

# Energy conservation by retrofitting of dwellings

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**Abstract.** This article investigates the impact of energy renovation on the indoor environmental quality of apartment building during heating season. The study was performed in one residential building before and after its renovation. Energy auditing and classification of the selected building into energy classes were carried out. Additionally, evaluation of indoor air quality was performed using objective measurements and subjective survey. Thermal environment and concentration of CO<sub>2</sub> was measured in bedrooms. Higher concentrations of CO<sub>2</sub> was observed in the residential building after its renovation. The concentrations of CO<sub>2</sub> in some cases exceeded the recommended maximum limits, especially after implementing of energy saving measures on the building. The average air exchange rate was visible higher before renovation of the building. The current study indicates that large-scale of renovations may reduce the quality of the indoor environment in many apartments, especially in the winter season.

## 1 Introduction

Most of the residential buildings in Slovakia that were built in the 20th century do not satisfy the current requirements for energy efficiency presented in the national building code. Nationwide remedial measures have been taken to improve the energy efficiency of these buildings and reduce their energy use [2]. However, since the impact of these measures on indoor air quality is rarely considered, they often compromise indoor air quality due to the decreased ventilation and infiltration rate.

The highest development in the housing stock, as a result of economic changes and population growth, was recognized during the second half of the 20th century [1].

The majority of housing in Central and Eastern Europe was constructed from panel technology. The degradation of its quality which has led to its renovation, has become one of the most important measures from an energy-saving point of view.

The aim of the study was to evaluate the impact of basic energy-saving measures on energy demand of the building and indoor air quality in a typical high-rise residential building built in the 1960s in Slovakia.

## 2 Building description

The residential building investigated (Figure 1.) is located in Samorin, Slovakia. It was built in 1964 from lightweight concrete panels. The building was naturally ventilated. Exhaust ventilation was only used in sanitary rooms, such as the bathrooms and toilets. Renovation of the building was carried out in 2015 and included the

following measures: insulation of the building envelope using polyethylene (80 mm), insulation of the roof using mineral wool (120 mm) and hydraulic balancing of the heating system. New plastic frame windows had already been installed in recent over the last years in most of the apartments in the building. [3]

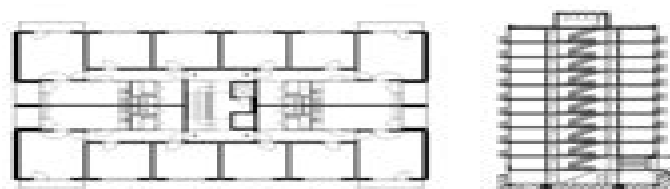


Fig. 1. Floor plan and cross section of the evaluated building



Fig. 2. The evaluated dwelling before and after refurbishment

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# Retrofitting For Energy Conservation

**N Noddings**



## **Retrofitting For Energy Conservation:**

Retrofitting for Energy Conservation William H. Clark (II), William H. Clark, 1997 Convert residences and light commercial buildings from energy wasters to energy efficiency New remodeling codes require improvements in energy efficiency Home and building owners want to reduce their energy costs And now with Retrofitting for Energy Conservation construction and design professionals can discover the most up to date plans methods tools and materials for improving energy conservation in existing structures Almost 85% of energy conserving projects are retrofits according to the National Association of Homebuilders Retrofitting for Energy Conservation gives you the tools you need to meet this demand with step by step help in retrofitting any residence or light commercial building for energy savings From assessing the challenge and offering the client options through initial project design and final execution of the building plan this book gives you solutions that meet and exceed code requirements *Retrofitting for Energy Conservation* Wh Clark, 2014-04-13 Reprint of the popular McGraw Hill how too book Hundreds of no cost and low cost energy saving projects for residential or light commercial buildings Ideal for craftsmen designers architects contractors and the savvy homeowner Each discipline lighting hvac electrical controls motors electrical is organized from the simplest cheapest projects to the most complicated projects No matter what your budget or skill level there are MANY good projects for you The appendix has over 300 one paragraph energy tips for all seasons and situations **Retrofitting of Buildings for Energy Conservation** Milton Meckler, 1994

**Retrofitting Homes for Energy Conservation** NAHB Research Foundation, 1975 *Optimal Design and Retrofit of Energy Efficient Buildings, Communities, and Urban Centers* Moncef Krarti, 2018-03-27 *Optimal Design and Retrofit of Energy Efficient Buildings Communities and Urban Centers* presents current techniques and technologies for energy efficiency in buildings Cases introduce and demonstrate applications in both the design of new buildings and retrofit of existing structures The book begins with an introduction that includes energy consumption statistics building energy efficiency codes and standards and labels from around the world It then highlights the need for integrated and comprehensive energy analysis approaches Subsequent sections present an overview of advanced energy efficiency technologies for buildings including dynamic insulation materials phase change materials LED lighting and daylight controls Life Cycle Analysis and more This book provides researchers and professionals with a coherent set of tools and techniques for enhancing energy efficiency in new and existing buildings The case studies presented help practitioners implement the techniques and technologies in their own projects Introduces a holistic analysis approach to energy efficiency for buildings using the concept of energy productivity Provides coverage of individual buildings communities and urban centers Includes both the design of new buildings and retrofitting of existing structures to improve energy efficiency Describes state of the art energy efficiency technologies Presents several cases studies and examples that illustrate the analysis techniques and impact of energy efficiency technologies and controls **Retrofitting Existing Housing for Energy Conservation** Stephen R.

Petersen,1974      **Old House Eco Handbook** Roger Hunt,Marianne Suhr,2019-09-17 How can we make old houses energy efficient without devaluing future sustainability And how can we do so without compromising their appeal and character This practical and essential guide to retrofitting for energy efficiency seeks to provide answers to this and other questions homeowners of old houses are asking Whether your house is medieval and timber framed or a Georgian Victorian or Edwardian terrace it can be made more energy efficient and sustainable This practical comprehensive and fully illustrated handbook will show you how Revised and updated throughout and with a foreword by Kevin McCloud Old House Eco Handbook includes chapters on the building envelope roofs and ceilings windows and doors walls floors paints energy air and water plus a brand new chapter on retrofit materials In association with The Society for the Protection of Ancient Buildings this is a must have for owners of old houses looking to make their homes more energy efficient and sustainable      Home Retrofitting for Energy Conservation and Solar Considerations ,1981 This manual explains both the key concepts behind our need for and our impact on energy usage as well as a nuts and bolts explanation of how to improve the energy efficiency of your home By reviewing both the concepts and practices of energy conservation the manual presents a comprehensive picture of how home energy use is effected by the inhabitants and by the structure itself The manual begins with an explanation of why we are looking at energy then proceeds to explain how the heat transfer occurs between houses and humans Next is a chapter on energy audits and how to use them followed by a comprehensive section on energy conservation actions to do now to reduce energy use Conservation actions include low cost no cost measures schemes to reduce infiltration how to increase insulation and what to do with windows and doors heating and heat distribution systems and water heaters Solar energy options are then briefly explained as well as the all important issues of financing and tax credits The manual concludes with a bibliography to direct the reader to more sources of information      **Retrofitting of Commercial, Institutional, and Industrial Buildings for Energy Conservation** Milton Meckler,1984      Energy Efficient Building Retrofitting ,2018-05 Nowadays the buildings are responsible for the 40% of the world energy The key aspects to design energy efficient buildings arises from a variety of factors and external pressures such as legislation emissions of ozone depleting gases and public awareness of the pollution of our planet There is a great need among public and private sectors to improve the energy performance of existing public buildings Specifically indoor air quality energy efficiency and thermal comfort conditions are the three main considerations for the good performance of buildings Existing buildings tend to undergo performance degradations change in use and unexpected faults or mal functions over time These events often result in significant deterioration of the overall system performance inefficient operation and unacceptable thermal comfort conditions However a building does not have to be new to be efficient Today s leading building owners are retrofitting buildings and converting existing buildings into models of sustainability Commercial retrofit offers significant opportunities for energy efficiency and sustains ability in the built environment Design of energy efficient and high

performance commercial retrofit requires that building performance and simulation tools are used and integrated with the design process Cost Effective Energy Efficient Building Retrofitting aims to provide building researchers and practitioners with a better understanding of how to effectively conduct commercial retrofit to promote energy conservation and sustainability including real world cases Several general design strategies are provided in the successful completion of sustainable and energy efficient retrofit projects It explores the current market size and why the building retrofit market has not expanded as much in past years Review of past practice and research efforts reveals that though a building retrofit project especially a deep retrofit project is no different than any investment case in business practice past retrofit projects are rarely motivated and convinced by the cost effectiveness of the project but more by building owners desire to green the building

**Deep Energy Retrofit Guide for Public Buildings** Rüdiger Lohse,Alexander Zhivov,2019-04-10 This book provides detailed information on how to set up Deep Energy Retrofits DERs in public buildings and shares in depth insights into the current status of the major technologies strategies and practical best practice examples of how to cost effectively combine them Case studies from Europe are analyzed with respect to energy use before and after renovation reasons for undertaking the renovation co benefits achieved resulting cost effectiveness and the business models employed The building sector holds the potential for tremendous improvements in terms of energy efficiency and reducing carbon emissions and energy retrofits to the existing building stock represent a significant opportunity in the transition to a low carbon future Moreover investing in highly efficient building materials and systems can replace long term energy imports contribute to cost cutting and create a wealth of new jobs Yet while the technologies needed in order to improve energy efficiency are readily available significant progress has not yet been made and best practices for implementing building technologies and renewable energy sources are still relegated to small niche applications Offering essential information on Deep Energy Retrofits the book offers a valuable asset for architects public authorities project developers and engineers alike

*Identifying Retrofit Projects for Buildings* United States. Office of Energy Conservation and Environment,1976

Cost-Effective Energy Efficient Building Retrofitting F. Pacheco-Torgal,Claes-Göran Granqvist,Bjørn Peter Jelle,Giuseppe Peter Vanoli,Nicola Bianco,Jarek Kurnitski,2017-01-03 Cost Effective Energy Efficient Building Retrofitting Materials Technologies Optimization and Case Studies provides essential knowledge for civil engineers architects and other professionals working in the field of cost effective energy efficient building retrofitting The building sector is responsible for high energy consumption and its global demand is expected to grow as each day there are approximately 200 000 new inhabitants on planet Earth The majority of electric energy will continue to be generated from the combustion of fossil fuels releasing not only carbon dioxide but also methane and nitrous oxide Energy efficiency measures are therefore crucial to reduce greenhouse gas emissions of the building sector Energy efficient building retrofitting needs to not only be technically feasible but also economically viable New building materials and advanced technologies already exist but the knowledge to

integrate all active components is still scarce and far from being widespread among building industry stakeholders

Emphasizes cost effective methods for the refurbishment of existing buildings presenting state of the art technologies

Includes detailed case studies that explain various methods and Net Zero Energy Explains optimal analysis and prioritization of cost effective strategies     Retrofitting an Existing Wood-frame Residence for Energy Conservation Douglas M. Burch, Charles Maxwell Hunt, 1978     **A Retrofit Tool for Improving Energy Efficiency of Commercial Buildings** ,2013

Existing buildings will dominate energy use in commercial buildings in the United States for three decades or longer and even in China for the about two decades Retrofitting these buildings to improve energy efficiency and reduce energy use is thus critical to achieving the target of reducing energy use in the buildings sector However there are few evaluation tools that can quickly identify and evaluate energy savings and cost effectiveness of energy conservation measures ECMs for retrofits especially for buildings in China This paper discusses methods used to develop such a tool and demonstrates an application of the tool for a retrofit analysis The tool builds on a building performance database with pre calculated energy consumption of ECMs for selected commercial prototype buildings using the EnergyPlus program The tool allows users to evaluate individual ECMs or a package of ECMs It covers building envelope lighting and daylighting HVAC plug loads service hot water and renewable energy The prototype building can be customized to represent an actual building with some limitations Energy consumption from utility bills can be entered into the tool to compare and calibrate the energy use of the prototype building The tool currently can evaluate energy savings and payback of ECMs for shopping malls in China We have used the tool to assess energy and cost savings for retrofit of the prototype shopping mall in Shanghai Future work on the tool will simplify its use and expand it to cover other commercial building types and other countries     *Cost-Effective Energy-Efficient Methods for Refurbishment and Retrofitting of Buildings* F. Pacheco-Torgal, Claes-Göran Granqvist, Giuseppe Peter Vanoli, Nicola Bianco, Jarek Kurnitski, 2025-01-11 Cost Effective Energy Efficient Methods for Refurbishment and Retrofitting of Buildings Materials Technologies Optimization and Case Studies provides up to date knowledge on this important research field Divided over three key parts the book s chapters cover materials and innovative technologies optimization strategies and actual case study applications that highlight the impact of different climatic conditions social factors and the economic specifications of each retrofit process Emphasis is placed on cost efficiency which is key in any energy retrofit process Taking into consideration key changes in the Energy Performance of Buildings Directive EPBD and the European Union Green Deal on Refurbishment and Renovation this book will be a valuable reference resource for materials scientists architects civil engineers and all those working on cost effective and energy efficient retrofitting and building refurbishment Discusses cost effective energy efficient methods for the refurbishment of existing buildings using state of the art technologies Includes detailed case studies that explain various methods and Net Zero Energy Explains optimal analysis and prioritization of cost effective strategies     *HVAC Retrofits* Herbert Wendes, 1994 Covering the entire

process of retrofitting HVAC systems to achieve energy savings this straightforward guide takes you step by step from the initial walk through audit through the monitoring of results after the retrofit project is complete You ll learn how to estimate labor and material costs for all types of HVAC equipment and systems You ll find out how to convert constant volume systems to variable air volume along with how to calculate the costs of doing so Methods for calculating analyzing and projecting energy consumption in terms of BTU and KW as well as in cost terms are detailed Sample energy retrofit estimates are included along with many time saving reference lists

Energy Design Strategies for Retrofitting A. Boeri,E. Antonini,J. Gaspari,D. Longo,2014-12-15 Providing a coherent and realistic vision of the implications of the energy issue in the future development of our cities places emphasis on the links between very specific and technical topics and the most challenging issues concerning energy savings and the transition to a low carbon society A great part of the built environment in most European cities consists of buildings dating from 60s to early 90s for residential purposes this stock clearly presents several problems related to its functional layout as well as its energy thermal behaviour Applying sustainable and energy savings principles to retrofitting interventions on the stock above is one of the most urgent challenges to be met in the very near future Giving some examples and case studies this book investigates retrofitting interventions in terms of energy balance from design strategies to choice of materials and components from market trends analysis to economical assessment from the targeted energy performance to the energy investments needed for achieving it The reader will benefit from the real life experiences and related results described in this book and acquire all the tools for a constructive evaluation of the different options available to him her when faced with retrofitting interventions thanks to a global view of all the issues involved

**Retrofitting for Optimal Energy Performance** Tantau, Adrian,2019-06-14 Retrofitting expresses in a traditional approach the process of improving something after it has been manufactured constructed or assembled These systems integrate new technologies new functions and new services that increase the energy performance in existing private public and commercial buildings Retrofitting for Optimal Energy Performance is a comprehensive reference source that examines environmentally conscious technologies and their applications in advancing retrofitting practices Providing relevant theoretical frameworks and the latest empirical research findings in the area it highlights an array of topics such as climate change energy management and optimization modeling and is essential for academicians students researchers engineers architects entrepreneurs managers policymakers and building owners

**Applying Energy Conservation Retrofits to Standard Army Buildings: Project Design and Initial Energy Data** ,1988 This report describes the initial and continuing efforts in a project demonstrating the energy performance of theoretically based retrofit packages on as found standard design Army buildings Four standard building designs are being investigated a motor vehicle repair shop the Type 64 L shaped barracks an enlisted personnel mess hall and a two company rolling pin shaped barracks for enlisted personnel The Army has over 840 of these particular buildings The objective of the project is to test the energy and cost performance of the

retrofit packages which include such measures as installing wall or ceiling insulation replacing and or blocking windows partitioning areas of differing temperature modifying air handling equipment modifying boiler controls replacing lights etc To this end energy data has been gathered from retrofitted and identical but nonretrofitted buildings for a test reference comparison Keywords Buildings Maintenance Modification Building codes Energy conservation Structural engineering Retrofitting Rehabilitation Reusable equipment JES



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