable the pre-implementation of renewable energy systems such as PV or solar thermal collectors. Integrated planning methods enable the design of modular building components that are suitable for different use scenarios within a specific building of the identified building type. As an interdisciplinary research project, 'Attic Adapt 2050' provides an in-depth analysis of the structural and thermal behavior of the proposed attic extension system under different boundary conditions [1]. A showcase project will not only aid in understanding the technical issues, but shall serve the purpose of convincing authorities and inhabitants alike of the advantages of the planned measures. Due to the typological design of post-war residential buildings, the described system can be adapted to many similar building types across Europe. It thus provides a suitable and low cost solution for highly efficient refurbishment and densification in Vienna – and elsewhere.

Urban densification in the form of attic extensions in Vienna has largely been focused on the 'Gründerzeit' buildings, located mostly in central quarters of the city. Due to restricted rents for pre-1945 buildings, these attic extensions and their subsequent sale or lease initially made large-scale refurbishment actions in these buildings affordable. Added benefits such as terraces and views over the city skyline as well as a high demand for living space made these attic extensions attractive investments and triggered a wave of developments, mostly in the high price segment of the market. At the other end of the market, the densification of post-war social housing developments has so far been hardly exploited. Focusing on this building stock for large scale refurbishment and urban densification actions has however advantages: The post-war social housing sector represents a high share of building types, which are very similar in shape and construction. Through their similar layout, these building types are highly suitable for prefabrication, allowing economical and fast paced construction.

In the Austrian Climate Strategy 2007 as well as in the Austrian Energy Strategy, a refurbishment rate of at least 3% has been defined, so far it has still not passed the 1% mark though [2]. Utilizing the building stock of the post-war years within the yet largely untapped social housing sector by improving its quality and thus energy efficiency combined with urban densification, will significantly support the climate goals.

Based on their year of construction, external shape and urban setting, the post-war social housing building types can be split into different typologies (cf. section 2.1 & Fig.1). Many of these buildings have been refurbished at some point; however some as far back as the 1980s with building standards adequate only for that time. Some of these buildings have so far never been refurbished. Assessing exemplarily the most common building typologies for their potential of attic extensions, the largest building type 1950.1 would allow roughly 150.000m^2 of available attic extensions, while the 1960.1 type would allow for approximately 190.000m^2. Assuming that the total floor area of the attic would be 10% smaller than a typical floor, there is still a substantial potential for the creation of additional living space.

Based on the fact that even with different building types, the overall layout, standard-dimensions and use of materials were fairly similar throughout the post-war construction era, modular lightweight and prefabricated timber-based elements can provide a sound and highly replicable solution for attic extensions of this building stock. Following this assumption, the research questions that have been assessed in the 'Attic Adapt 2050' project can thus be summarized as follows: