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A two-factor method for appraising building renovation and energy efficiency improvement projects

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Abstract

The renovation of residential buildings usually involves a variety of measures aiming at reducing energy and building maintenance bills, increasing safety and market value, and improving comfort and aesthetics. A significant number of project appraisal methods in current use—such as calculations of payback time, net present value, internal rate of return or cost of conserved energy (*CCE*)—only quantify energy efficiency gains. These approaches are relatively easy to use, but offer a distorted view of complex modernization projects. On the other hand, various methods using multiple criteria take a much wider perspective but are usually time-consuming, based on sometimes uncertain assumptions and require sophisticated tools. A 'two-factor' appraisal method offers a compromise between these two approaches. The main idea of the method is to separate investments into those related to energy efficiency improvements, and those related to building renovation. Costs and benefits of complex measures, which both influence energy consumption and improve building constructions, are separated by using a building rehabilitation coefficient. The *CCE* is used for the appraisal of energy efficiency investments, while investments in building renovation are appraised using standard tools for the assessment of investments in maintenance, repair and rehabilitation.

Keywords: Energy efficiency; Buildings; Project appraisal

1. Introduction

During the last 15 years, most Central and Eastern European countries (CEEC) including the Baltic States have made significant progress in restructuring their economies and, in some sectors like telecommunications, are rapidly closing the gap between so-called "old" and "new" Europe. Other sectors are more difficult to restructure. One of the most problematic is the housing sector. Climatic conditions determine that inhabitants of the CEEC spend most of their time indoors, and consequently a substantial amount of energy resources is consumed in buildings. Housing is one of the biggest assets of the CEEC economies accumulated over a period of several centuries. The efficient use and optimization of the value of this property is a challenge for both the owners of individual buildings and societies as a whole.

A significant proportion of the current building stock in the CEEC was constructed between the 1960s and the 1990s. Speedy urbanization and artificially low prices of energy resources were responsible for the relatively poor energy performance of these buildings. Political changes in the 1990s were followed by massive privatizations which resulted, with minor exceptions, in the predominantly private ownership of the housing stock. For example, in Lithuania the ownership rate exceeded 95% at the turn of the century (United Nations Economic Commission for Europe, 2000). Tenants of formerly public housing obtained dwellings at marginal prices, while building maintenance and renovation problems were largely neglected. The new owners of multifamily buildings lacked experience in, and traditions of, property management. As of 2005, only around 20% of Lithuanian apartment owners had established homeowners' associations to take full control of their property. The rest of the multifamily building stock, despite being in private ownership, was maintained by municipal or private companies designated

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by municipalities. Often due to political pressures, these companies collect insubstantial fees and perform only the most urgent repairs. All these circumstances have caused a substantial deterioration of the housing stock and sustained an excessive level of consumption of energy resources.

Continuously increasing energy prices make such wasteful energy consumption an unaffordable burden for income-constrained consumers. The declining quality of multifamily buildings and increasing income segregation also pose a risk that wealthier families will move to higher quality housing, while the remaining apartment owners lack sufficient funds even for routine maintenance. Thus, the existing multifamily buildings could develop into run down refuges for low-income households. It follows that wide-scale modernization of the existing housing stock and improvement of energy efficiency are important tasks for CEEC societies.

Financial resources are limited; they should therefore be used efficiently. Dwelling owners, energy utilities, commercial banks, insurers, energy consultants, housing policy makers and other stakeholders have different and sometimes conflicting interests in housing renovation undertakings. There is therefore a need for an appraisal methodology for building renovation and energy efficiency improvement projects (or a set of methods) which make sense for most stakeholders and at the same time take into account societal interests such as protection of the environment, public health and social cohesion.

As noted by Sarja and Vesikari (1996) and Sarja (2000), housing is a multifaceted phenomenon which is expected to meet human requirements (functionality in use, safety, health, comfort), economic requirements (economy of investment, construction and lifetime), cultural requirements (lifestyle, building traditions, business culture, aesthetics, architectural styles and trends, image), ecological requirements (economy of raw materials, energy, environmental burdens and waste, also biodiversity). The EU Construction Products Directive 89/106/CE requires all structures to comply with six essential requirements: (1) mechanical resistance and stability; (2) safety in case of fire; (3) hygiene, health and the environment; (4) safety in use; (5) protection against noise and (6) energy economy and heat retention. All these aspects must be taken into account considering both building construction and modernization projects.

There are a number of energy efficiency measures such as wall or roof insulation which not only reduce energy consumption but also improve the general condition of a structure. On the other hand, building improvement measures such as replacement of leaking pipes are often needed to ensure the proper performance of installed energy efficiency measures. Sensible renovation packages usually involve a combination of measures aiming at reduction of energy and building maintenance bills, an increase of safety and market value, and the improvement of indoor comfort and aesthetics. Ideally, all these benefits should be taken into consideration when appraising building renovation and energy efficiency improvement projects.

2. Current building renovation assessment methods

There is probably no comprehensive review of appraisal methodologies for renovation projects, and it would perhaps be impractical to compile, but it is likely that techniques quantifying energy efficiency gains would be the most popular. An on-going dispute as to whether improving energy efficiency inevitably leads to a reduction of energy consumption (Herring, 1999) casts a serious shadow over the feasibility of these approaches from the environmental point of view. Nevertheless, the available evidence suggests that even if a significant part of the savings is used for improvement of thermal comfort or related expenditures utilizing energy resources, the rigid nature of the building sector imposes certain restrictions on the "rebound (or takeback) effect" (i.e. increase of service demand when efficiency increases and service becomes cheaper). In their survey, Greening et al. (2000) estimated the potential size of the rebound effect for space heating in the US to be between 10% and 30%. Haas and Biermayr (2000) provided empirical evidence from Austria of the rebound effect between 20% and 30% for space heating. Monitoring of residential buildings renovated in the Energy Efficiency Housing Pilot Project (EEHPP) in Lithuania (The World Bank, 2002) demonstrated average 15–20% actual energy savings despite noticeable increases of indoor temperatures. Comfort improvements annulled around 30% of theoretical savings.

Currently, the most popular methods to quantify benefits of energy efficiency upgrading of buildings are calculations of a simple payback time, net present value (*NPV*), and internal rate of return (*IRR*) of an investment or cost of conserved energy (*CCE*) (Martinaitis et al., 2004). In most cases, only energy savings are included in the economic analysis, while other benefits of building renovation are neglected.

The simple payback time is the most straightforward method to assess benefits of building renovation. The simplicity of this method is counterbalanced by its drawbacks. First of all, the lifetime of an energy saving measure is not taken into account. If the payback time of two measures is the same, that does not necessarily mean that these measures are equally efficient. Their lifetimes can be different and as result, one measure can produce energy savings over longer term than its payback time, while the other measure can last shorter than its payback time. The simple payback time also fails to take account of the costs of borrowing money. Therefore, if implementation of alternative measures is linked to different financing schemes this method cannot be used. Finally, the simple payback time depends on future energy prices, which often are difficult to predict.