Retrofitting Homes for Better Energy Performance:
The occupant's perspective

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ABSTRACT: This paper recaps the findings of various European projects supported by the Intelligent Energy-Europe programme focusing on retrofitting of housing blocks for better energy performance. It is structured in sections covering aspects including existing barriers for renovations, opportunities and drivers, technical solutions, financial schemes, user behaviour and best practices, presented from the occupant's perspective. It winds up with the main conclusions.

INTRODUCTION

In Europe the energy saving potential in the residential sector is estimated at around 28% [1]. Renovations can lower the energy consumption by 30% and offer the singular largest potential for energy savings and CO2 emission reduction. It is mainly through environmentally -friendly retrofitting those European citizens can benefit in the short term from improved comfort and less environmental impact. Radical changes in the way we design and construct buildings and how we approach urban development will play a leading role in creating a sustainable future for buildings and cities. If people also change the way they interact with buildings, additional major savings could be obtained. Occupants need to recognise their role in energy consumption and the resulting environmental impact. Changing today's patterns of energy use is the major challenge facing buildings and their occupants. A range of technical energy-efficient measures and solutions appropriate to specific housing schemes and to particular climatic region and tailored financial instruments are available to support refurbishment activities. In Europe several projects funded by the Intelligent Energy Europe Programme aimed at tapping into the existing energy potential with innovative measures designed to raise the energy performance of existing residential buildings. Many of these projects encourage active involvement of occupants through events, local forums, training programmes, information campaigns, awareness workshops, voluntary schemes and other activities [2]. The main barriers, drivers and opportunities, technical solutions, financing schemes, user behaviour, awareness raising, training and best practices for undergoing activities are discussed in the following sections.

MAIN BARRIERS FOR RETROFITTING

The major barriers to housing refurbishments are very often related to the lack of awareness, ownership or tenure structures, specific legal frameworks, and financing opportunities. Technical aspects related to the quality and age of the building can represent another difficult obstacle to deal with. There are other concerns such as the need of temporary moving of the occupants during renovation works or the fear of increased rents after retrofitting which can also hinder retrofitting activities [3].

The lack of awareness among residents towards new energy efficient technologies and the experience with starting a refurbishment project is a serious barrier as little or no information is available from independent bodies such as agencies or municipalities [4]. The specific interest in energy as a single issue is limited. Whilst tenants are partially interested in energy, this is usually the most important household concern.

Mixed ownership of dwellings with tenants and building owners or housing blocks occupied by a mix of low- and high income families result very often in problems with decision process about refurbishment. This is a major barrier in countries with privatised housing stock, such as in many new Member States. The problem increases in those countries where the law on ownership, requires agreement of *all* owners (100%) for refurbishment. The fact that the greater part of the housing stock in multifamily dwellings is in private hands can also create an additional barrier when planning any housing refurbishment. Plans for refurbishment have to be agreed by a large majority of the owners and often require an organised approach. In countries where homeowner associations have been formed, decision-making procedures are often easier, but not every

association can act as a legal entity representing the owners in e.g. applying for a loan [4]. A real obstacle to the realisation of refurbishment measures with influence on energy consumption is set in the difficulty to have a pay back of the investment: the social housing agencies are not allowed to increase the rent, when they make a refurbishment, even not if the outcome is a substantial reduction of heating costs, in most of the cases directly in charge of the tenant. This financial point is the key of the realisation of extended energy saving measures in Italy, for instance [3]. Investment costs affect mostly multi-family buildings with low income residents. These do not usually have financial means to undergo improvements in their homes. Tenants, in particular, rarely see benefits in paying for refurbishment works, when they believe the main beneficiary is the owner of the building. In many European countries, there is a lack of suitable financial mechanisms. Given the enormous amount of houses that need to be refurbished, the available public financial sources and programmes are limited. Conditions for access to capital (e.g. mortgages) remain relatively restricted and a large part of the population does not qualify for loans. While in The Netherlands the rent increase after refurbishment lowers governmental support (rent subsidies), it is possible in Czech Republic to increase rents after refurbishment of housing owned by municipalities. Another important psychological barrier is that people are not yet used to take loans [4]. Other financial barriers are reported to be related to technical aspects. In most new Member States serious technical barriers due to aging and deteriorating housing stock are an issue. In The Netherlands there are bad experiences with insulation technology in the 1980s due to worsened ventilation causing moisture and mould problems.

OPORTUNITIES AND DRIVERS

Improvements in the building can lead to better quality of life and energy savings is good for the environment. In addition, it decreases the energy bill. In general, tenants expect that retrofitting their homes will reduce energy costs and that they will have improved energy services and/or a better living environment [5]. Renovations can lead to potential energy savings of 30% [6], but higher levels have been demonstrated. Energy savings up to 58% have been reported in pilot case studies carried out in several European countries (e.g. Ireland, Germany, Austria, Italy, Poland and Bulgaria) [3]. The aging and deteriorating housing stock increases the need for refurbishment and can be a driver for increasing the energy performance of the building.

Due to rapidly increasing energy costs during the last decade, combined with the poor energy performance of the existing building stock, energy costs of households have increased and became unbearable among parts of the population. This provides a strong motivation towards improving the energy performance of households. A large number of households cannot afford to pay their energy bill and therefore a large number of dwellings are not normally heated. Estimates show that this concerns as much as 40% of households in Europe [4].

Energy buildings certificates have been identified as a good way to demonstrate in a simple way how different refurbishment measures can improve the buildings energy rating [3]. The current obligation for energy certificates is also contributing for awareness raising in this domain and increasing possibilities to take loans from commercial financial institutions for housing refurbishment projects. Certificates should inform the future owner about the thermal performance of the asset they are going to pay for and tenants about the potential rent they may be paying for heating and cooling expenses of their homes. Certificates must include measures for improvements towards energy efficiency, or at least simple guidelines on the economic and other benefits of energy retrofitting. Otherwise many owners will not see the advantages of these and will perceive it as just another bureaucratic paper and an additional expense. Energy certificates are also opening roads for the provision of economic incentives for owners and users. Housing refurbishment and increasing the energy performance also make the housing stock more attractive; with the potential to increase housing rents and increase of the real estate value of the dwellings. In countries where owner-occupied dwellings are the majority, owners will see the value of their real estate increase. This is especially attractive when still a large part of the housing stock has a very unfavourable energy performance.

A major driver that should not be underestimated is the dissemination of good housing refurbishment examples by independent agencies as in Germany and in the Netherlands. This gives target groups, such as home-owner associations and housing cooperatives, the possibility to learn from successful projects and ask for advice for their own projects from independent agencies with regards to technologies and financing possibilities. The private ownership in buildings with multiple dwellings is a complicating factor in organising housing refurbishments.

Private or sometimes mixed ownership of housing blocks severely complicates decision making for housing refurbishment. Approval of majority of owners is required for any major investment and costs are provided by the owners.

A building manager helping in the communication among the tenants can be a good solution for multiple occupancy dwellings with different ownership structures and forms of tenure [7].

TECHNICAL SOLUTIONS

Tenants are less interested in technical specifications but more interested in their individual needs such as balconies, noise protection and, above all, low energy costs [3]. Overall the attitude of tenants towards renovation is favourable. The majority of interviewed people within the *ISEES* project believe that renovation would improve the living standard.

Occupant's needs for renovation usually include improving the thermal insulation of the building's envelope, correction of thermal bridges, solving humidity and mould formation, modernising heating system and old or defect windows. Disturbing aspects of a renovation like noise and dust are willingly accepted as the benefits outweigh the irritation. However, almost half of the interviewed people within the same project are afraid that a renovation would raise the rents. A high percentage would like to be informed regularly about all work being undertaken and want to be involved in decisions about renovation. Social dialogue must become more widely used in the case of planning refurbishment activities in the residential sector. The involvement of housing owners, local decision-makers, planners and architects, energy utilities in this process is crucial [5]. In general, the prefabricated housing blocks in the new Member States (built after WW II) are in the largest need of refurbishment with energy consumption in most cases at least twice as high [4].

A range of technical refurbishment measures is widely available and technologies appropriate to specific housing schemes in a specific climatic region are offered by the market [3] [6]. The energy consumption and the thermal comfort of a building can be effectively achieved most of the time through improved physical properties of the building shell – consisting of windows, walls, roofs and ceilings – the appropriate ventilation rate changes control and the application of solar control strategies or usage of heat recovery systems, depending on local climatic conditions,. The temperature of the inner surface of the walls can be significantly increased in winter and reduced in summer through the thermal retrofit of the building shell. This leads to a better indoor climate and minimizes the risk of a potential old infestation. In the Mediterranean and temperate climatic regions appropriate external shading devices will increase comfort and improve the building's environmental performance in the cooling period. Additionally, there are other aspects related to sound insulation, fire protection, installation lines for sewage water, listed-protected buildings and modernization of the energy supply and distribution, which should be integrated as well. Attention should be paid on the fact, that the conceived noise protection may be declined due to a thermal retrofit. Because of the energy requirements including tight building shell and new or reconstructed window constructions, the noise between the spaces within a building can be perceived more disturbing for the residents. In apartments with high-traffic noise exposure, it should be taken into account that after the installation of new, soundproofed and insulated window constructions interior noises in the house are perceived to be much stronger. In the case of a thermal retrofit and adaptation of larger storey buildings, the adjustment of the current fire standards has to be scheduled. Each main staircase has to be a fire protection unit and the entrance doors to flats have to be fire retarding construction. There has to be a ventilation opening on the top of the staircase. In principle all installation lines for sewage water, warm and cold water and the heating system have to be checked and renewed if required. It is recommended to do this in the context of a comprehensive renovation. Regarding planned retrofit measures in listed-protected buildings, especially at the façade including the window construction, an early agreement with the monument protection authority should be made. Another particularly energy-efficient and environment-friendly measure is to modernize the energy supply and distribution by moving to a district heating system. The realisation of this measure is technically simple because the district heat transfer station needs only a small amount of space and can be connected to the existing heat supply system. A further advantage is that no storage space is needed. Nonetheless, in order to guarantee an effective implementation of retrofitting measures certain steps are necessary These include a) an audit for the identification of energy efficiency strategies that better suit a specific situation, b) decision process to offer the building owner concrete support and advice, c) planning advice for a detailed conception of retrofitting measures, d) implementation, e) quality assurance, a crucial element necessary for enabling successful implementation of energy efficient housing, and f) monitoring and continuous controlling to provide key information on the success of the project and offer the possibility to improve the management [3].

FINANCIAL SCHEMES

Financial support is very often the only means for low income owners to renovate their buildings. In Europe, a range of financial instruments, schemes and opportunities are available to fund refurbishment activities for better energy performance. Certain countries such as Denmark, Germany and the Netherlands have introduced extensive grant programmes for housing refurbishment up to the present day. This has led to a significant improvement of the energy performance of the building stock. However this required enormous amounts of public money for refurbishment and investments may not have always been cost-effective. Findings from the *InoFin* project which focused on experiences with financial housing

refurbishment in various European countries (Denmark, Germany, The Netherlands, Bulgaria, Czech Republic, Latvia, Poland and Slovakia) indicate that the role of housing cooperatives is leading in some countries such as Denmark, The Netherlands and Germany. In the new Member States much of the programmes are aimed at single households (with the Czech Republic as exception where programmes are often aimed at housing cooperatives). However, the possibilities of using financial sources from the commercial sector are increasing both in the old and new Member States. Reasons for this are twofold. In one hand, grants in both new and old Member States are limited compared to the refurbishment needs. In the other hand, private financial institutions are increasingly more willing to provide loans or mortgages for housing and renovation projects [4]. In some countries funds only cover specific retrofitting measures. In Italy, where the main funds arrive from regional budget, usually only the realisation of new buildings is supported. Money has to be found for each case, each building and each retrofitting measure. In general this lack of funds determines a situation where only the strictly necessary maintenance activities are executed. In most cases the measures do not regard the building or its elements but only the plant [3].

During the last five to ten years, some kind of financial support has been set up for refurbishment of the current housing stock in the new Member States. Grants, soft loans credit guarantees and mixed schemes are among different existing types of support. Grants have been very useful in promoting new technologies. In The Netherlands a number of technologies were successfully applied in mass through these programmes. First wall insulation, later also is condensing boilers, double glazing, etc. Although grants can be effective in promoting certain technologies, there remains risk of free-rider effects. The provision of loans with lower interest rates than commercial loans helps to overcome the financial barrier for larger investments that risk feasibility with a commercial loan. Banks view some refurbishments relatively risky, especially when concerning small-scale housing projects. As a result they charge high interest rates, making the projects less attractive. Conversely, when a large institution such as a governmental agency provides a guarantee, banks will charge lower interest rates, making these projects more attractive. A credit guarantee is a good option when access to capital is a major barrier and not the economic feasibility of the project. Some countries use mixes of schemes such as loans combined with grants. There are good examples in Poland and Bulgaria of these. The advantage of providing a loan in combination with a grant is that people applying under this system are usually committed to carry out a refurbishment and not just applying for a grant because of its availability.

The traditional ways of financing, through increasing the rent is not always possible through regulated rent increases and it frequently leads to protests of tenants. There are other possible financial schemes which can be applied such as energy supply or performance contracts or living expenses guarantee. Energy supply contracts with energy suppliers consist in an energy supply company managing the energy supply of a whole building block, leasing boilers to the tenants and taking care of the energy management. Energy performance contract is a contract between tenants, the housing cooperative and an external party about (collective) energy supply with a certain percentage of realised savings. A living expenses guarantee is when the housing cooperative guarantees that the total living expenses (rent plus energy expenses) will not increase after refurbishment, or will increased by a very limited amount only. A relatively new approach is financing energy efficiency investments through the mortgage. One example in the Netherlands shows that this option enables private persons to borrow an additional amount of money specifically aimed at investments in energy efficiency. Leasing of equipment (solar boilers etc.) is another way of financing energy efficiency measures that is applied by energy suppliers and several banks. In the Czech Republic, Slovakia and Latvia, private banks started to develop specific loan programmes for private owners and housing cooperatives. Interesting is the situation in Latvia, where practically no government funded grant programmes exist, but banks offer commercial loans for energy efficiency and general refurbishment projects in apartment dwellings.

USER BEHAVIOUR

Energy consumption of private households basically depends on environmental and human factors. Human factors are related to the user influence like the number of occupants, the length of occupancy in the home and other aspects such as people with special heat demand (like babies or old people) and the user behaviour such as temperature choice or ventilation behaviour (Hertle et al 2005) [9]. A number of empirical studies demonstrated a broad range of room temperatures people feel comfortable with. Moreover, the room temperatures depend on the room use and may differ within the family [10]. It differs according to individual preferences, the availability of control systems or the room use, among other aspects. Big inter-individual differences in energy consumption may implicate a “wasteful” consumption of energy. Aimed at energy savings in residential sector the main problem seems to be that most people have only “a vague idea of how much energy they are using for different purposes and what sort of difference they could make by changing day-today behaviour or investing in efficiency measures” (Darby 2006) [8]. The *Save@Works4Homes* project, aiming at supporting European housing tenants in optimising resource

consumption, carried out a survey including over 2.600 tenants to collected quantitative data about energy saving related issues and to identify gaps in knowledge and typical "wrongdoing" in energy consumption. The most important results are that a) most tenants are worried about the climate change and feel themselves as being aware of environmental issues. Saving money motivates tenants more to save energy than protecting the environment, and b) most tenants value their own energy consumption as medium. On the other hand the collected data show a set of possibilities to tap the full potential of energy saving - for example improvements in ventilation and heating behaviour. Concrete solutions provided to overcome barriers on the way to achieve energy efficient housing were examined within the *ISSES* activities. This project has shown that it is possible to influence tenants' behaviour with respect to the energy consumption through direct two-way social dialogue. Tenants were interviewed and were given advice on how to reduce energy consumption (through user manuals and other means). Whilst it has not been impossible within the duration of the project to evaluate energy savings achieved it is anticipated that these will be significant as many tenants reported that they would change their behaviour. Further results show that the potential for improvements in user behaviour alone to save energy is limited in non refurbished residential buildings. Poorly sealed buildings in particular are responsible for an uncontrolled loss of warm air on one side, and cold draughts on the other. In order to achieve comfort levels, these draughts are typically countered with higher room temperatures resulting in still higher heat consumptions rates and higher losses [5].

There are many opportunities to optimize user behaviour in several European countries, which optimally should go together with potential refurbishment activities. Generally, user behaviour of tenants did not change because of measurements performed within the *ISEES* project, although the distributed information leaflets were considered useful. However, residents show in many aspects appropriate user behaviour, but at the same time there is a high potential for improvement such as regards ventilation, for example. Further information on correct user behaviour is considered necessary by tenants, as they seem to lack the appropriate know-how on how to "behave energy efficient". Occupants in general are not able to give any recommendations on how they think energy efficient user behaviour should look like, though they sometimes practice it. However, results of the survey revealed that better and more qualitative information on user behaviour is only relevant to tenants when the buildings are in a good condition. For most of the surveyed buildings this was not the case, therefore people do not see any chances to benefit from behavioural changes they would otherwise be ready to take. To motivate residents to improve their user behaviour will hardly be fruitful as long as the user behaviour shows no effect because of the inadequate building structure. Subsequently, in these cases activities to raise awareness and to inform about user behaviour should be a second step after a renovation of the building.

AWARENESS RAISING AND TRAINING

Convincing people of the usefulness of a comprehensive refurbishment is quite difficult and takes time. It is also very important to give practical advices of energetic retrofitting and using a modernized building correctly. For these reasons training courses and an awareness campaign have been of major importance and showed to be most welcomed. Although most tenants feel well informed about environmental issues in general, they otherwise describe gaps in knowledge about the consumption of energy in their flats and about the possibilities of saving energy there. Most tenants are interested in a service which gives an exact overview of their energy consumption and hints about how to save energy (electricity, water heating and space heating). They value insufficient information obtained from TV, newspapers and brochures to satisfy their needs. However, they prefer pamphlets [10]. Personal training of tenants is another suitable method to achieve energy awareness and reduction of energy consumption. Training in smaller groups allow general training on energy and cost saving measures at home to be provided at demonstration flats, while larger groups can promote the exchange of experiences among the tenants. On site visit to the flats is the most effective method to train the tenants about a very specific topic, such as issues concerning condensation, mould and connected heating and ventilation problems. Furthermore, it has been of importance to involve respected energy experts to contribute to the courses. It was the excellent mix of individuals (from tenants to executives, fuel suppliers to local authorities, health professionals to architects) which has made the *SHARE* forums a great success [11]. The *EI-EDUCATION* project concluded that it's possible through education and courses to reach a large number of social housing organisations – public and private. Guidelines for setting up a social housing energy forum were developed by the *SHARE* action on gaining support, ensuring continued support and on operational details such as the importance of choosing the right location. As an example, in Ireland the forum met in a popular local pub, which encouraged participation as people enjoyed going to that location anyway and also had the option to stay for lunch afterwards. Other countries found it better to develop a relationship with a municipality, commercial organisation or housing company and use their offices to meet. For social dialogue to become effective it is important that it is organised in such way that the participants are accountable for a transparent process and outcomes that may occur [5].

BEST PRACTICE EXAMPLES

In a number of countries, projects have been established to showcase and demonstrate the feasibility of adopting a range of measures to reduce the negative environmental impact of housing including the reduction in electricity, heat and water use. But up till now the focus has mainly been on new buildings. In the existing housing stock the need for improving of the energy efficiency is still an objective. Some of the largest, organized actors in the housing sector in Europe, the social housing companies and municipalities have an important task in initiating energy savings in their properties. Seeing the properties as resources for the future, the question is not only about saving energy, but also about providing adequate living conditions and improving living conditions in general to future standards – also for low income groups. Good practice examples and demonstration projects increase awareness among residents in non-refurbished dwellings and help spreading know-how on sustainable retrofitting from a technical as well as financial point of view [4]. These examples can also help during the decision process and can trigger a multiplier effect by playing an important role for motivating further building owners of sustainable refurbishing activities. The *EI-EDUCATION* project compiled 62 best practice examples from 11 European countries showing increases in energy efficiency of at least 30% [6]. The *ROSH* project also show 10 shining examples in 5 different of successful implementation of renovation projects planned involving regional players such as housing companies, local authorities and tenant associations [3]. The curiosity among social housing organisations on experiencing what they do in other European countries, has contributed positively to the communication in several of these projects. Lessons learned from both more and less successful projects should be disseminated in order to help avoiding making mistakes in the future. Of special interest in the IEE projects was to learn from what is done abroad and the compilation of best practice examples was appreciated.

CONCLUSION

Retrofitting activities leading to energy savings is a good opportunity for improving living indoor conditions and helping the environment. Renovating homes is also a chance to lowering energy bills. The energy certificates are a driver for awareness raising, energy improved residences and a door for the provision of economic incentives. Sustainable renovations will homes more attractive with additional potential to increase the house rent and the real estate value. Buildings occupied by mixed ownership or occupied by tenants with mixed income levels and resources can represent an additional barrier for the decision-making process. A building manager helping in the communication among the occupants can be a good solution for multiple dwellings with different ownership structures and forms of tenure. A wide variety of technical solutions and measures is available for solving various problems in the buildings. In Europe, a range of financial instruments, schemes and opportunities exist to fund refurbishment activities for better energy performance. Grants, soft loans credit guarantees and mixed schemes are among different existing types of support. Other possible financial schemes are energy supply contracts with energy suppliers, energy performance contracts and living expenses guarantees. There are many opportunities to optimize user behaviour in several European countries. Occupant's are in general willing to be informed and training courses and awareness campaigns are proven to be of great use and interest. Forums covering a specific topic focusing on the resident's actual needs and involving the participation of experts and other relevant actors can be of great success. Good practice examples and demonstration projects contribute for awareness raising and are an important motivation for further sustainable refurbishment.

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