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Effect of different renovation actions, their investment cost and future potential

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Abstract

65% of the buildings in Västerås, situated in the region of Mälardalen, Sweden were built before 1970. It is thus time for renovation. The situation is the same in most cities in Sweden and Northern Europe. The depth of renovation can be quite different. In this paper we evaluate some examples where cost is compared to energy saving effect. How to plan renovation to make use of the available capital in the cities is discussed. As a complement to direct renovation actions also behavior change with respect to energy is discussed and exemplified. The cost for energy actions in relation to other renovation aspects is discussed especially for the passive house case in Allingsås, Sweden. The passive house center calculate an extra cost for passive house standard to be 10 000 €/apartment while an external consultant has the figure 40 000 € of the total cost of 120 000 €. With this space heating can be 18 kWh/m^2.year, or a reduction by 84 % with respect to space heating and 62% for overall heat and hot water demand. If you use the latter cost figure passive house standard is not motivated from an energy savings perspective while if using the lower figure it is very interesting. For the other less deep renovations we see that adding more insulation and three glass windows is motivated if the degradation has been strong, while a simpler renovation may be ok if the outer surface coating is not too bad. For these less deep renovations we see cost figures of 65 €/m^2 respectively 28 €/m^2 with reduction of heating and hot water demand of 56 % respectively 34 %.

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Keywords: Renovation; Buildings; Cost; Energy Savings; Passive Houses

1. Introduction

Different renovation actions have been evaluated with respect to energy savings. The renovation of a number of multi-family houses in Allingsås to passive house standard was evaluated and described in [1] where also a number of other renovation projects are evaluated with respect to costs and profitability. From the passive house center in Allingsås, complementary information has been given about the same project in interviews [2]. The energy related costs is reported in [1] to be approximately 40 000 € for a

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75 m^2 apartment, while the extra specific costs for going from normal renovation to passive house standard is reported to be approximately 10 000 € per apartment according to Hans Eek at passive house center in Allingsås [2].

This can be compared to the total renovation cost of 120 000 € per apartment including other features not related to energy. Chigbu [3] describes renovation of villages in Germany as an instrument for renewal generally. Dale [4] has been describing how renovation was performed in Singapore with it hot climate. Cohen [5] has discussed how to motivate renovations for the board and financers, while Wallender [6] is discussing costs for different renovation actions generally. Behavior change can reduce energy use as well. It sometimes is difficult to know if energy reduction is due to concrete renovation actions or due to changed behavior as renovation gives the tenants awareness of energy aspects, if the real-estate owner performs energy information activities [7-9]. This is especially related to hot water use and household electricity.

The energy for space heating has dropped for each kWh/m^2 living area during the last 50-60 years but much less than could be expected if we look at the much better technology used [10]. It can be interesting to look at some concrete examples of renovation made during the last few years and investigate what effect those have given.

Table 1. Amount of buildings built in Sweden during different times and average kWh/m^2 building area [10]. The % of buildings was made until 2003.

Building year	% of buildings	kWh/m^2
2011-2013	Not available	90
1991-2003	7%	120
1981-1990	10%	130
1971-1980	17%	135
1951-1970	34%	140
1921-1950	20%	150
-1920	12%	160

During the last decades about 2500-3000 units are being retrofitted annually in Sweden. Today 29% of single-family houses have direct electricity for space heating and hot water while 92% of multi-family houses have district heating. In 2010 52% of all single-family houses was using heat pump technology, or nearly 1 million heat pumps.

40% of all energy used in Sweden 2013 was for residential and service sector, and almost 41% of this energy was in single family houses, 31 % for multi-family houses respectively. The remaining 28% of energy is then used in commercial buildings [10]. The energy distribution on different means is not well known, but rough numbers from EU-countries are given by [12]. According to this report the use of energy in households in Sweden is approximately 58% for space heating, 22% for hot water production, 3% for cooking and remaining 17 % for appliances. Roughly 60% of energy in household are used for heating in EU.

2. Consumption statistics and energy renovation experiences – examples from different cities in Sweden

2.1 Västerås, Sweden

The Västerås is a city with 145 218 inhabitants. According to Statistics Sweden [11] the built area including gardens is 8.2 % or 7843 ha. 43% of the buildings are detached, single family houses and 48.8% constitutes of apartments in multi-family houses. The remaining buildings, 8.2 %, is industrial and commercial buildings. Most cities in Sweden have similar conditions as Vasteras with respect to when houses were built and standard of the buildings and thus Vasteras can represent also many other cities from a renovation demand perspective. If we look at the whole Sweden there are 4.7 million apartments, from which 2 million detached houses single family) and 2.35 million apartments in multi-family buildings. The average size of a multi-family apartment is 68 m^2 while the average single family house is 122 m^2 [11]. The size of the households inVästerås is as follows: 17.4 % with 1 person, 27.7 % with 2 persons, 16.7 with 3, 21.3 % with 4 and 15.2 % with 5 or more persons. The total amount of households in Västerås is about 65 000 units and the square meters for each buildings type is estimated to following: Single family houses: $47\% \times 65\,000\,units \times 122m^2 = 3\,730\,000m^2$ (Ekv 1); Multi-family houses: $53\% \times 65\,000\,units \times 68m^2 = 2\,343\,000m^2$ (Ekv 2). Potential reduction by some 60%*(1-(50/200) kWh/m^2)= 45 % of the total household energy if we extrapolate from the discussion from Sweden above. This would mean some 3310 x 0.45 = 1490 TWh/y potential saving for heating. Aside of heating also hot water is a significant cost in apartments. In figure 1 (left) we see how it varies between different apartments in two buildings in Vasteras. The difference between the highest and lowest consumer is 10 times! The energy use is also about the same for the