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Performance gaps in Swiss buildings: an analysis of conflicting objectives and mitigation strategies

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Abstract

The term "Performance Gap" is used to denote deviations between a building's planned and actual performances. We conducted an international literature search and identified more than 240 relevant references. Here we report our main findings. Currently, mainly the energy performance gap is discussed, which is neither properly standardized or regulated nor precisely defined. In our opinion, the performance gap discussion needs to be extended to the indoor environment and the operation expenses. A more differentiated approach must distinguish between individual buildings and entire building stocks where a statistical interpretation becomes unavoidable. We propose that the evaluation of the building performance should be based on thorough application of statistical methods. At the same time preventions of gaps require an integrated performance and risk management process, for instance through application of the "performance-based building design" and "integrated project delivery" approaches. For Switzerland, this is an invitation to experiment with alternatives to today's economic and contractual practice.

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Keywords: Performance gap, Energy, Indoor Environment, Operational Expenses, System thinking, Stakeholder analysis

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1. Introduction

The "Performance Gap" as the difference between planned and real performance of a building, is a complex and multi-faceted matter that is often treated only in a fragmentary manner. Until recently the issue had received only limited attention in Switzerland [1, 2]. No systematic study for the Swiss building and energy sectors has been made available so far neither for research nor practice.

The performance gap is neither properly standardized or regulated nor precisely defined. In general, a performance gap can be defined as a deviation from a target or as a result of a performance assessment [3]. It is part of the quality assurance, as well as expectation and risk management in which objectives, methods and assessment aspects are defined.

Independent of the view point of the building sector, a performance gap must follow reliably from existing evidence, i.e., there must be both a comprehensible and reliable baseline (objective) as well as a comprehensible, reliable and comparable actual state. Objectives and actual situation can be derived from measurements, models, surveys, evaluations, and comparisons.

2. Approach and Methods

This paper reports on the progress and findings of the "ParkGap" project, funded by the Swiss Federal Office of Energy (SFOE). In addition to the "Energy Performance Gap", the project addresses the "Indoor Environmental Quality Gap" and the "Operating Expenses Gap". The project consists of three parts: (i) An overview of gap definitions as well as the mapping of relationships between the relevant stakeholders, processes and technologies; (ii) an international literary search and comparison of results with Swiss projects; (iii) recommendations for action for the Swiss building stock.

We report mainly on selected results from part (ii). In the literature survey, we considered not only peer-reviewed journals but also academic research reports, dissertations, conference proceedings, project reports of organizations and authorities, as well as relevant guidelines and standards. The publications were evaluated with regards to the following aspects: Nature of the reported gaps, causes, assessment methods, integration in construction and operating processes, recommendations for avoiding gaps.

3. Results

3.1. Overview

The literature survey identified over 240 relevant national and international references, which mainly deal with energy performance gaps. The granularity and depth of detail of the studies vary widely and a large range of empirical methods and models are covered.

3.2. Evidence of gaps

Here, we focus on the numerous studies that relate to energy performance gaps. So far, we have not found any studies that deal with indoor environmental or operating expenses gaps in the context of a "Performance Gap". However, further research is in progress.

The studies fall into two categories. First, the assessment of individual buildings. Second, the analysis of the energy performance of building stocks. In both cases, energy consumption, usually from measurement or in some cases from simulation, is compared with a given target value or range [1, 4, 5].

The following studies of the first category are of interest:

Cali et al. [6] investigate and compare three buildings of identical construction but with different renovation strategies. Different energy consumptions are found mainly attributable to occupant behavior, location, and building technology problems.