

Chapter 7

Improving the Design of Energy-Efficient Building Retrofitting: Design Guidelines, Energy Simulations, and Selecting of Technologies

Mari Aino Hukkalainen

VTT Technical Research Centre of Finland Ltd, Finland

Krzysztof Klobut

VTT Technical Research Centre of Finland Ltd, Finland

Tarja Mäkeläinen

VTT Technical Research Centre of Finland Ltd, Finland

Vanda Dimitriou

Loughborough University, UK

Dariusz Leszczyński

E&L Architects, Poland

ABSTRACT

Practical guidelines are presented for improved process for design and retrofitting of energy-efficient buildings, with an aim to integrate buildings better with the neighbourhood energy system, among others through energy matching. The chapter describes the role of energy simulations in an integrated building retrofitting process and how to select technologies for the retrofitting toward nearly zero energy building level. Feasibility of performing a holistic analysis of retrofitting options can be increased through the integration of BIM, well populated, and linked databases and a multi-criteria decision-making approach. Multiple-criteria decision-making methods aid taking into account a number of building energy performance and user-preference-related criteria and the trade-offs between the different criteria for each retrofitting option. The real-life viewpoints and benefits of utilising the developed methods and processes are discussed, especially from the Eastern European view.

DOI: 10.4018/978-1-5225-4105-9.ch007

INTRODUCTION

The building should be considered as a composition, whose functionality is affected by its various elements. The functionality of the building is largely dependent on well-functioning structures that also form a framework for building service systems. In the retrofitting process, replacing a single part, e.g. a window, often affects other structures and systems, so its design must involve understanding the factors affecting the entire building performance. The starting point for planning, also for planning of retrofitting actions, should be the prospective end result in terms of a good indoor climate and energy efficiency. Solutions for retrofitting are always case-specific, and they also include cost-effectiveness analyses.

The primary goal of retrofitting is to repair damaged or obsolete parts but the activity can also aim at improving functionality in all aspects. Since the service life of the repaired structure corresponds to a new one after repair, the target level of the correction needs to be set accordingly (Ojanen et al. 2017). According to Ojanen, requirements may also be other than only regulatory requirements, such as clients' wish to have a higher quality indoor climate and lower energy consumption than before. High quality solutions typically reduce energy consumption and increase living comfort, but the success of the action requires that property is considered as a whole (Ojanen et al. 2017). In this contexts, clients must require the designer, contractor and supervisor to have good expertise on retrofitting. Actions for improving of energy efficiency are undertaken almost exclusively at the same time when some construction or technical systems are repaired or renewed, instead of separate activities.

Choices made during the design of the retrofitting will affect for decades, e.g. the energy demand of the building and other maintenance costs. Better energy efficiency extends the lifespan of the building, improves user comfort and can affect the building's value as a property. An appropriately repaired building consumes less energy, which reduces operating costs. Design is encouraged in the direction of introducing long-term passive measures for saving future heating and cooling energy. When designing a retrofitting project, the order of the design should proceed, as far as possible, toward the minimization of energy demand. This includes, among others, actions to reduce heat losses and the need for cooling, to enhance the efficiency of electricity usage, utilize free (passive) energy sources, control the energy demand, and ultimately select appropriate energy sources (potentially produced on-site).

This chapter presents how these design aims can be achieved by using up to date methodological know-how and the new software tools efficiently employing energy simulations. The chapter is structured as follows. Background describes the current use of energy simulations in retrofitting, and how BIM fosters the paradigm change in the building design processes. Then, the main focus of the chapter is described, followed by describing the design science research methodology. An overview of the developed DESIGN4ENERGY methodology is given for designing energy efficient buildings with holistic approach. Next, developed holistic design guidelines are presented, including to-do lists for designers for the retrofitting phase. These are followed by showing, how energy simulations can be utilised in retrofitting, and how to select the retrofitting options. Finally, future research directions are discussed and conclusions summarise the main findings of the presented research.

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/improving-the-design-of-energy-efficient-building-retrofitting/199590

Related Content

Wavelet Transform Modulus Maxima Decay Lines: Damage Detection in Varying Operating Conditions

Andreas Kyprianou and Andreas Tjirkallis (2015). *Emerging Design Solutions in Structural Health Monitoring Systems* (pp. 48-68).

www.irma-international.org/chapter/wavelet-transform-modulus-maxima-decay-lines/139284

Improving the Energy Quality and Indoor Environmental Quality in Retrofit Buildings

Joanna Ruciska (2018). *Design Solutions for nZEB Retrofit Buildings* (pp. 186-208).

www.irma-international.org/chapter/improving-the-energy-quality-and-indoor-environmental-quality-in-retrofit-buildings/199591

A Computer-Aided Conceptual Cost Estimating System for Pre-Stressed Concrete Road Bridges

Nikolaos Fragkakis, Sergios Lambropoulos and John-Paris Pantouvakis (2016). *Civil and Environmental Engineering: Concepts, Methodologies, Tools, and Applications* (pp. 563-575).

www.irma-international.org/chapter/a-computer-aided-conceptual-cost-estimating-system-for-pre-stressed-concrete-road-bridges/144515

A New Design of Intelligent Traffic Signal Control

Fatemeh Daneshfar and Javad RavanJamJah (2015). *Transportation Systems and Engineering: Concepts, Methodologies, Tools, and Applications* (pp. 1686-1702).

www.irma-international.org/chapter/a-new-design-of-intelligent-traffic-signal-control/128741

Business Process Re-Engineering

(2013). *Implementing IT Business Strategy in the Construction Industry* (pp. 118-140).

www.irma-international.org/chapter/business-process-engineering/78010