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Shining examples analysed within the EBC Annex 56 project

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Abstract

The International Energy Agency established an Implementing Agreement within the Energy in Buildings and Communities Program to undertake research and provide an international focus on Cost Effective Energy and Carbon Emissions Optimization in Building Renovation (EBC Annex 56). The project aims at developing a new methodology to enable cost effective renovation of existing buildings while optimizing energy consumption and carbon emissions reduction. Gathering of case studies is one of the activities undertaken to reach the overall project. Of the case studies a selection of "Shining Examples" is made to encourage decision makers to promote efficient and cost effective renovations. This paper presents the results of the analyses made on the Shining Examples.

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1. Introduction

Within IEA EBC Annex 56 [1], the gathering of case studies is one of the activities undertaken to reach the overall project objectives, because it is a recognized fact that the process of decision-making has to be strongly supported by success stories from real life and experiences and lessons learned from practice.

The specific mission of the case study activity of the Annex 56 project is to provide significant feedback from practice (realised, ongoing or intended renovation projects) on a scientific basis. The main objectives of this work are:

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- To understand barriers and constraints for high performance renovations by a thorough analysis of the case studies and feedback from practice in order to identify and show measures to overcome them;
- To align the methodology under development in Annex 56 with practical experiences;
- To support decision-makers and experts with profound, scientific based information (as result of thoroughly analysed case-studies) for their future decisions;
- To show successful renovation projects in order to motivate decision-makers and stimulate the market.

The Case Studies within Annex 56 are studied at two different levels. Level 1 – the “Shining Examples” and level 2 – the “Detailed Case Studies. Within level 1, a selection of “Shining Examples” to encourage decision makers to promote efficient and cost effective renovations is provided. In level 2 a deeper analysis is performed in order to evaluate the impact and relevance of different renovation measures and strategies within the project. The “Shining Examples” are gathered mainly for motivation and stimulation purposes, highlighting the advantages of the energy and carbon emissions cost optimized renovation. The focus is to highlight advantages and innovative (but feasible) solutions and strategies.

2. Shining examples collected

The compilation of shining examples is being carried out in two rounds. During the first round – which finished by December 2013 the nine Shining Examples presented in table 1 had been found and presented in brochure published by the project [2].

Table 1. The nine Shining Examples collected and documented in the first round.

Country	Project name	Type	Photo
AUSTRIA	Kapfenberg	Multi family	
DENMARK	Skodsborgvej, Virum	Single family	
DENMARK	Traneparken, Hvalsø	Multi family	
NETHERLANDS	Wijk van Morgen, Kerkrade	Single family	
PORTUGAL	Lugar de Pontes, Melgaço	Single family	
PORTUGAL	Neighborhood RDL, Porto	Multi family	
SWEDEN	Backa röd, Gothenburg	Multi family	
SWEDEN	Brogården, Alingsås	Multi family	
SWITZERLAND	Les Charpentiers, Morges	Multi family	

In the second round to be concluded by February 15, 2015 another set of shining examples have been identified and documented. The final brochure with all the Shining Examples will be presented in the summer of 2015.

3. Analyses of shining examples

A cross-section analysis of the shining examples has been carried out to identify similarities, differences and general findings. The results of this analysis are presented in 5 sections covering: barriers/solutions, anyway measures, rational use of energy/renewable energy supply (RUE/RES) balance of measures, co-benefits and country/climate specific measures. The shining examples gathered in the second round will be included in this analysis in the spring months of 2015.

3.1. Barriers/Solutions

The implementation of energy renovation projects in the building sector is not just a technical and/or economical matter. It involves the users/inhabitants/owners of the buildings, who, in some cases, have to leave the buildings for a shorter or longer period. Additionally, those who pay for the energy renovation are not always those who benefit from it. Therefore, energy renovation projects often run into barriers that may hold up the project. It is then necessary that owners, technical consultants and policy makers find solutions to overcome these barriers. In a pre-study on barriers and solutions carried out in the context of this work, four different categories of barriers were identified:

- Information issues;
- Technical issues;
- Ownership issues;
- Economic issues.

The information issues can be either confusing information, i.e. different opinions expressed by different professionals, or incomplete information. It can also be lack of clear requirements, lack of inspiration or lack of knowledge about possibilities, potential benefits and added values. The technical issues are mainly related to lack of well proven systems and lack of complete solutions consisting of packages of technologies. The ownership issues generally have to do with who has to pay for the investment in energy renovations and who saves the money – not always the same person(s). The economic issues can be as simple as too high investments needed, which often are also coupled with lack of incentives. Additionally, there may be uncertainty as to how much money can be saved from the energy renovation (sometimes just the comfort is improved) and finally, lack of economic understanding or knowledge.

The analysis reveals that the barriers met were sometimes a combination of different kinds of barriers including information, economic and ownership/user issues. Tenants in rented apartments are often in focus as critical elements in the renewal process as for example in the Swiss case, where it was important to keep the largest possible number of tenants in their apartments during the renovation. In Denmark, tenants came into play in a different way as the democratic requirements in the Danish housing rent laws demand that tenants vote for the energy renovation before it can be initiated.

In Portugal, the financing was a barrier in both cases and also in both, the lack of knowledge by some stakeholders and different opinions among involved partners, were issues necessary to deal with. In all cases, the solutions found to overcome the barriers met were quite straightforward and can be summarized in one word: “perseverance”. Many of these projects could not have been implemented if a single person or team had not taken ownership of the project and had fought for their completion.

The overall conclusion from the analysis of the 9 shining examples is that for 3 of these there were apparently no barriers worth mentioning. For 3 of them, the barriers were mainly of administrative matter – for example delay caused by poor project leadership. For 2 of the cases, the economical/ financing issues created barriers causing problems and delays. The shining examples documented so far may be characterised as forerunners and therefore not typical energy renovation projects.

3.2. Anyway measures

The expression “anyway measures” was chosen to highlight the inevitability of the costs associated to maintaining, extending or replacing materials, equipment and systems to keep the building fully functional, or to make it contemporary with impending mandatory regulations.

The definition of a “Cost Effective Energy and Carbon Emissions Optimization in Building Renovation” calculation requires a reference scenario. Having in mind that the optimization costs include all expenses regarding the optimization and related procedures (soft costs), it is fair to assume “anyway measures” costs deducted from this total investment, as they would occur anyway without optimization. In fact, these “anyway measures” can be triggers for intervention, as demonstrated later.

The scope of the “anyway measures” tag includes all the costs that would naturally occur during the expected lifetime of the building and without which failure would occur. Well performed “anyway measures” increase or maintain the existing building value, and the same can be achieved by well performed optimization interventions. The “anyway measures” considered in this analysis included all the costs that the proposed optimization measures are able to substitute or defer in the existing building.

That insulation of external walls has been applied in all the “shining examples” can be explained by the fact that external walls require “anyway measures” that range from regular condition verifications to periodic paintings or substitution due to wear and tear. The “anyway measures” costs account for scaffolding or other lifting methods to execute the work, workmanship, materials and soft costs. In the end the aesthetics is improved or maintained, and the value of the building increases, or at least does not decrease. An optimization measure using external insulation will need the same scaffolding or other lifting methods to execute the work, some of the workmanship and a few similar materials. The optimization measure costs can then be calculated accounting the expenses directly related to the optimization measure, subtracted by the values that would happen in the “anyway measures“.

The shining examples show that the need for renovation or maintenance - the need for the “anyway measures”, created most of the opportunities for renovation. In programmed change situations it would be fair to assume that “anyway measures” can consider recent solutions that represent the local trends: if a district heating system is available, it is natural to consider that a system renovation would use the network solution. In rupture related situations, “anyway measures” consist frequently in exchanging the existing system by an equivalent one that will be more efficient due to the normal evolution of equipment, regulations and certification.

3.3. Which measures (RUE/RES balance)

When tackling energy consumption reduction in existing building renovation, two major approaches (often combined in one project) describe most of the options: those that reduce energy consumption, associated to a Rational Use of Energy (RUE), and those related to supplying the existing needs with Renewable Energy Sources (RES).

Many of the Rational Use of Energy (RUE) measures are currently less expensive while including the advantage of reducing the energy that has to be supplied by Renewable Energy Sources (RES), although further evolution in the existing or innovative technologies may alter this cost relation.

In several of the shining examples energy consumption reductions (RUE) were achieved by improving the performance of the building envelope and recovering heat from the ventilation losses, and for others significant use of solar panels or renewable-based district heating (RES) was used to complement the remaining needs. What both show is that each combination is a direct result from the existing context, the available solutions and sources, and significant integration efforts. Depending on the climate severity, period/quality of construction and many other factors (see topic Barriers) the buildings behave differently, create different baselines and require different intervention strategies.

Many of the RUE measures included the renovation of the boundaries with poor thermal performance (roofs, ceilings, walls, windows and floors with insufficient or no insulation), with particular focus on those in need of renovation due to wear and tear (see topic “Anyway measures”). The improvement of energy conservation noticed in roofs ranged from 30% to 95%, while in the walls it ranged from 60% to 90%. It is important to notice that in walls the U-values after renovation vary from 0.45 $W/m^{2o}C$ in warmer climates to 0.11 $W/m^{2o}C$ in more severe ones. In roofs, the variation ranged from 0.09 $W/m^{2o}C$ to 0.64 $W/m^{2o}C$, in the same situations. In the particular case of windows, the improvements ranged from 15% to 75%, where countries and specific locations with higher demands for heating demonstrate the use of a wider range of high performance windows (triple glazing is rather common).

In most of the examples, the RUE measures were taken as a first step to reduce the energy demand while improving the occupants' comfort (see topic "Co-benefits"), while reducing the amount needed from RES production. The Renewable Energy Sources approach was implemented in most of the buildings either by connecting to existing district heating structures fuelled by biomass or garbage combustion, or using biomass based heating systems. Many also included solar thermal panels for domestic hot water and/or heating or solar photovoltaic (PV) panels for consumption or connection to the grid.

3.4. Co-benefits

Several terms are used in the literature for side-effects that arise from building renovation such as co-benefits, non-energy benefits (NEBs) and multiple benefits. In Annex 56 it is used the term co-benefits to include all effects of energy related renovation measures besides reduction of energy, CO_2 emissions and costs. These co-benefits can have a significant value but are most often disregarded being the reason for the underestimation of the full value of the renovation works.

In Annex 56 the following co-benefits are considered: 1) Thermal comfort, 2) Natural lighting and contact with the outside environment, 3) Improved air quality, 4) Reduction of problems with building physics, 5) Noise reduction, 6) Operational comfort, 7) Reduced exposure to energy price fluctuations, 8) Aesthetics and architectural integration, 9) Useful building areas, 10) Safety (intrusion and accidents), 11) Pride, prestige, reputation and 12) Ease of installation.

An analysis for the valuation and integration of co-benefits in the decision making process will be performed under a private perspective (from user/promoter/owner point of view). It is therefore relevant to identify and evaluate all the effects that arise from different renovation measures.

It is one of Annex 56 goals to evaluate possible forms of integrating co-benefits in the methodology for cost effective energy and carbon emissions optimization. However, these benefits are often difficult and nearly impossible to quantify and measure accurately, which makes it much more difficult to add their contribution into a traditional cost-benefit analysis. Some of the co-benefits occur as a consequence of reduction of energy consumption, CO_2 emissions and costs respectively while others occur as a side effect of the renovation measures (e.g. less noise if change of windows).

Many issues determine whether occupants find energy renovation to be successful. The co-benefits in the shining examples include a big variety of issues like better indoor climate, comfort and architecture.

3.5. Country / climate specific measures

The energy renovation technologies implemented in the shining examples has been systemized according to the country or climate. All the buildings have been insulated, and 8 out of 9 have included new windows in the renovation. Solar heating is exploited either in an active or passive way in 5 of the cases. In most of the cases the heating system was renovated and/or supplied with renewable energy systems.

Summary of the energy renovation features:

- All the 9 examples carried out insulation of the envelope in one way or another. One Austrian and one Swiss example have changed the facade with new facade elements including active and passive elements or added an extra module for passive solar use;
- 8 examples have changed windows or glazing;
- 8 examples have ventilation with heat recovery;
- More than half (5) of the 9 examples have solar thermal features mainly for domestic hot water;
- 4 of the 9 cases have improved their lighting by LED or other efficient light;
- 4 of the 9 cases have new or improved heat distribution systems such as thermostatic valves, insulation of tubes or implemented individual meters;

- 6 of the 9 examples have changed or improved their heat supply: two of the examples have solar heating as heating supplement, one with ground coupled heat pump; one example has air to air heat pump (also working as air conditioning system), one new gas boiler is installed and one example has a gas driven CHP system.

Only one example has implemented an air condition system. This is one of the South European examples (in Portugal), where it gets quite hot during summer. In this case the windows area has been increased, improving the use of daylight and increasing heat gains, which are useful for winter. On the other hand, the increase in windows area also led to higher heat gains in summer and necessity of dealing with cooling needs.

Also in this example, heat recovery of the ventilation air is not applied due to the low savings potential because of the relative mild winter in this region of Portugal.

The examples from the Alps countries and the Central European country – The Netherlands – are using solar thermal systems for room heating – active or passive. This may be explained by a comparatively better coincidence of heating demand and available solar radiation.

4. Conclusions

The shining examples documented so far may be characterised as forerunners initiated by “first movers” and therefore the experiences documented may be somewhat different from what other new renovation project may meet. However, the multidisciplinary design approach of these examples demonstrates the potential of the renovation measures beyond functionality and energy consumption reduction. As a whole they state that this potential can be harnessed in all the scope of existing buildings renovations, from single family to multi-family buildings, with the appropriate adaptations to each context.

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References

[1] IEA EBC Annex 56, 2011-2015. www.iea-annex56.org

[2] Ove Christen Mørck et.al., “Shining Examples Brochure”. ISBN: 978-989-95961-7-7. Edited by University of Minho, May 2014 (112 pages). Available on line at: www.iea-annex56.org/index.aspx?MenuID=4