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Achieved Energy and Climate Goals in Project Ålidhem: An Evaluation of a Refurbishment of 21 Swedish multifamily Buildings

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Abstract

In Umeå, situated in the north part of Sweden, the largest refurbishment project undertaken by the public housing company in Umeå was completed in 2014. The project had ambitious goals to decrease the bought energy use for domestic hot water, building electricity and space heating, by 50 %. In order to achieve this, a variety of energy conservation measures were implemented in 21 multifamily buildings during the four-year project. This paper describes the used evaluation approaches and the achieved energy and climate goals. Finally, it offers some reflections that are hoped to be useful in similar projects.

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Keywords: Building refurbishment; Measurements; Energy performance

1. Introduction

In many European countries, the building stock increased at a fast pace during the years 1950-1975 [1]. In the case of Sweden, the construction rate was at its highest during the years 1965 to 1975. During this period, the Swedish government set the goal to build one million apartments in ten years, to remedy the acute housing shortage in Sweden [2]. Most of these buildings are now in need of renovation [3] and there is, amongst others, a possibility of introducing energy conservation measures (ECMs) in the renovation process. However, the renovation of this aging building stock is not always a straightforward one, since in addition to energy efficiency targets, the property owner also often needs to consider economic, social and architectural issues. Social sustainability in the renovation of buildings has received increased attention in recent years in Sweden [4]. Mangold concluded in his thesis [5] that subsequent rent increases from renovation projects in economically disadvantaged areas risks aggravating economic inequities. Thus, social sustainable renovation can be presumed to be dependent on keeping the rent increase at a manageable level for the tenants. The rent increase is in turn dependent on good decisions made by the property holder during the planning stage of a renovation project. If ECMs should be implemented, it is important to have a good knowledge of the expected energy savings.

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There exists in the literature a fairly large amount of examples of actual outcomes from individual case studies in renovation projects e.g. [3] and [6]. However, studies that show how well such results agree with results on a building

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aggregated level (multiple buildings) are less common. Therefore, in this study we would like to present results and experiences from a large refurbishment project undertaken by the municipal public housing company in Umeå. During this four-year long refurbishment project, a variety of ECMs were implemented in 21 multifamily buildings. The renovation was done in a stepwise manner, where in the first phase two case study buildings were evaluated and the results had a significant role in decision making in the remaining full scale project. This paper details the taken ECMs and the projects achieved energy and climate goals, both on building level as well as in total. In addition, the paper offers some reflections of the used evaluation approach which is hoped to be usable in similar projects.

2. Project area and measured data

The project area is shown in Fig.1 and includes 21 multifamily buildings, (buildings with common outer walls have been counted as one building). The buildings were built during the years 1970-1971 and initial measurements indicated a high average specific energy use as well as a low indoor comfort in the area. Therefore, a number of ECMs was decided to be included in the refurbishment. In order to decide suitable and cost-effective ECMs for the project a test-building, referred to as Building 1 was initially evaluated. The evaluation of energy savings (building level) was done through a comparison with a similar building, Building 2 in which no measures were undertaken at the time (a comparison possible through very high building similarities). Building 1 and Building 2 can be seen marked in Fig. 1.

Fig. 1.(a) 3D model of one block of buildings in the project area including case study buildings, Building 1 and Building 2, Fig.1.(b) 3D model of the second block of buildings in project area. Both models were created with the help of Google Earth [7].

The initial energy saving target in the project, (all buildings in Fig 1), was to decrease the supplied energy use of domestic hot water, building electricity and space heating per floor area, (referred to as EUI indicator), by 50 %. In order to evaluate this goal, the buildings energy use pre and post renovation had to be collected as well as degree day data. This was done through the local energy company and the Swedish Meteorological and Hydrological Institute (degree day data). The collected energy data consisted of supplied district heat (DH) for space heating and domestic hot water preparation, supplied electricity (property and household electricity) as well as exported and produced solar electricity. The resolution of this data was monthly.

The same categories of data were collected for Building 1 and Building 2. In addition, the indoor climate was monitored, in these buildings, with on-site measurements of the outdoor and indoor air temperatures as well as the supply temperature from the air-handling units to the apartments. Controlled air-supply velocities were also spot measured with a thermal velocity probe. In addition, a survey was conducted to collect data on user perception of the indoor climate. The supplied DH for space heating was monitored in Building 1 and Building 2, in three parts: combined heat to the radiators and air-handling units, sub metering of the supplied heat to the air-handling units and heat for domestic hot water circulation.

3. Description of buildings before renovation

The buildings have a concrete ground slab incorporating a crawl space in the center for inspection of media pipes. The loadbearing frame is made of concrete and the gables and apartment dividing transverse walls are used as loadbearing structure. The original gable walls were made of (from the outside to inside) 12 cm half stone brick, 10 cm mineral wool and 15 cm concrete. The long side outer walls were made of (from the outside to inside) 12 cm half stone brick, 1.2 cm asphalt board, wooden skeleton, 10 cm mineral wool, vapor barrier and 1.3 cm gypsum board. The roof construction consisted of a flat roof type, enclosing a 14 cm concrete attic floor insulated with 25 cm sawdust. The