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Building renovation: which kind of guidelines could be proposed for policy makers and professional owners?

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Abstract

IEA IBC Annex 56 methodology provides the basis for the assessment and evaluation of energy related renovation options of residential building stock, first and foremost with respect to cost, energy use and carbon emissions. Furthermore, it allows also for a broader approach going beyond cost effective reduction of carbon emissions and energy use by taking into account co-benefits achieved in a renovation process. Besides impact indicators for primary energy use, carbon emissions and costs it also provides a methodological framework for integrating at least embodied energy use for renovation measures as part of a lifecycle impact assessment. The methodology and resulting fundamentals for renovation standards have to be applicable to different climatic and country specific situations. The Guideline for policy makers proposed by the Annex 56 gives useful information and suggestions to the drafting of legislative and administrative measures, at the national or local level, for reducing the amount of energy consumption and greenhouse gas emissions in renovation of residential buildings.

The reachable saving targets must be defined in agreement with the actors in the energy market, as the owners and / or the managers of buildings, but policy makers must be aware of their responsibility in defining cost effective levels for nearly zero energy or emissions building renovation, using a life cycle perspective, and the relevance of preparing adequate financial packages to support ambitious levels for building renovation. Furthermore, the Guideline for professional owners shall report outlines key drivers for building retrofit and use and the resulting impacts on energy consumption. This Guideline shall describe building and energy efficiency trends specific to the residential building sectors.

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1. Introduction

Buildings are responsible for more than 40% of world global energy used and as much as one third of global greenhouse gas (GHG) emissions, both in developed and developing countries. One of the fundamental questions in the global climate negotiations is to define what level of "ambition", in terms of collective emission reductions is needed to protect global climate. Building design decisions influence operation cost and environmental impact for a long time, typically decades. Among researchers and practitioners futures are discussed through scenarios and future environmental impacts and costs through life cycle assessment (LCA) and calculation of life cycle costs (LCC).

IEA IBC Annex 56 focuses his activity on "Cost Effective Energy and Carbon Emissions Optimization in Building Renovation". Annex 56 methodology (see Figure 1) provides the basis for the assessment and evaluation of energy related renovation options of residential building stock, first and foremost with respect to cost, energy use and carbon emissions to be used by interested private entities and agencies for their renovation decisions as well as by governmental agencies for the definition of regulations and their implementation. Furthermore, it allows also for a broader approach going beyond cost effective reduction of carbon emissions and energy use by taking into account co-benefits achieved in a renovation process. Besides impact indicators for primary energy use, carbon emissions and costs it also provides a methodological framework for integrating at least embodied energy use for renovation measures as part of a lifecycle impact assessment. The methodology and resulting fundamentals for renovation standards have to be applicable to different climatic and country specific situations.

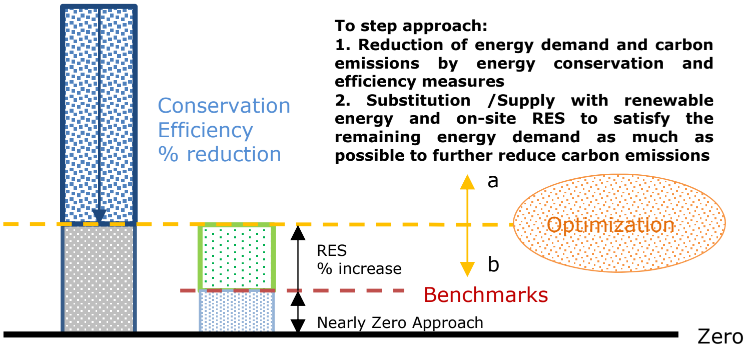

Figure 1 How to indicate an energy an GHG optimized building renovation (Geier S., Ott W.) [1]

The energy performance of buildings is generally so poor that the levels of energy consumed in buildings place the sector among the most significant CO_2 emissions sources in Europe [2]. While new buildings can be constructed with high performance levels, it is the older buildings, representing the vast majority of the building stock, which are predominantly of low energy performance and subsequently in need of renovation work. With their potential to deliver high energy and CO_2 savings as well as many societal benefits, energy efficient buildings can have a pivotal role in a sustainable future. Achieving the energy savings in buildings is a complex process. Policy making in this field requires a meaningful understanding of several characteristics of the building stock. Reducing the energy demand requires the deployment of effective policies which in turn makes it necessary to understand what affects people's decision making processes, the key characteristics of the building stock, the impact of current policies etc.

Integrated healthy home and energy-efficiency retrofit activities can simultaneously lower utility costs and improve indoor air quality. Leading energy-efficiency retrofit programs have demonstrated the feasibility of integrating many indoor air quality and safety improvements [3], [4]. However, home energy retrofit activities might negatively affect indoor air quality if the appropriate home assessment is not made before work begins and issues that may affect indoor air quality are not identified and properly addressed [5]. Today's building industry appears to be entering another era of change, with a view toward minimizing a different kind of footprint: the energy, carbon, and environmental footprint of commercial and residential buildings. Once again, change is being driven by a need to optimize and conserve resources — this time, clean air, water, and energy as well as land. And transformative technologies may hold the key to meeting the challenges. As designers, developers, and owners search for ways to minimize the operating costs and environmental impacts of buildings, while also increasing their functionality and appeal to occupants, "green" trends are becoming observable in the marketplace. One of the Guideline proposed by Annex 56 is addressed to a particular kind of owner, mean as "professional owners" or "professional promoters", who are typically involved in retrofitting interventions, rather than people involved in the renovation of singular buildings that need technical and economic information on renovation measures.

2. The "professional owners" Guideline

Millions of homes will be retrofitted in the coming years in order to improve their energy efficiency, make them more "green" or add features their owners want. For example, a substantial share of the stock in Europe (see in Figure 2 the main typologies for European buildings stocks [2]) is older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of our residential buildings have been constructed before the 1960s when energy building regulations were very limited. In EU 27, countries with the largest components of older buildings include the UK, Denmark, Sweden, France, Czech Republic and Bulgaria. A large boom in construction in 1961-1990 is also evident through our analysis where the housing stock, with a few exceptions, more than doubles in this period.

The performance of buildings depends on factors such as the performance of the installed heating system and building envelope, climatic conditions, behavior characteristics (e.g. typical indoor temperatures) and social conditions (e.g. fuel poverty). Data on typical heating consumption levels of the existing stock by age shows that the largest energy saving potential is associated with the older building stock where in some cases buildings from the 1960s are worse than buildings from earlier decades. The lack of sufficient insulation of the envelope in older buildings was also reflected through the historic U-value data which comes with no surprise as insulation standards in those construction years were limited. The average specific energy consumption in the non-residential sector is 280kWh m^{-2} (covering all end-uses) which is at least 40% greater than the equivalent value for the residential sector. In the nonresidential sector, electricity use over the last 20 years has increased by a remarkable 74%.

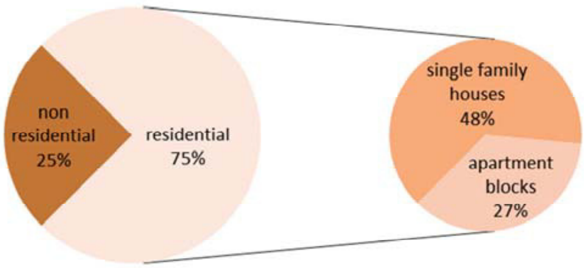

Figure 2 - EU 27 buildings stock [2].

Energy Performance Certificates (EPC) are required whenever a building is constructed or for existing buildings, before it is marketed for sale or rent [6]. EPCs are produced using standard methods with standard assumptions about energy usage so that the energy efficiency of one building can easily be compared with another building of the same type. This allows prospective buyers, tenants, owners, and occupiers to see and compare information on the energy efficiency and carbon emissions from a building, so they can consider energy efficiency and fuel costs as part of their investment decision. An EPC will include a recommendation report listing cost effective and other measures (such as low and zero carbon generating systems) to improve the energy rating of the building. The EPC also contains information about the rating that could be achieved if all the recommendations were implemented.

As consequence, the decision about the better interventions to be adopted (envelope, i.e. insulation of the external wall, basement, roof, improvement of the windows quality, the improvement of HVAC system and components, use of renewable energies) shall be made basing on a clear and detailed methodology as proposed by Annex 56.

Annex 56 methodology provides the basis for the assessment and evaluation of energy related renovation options of residential building stock, first and foremost with respect to cost, energy use and carbon emissions. Furthermore, it allows also for a broader approach going beyond cost effective reduction of carbon emissions and energy use by taking into account co-benefits and overall added value achieved in a renovation process. Besides impact indicators for primary energy use, carbon emissions and costs it also provides a methodological framework for integrating at least embodied energy use for renovation measures as part of a lifecycle impact assessment. It is supposed to allow to assume either an individual end-user and investor perspective respectively (financial or microeconomic) or a societal (macroeconomic) perspective. The methodology and resulting fundamentals for renovation standards have to be applicable to different climatic and country specific situations.

Buildings renovation give substantial benefits that can be felt at different level: economical, environmental al social one. One of the common problems associated with the evaluation of building renovation measures is that only the energy savings and the costs are considered, disregarding other relevant benefits and thus, significantly underestimating the full value of improvement and re-use of buildings at several levels of the economy [7]. A building owner will appreciate benefits like an increased user comfort, fewer problems with building physics or an improved aesthetics.

2.1 The Annex 56 Methodology

In this context, the notion co-benefits in Annex 56 refers to all benefits (positive or negative) resulting from renovation measures related to energy and carbon emissions optimized building renovation, besides or as a consequence of energy efficiency increment, carbon emissions reduction or costs reduction (see Figure 3).

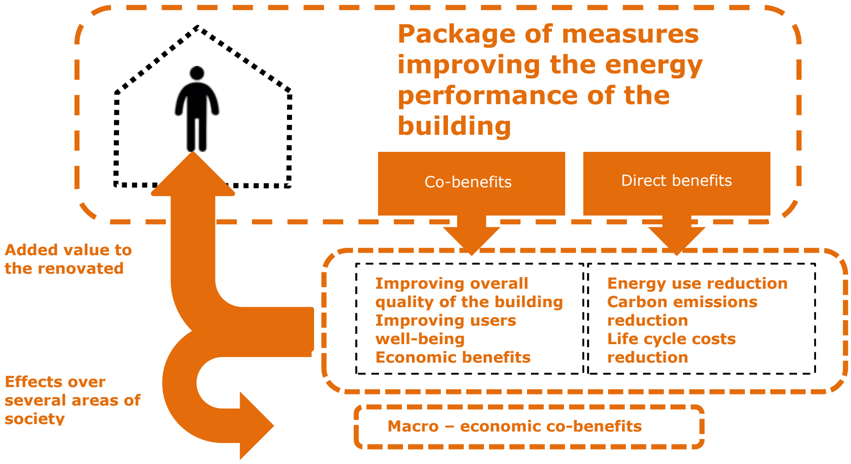

Figure 3 Direct benefits and co-benefits from cost effective energy and carbon emissions related building renovation

In Annex 56 the term co-benefits is used 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.

The co-benefits that arise from energy and carbon emissions related building renovation can be independent from energy, carbon emissions and costs (e.g. less outside noise), or can be a consequence of these (e.g. less risk exposure to future energy price increases), and the benefits can impact at private level (e.g. increased user comfort) or/and at society level (e.g. impact on climate change or air pollution). In Annex 56 the following co-benefits are considered: a) Thermal comfort; b) Natural lighting and contact with the outside environment, c) Improved air quality, d)

Reduction of problems with building physics, e) Noise reduction, f) Operational comfort, g) Reduced exposure to energy price fluctuations, h) Aesthetics and architectural integration, i) Useful building areas, j) Safety (intrusion and accidents), k) Pride, prestige, reputation and Ease of installation. 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).

3. The "policy makers" Guideline

The societal "macro" economic perspective is a basic approach to regulatory policy-making from an economic perspective. It is used when the justification for introducing energy performance regulations is to make organizations or individuals take actions that do not reflect their own direct interests (and are therefore unattractive as investments) but that can be shown to be beneficial for the society as a whole. An alternative – or complementary - approach would be to use taxation and financial policy to better align users perceptions with societal aims.

This approach takes into account all the costs incurred by any part of society and all the benefits that result, irrespective of where they occur. There is no distinction here between costs and benefits that fall on different sections of society - it is the net balance that is important. The macro perspective includes benefits (and costs) of "externalities", e.g., damage from climate change associated with CO_2 emissions. Since there is rarely a market price for such externalities (except for industry), it is necessary to devise "shadow prices" that reflect estimates of the value of such implications. Future costs and benefits are discounted at a "social discount rate" which is typically quite low, say 3 % per year in real terms. With the macro-economic approach, taxes and subsidies are ignored, since they represent a transfer of money from one part of society to another, rather than an aggregate cost or benefit.

For all perspectives (not only for the macro-economic case), there is also the risk that taxes and subsidies will not be maintained over the building lifetime. Although existing buildings represent a huge potential for climate change mitigation [2], it has been found hard to fully exploit this potential, mainly because of social and economic barriers that hamper owners and promoters in the decision-making process and mislead policy makers in the development of subsidy programs and in the design of building directives [7]. The possible barriers can be summarized as follows: economic/financial barriers; knowledge/information barriers; lack of interest and motivation for energy efficiency improvement; the landlord-tenant, developer-buyer or investor-user dilemma; technical barriers; market distortions and regulatory barriers; hidden costs and benefits; behavioral and organizational constraints; information barriers.

3.1 The role of the stakeholders

An important, but often overlooked, determinant of success in reducing greenhouse gases from buildings lies in the capacity of governments and other stakeholders in the Building Sector to design and implement policies effectively. Policies to reduce greenhouse gas emissions from buildings are usually multi-faceted and involve more than one stakeholder. Building activities must therefore involve the relevant parties to have the desired effects. Different types of skills are needed as indicated as follows:

Data collection, analysis and use: energy performance indicators are a critical ingredient in a wide variety of policy measures. However, without the capacity to collect, analyze and use data pertaining to energy consumption in buildings, government officials and building professionals alike will not be able to use them. Building this capacity requires both training as well as the availability of equipment to measure energy use. The availability of reliable data could also facilitate the application of energy use simulation software for buildings, which are proving to be effective tools for building designers and engineers.

Enforcement of regulatory policies: regulatory policies, such as Building Codes or Energy Efficiency Standards for appliances, will only make an impact on reducing greenhouse gas emissions if they are enforced. Enforcement requires appropriate training and understanding of what the policies are and what steps are needed if the object which is subject to the regulation falls short of the legal standard. The lack of enforcement has been identified as a major weakness of energy efficiency policies in developing countries.

Technical knowledge and skills: in order to propagate a new technology or building technique, the building professionals involved must be able to actually apply them. In this regard, the following training is needed for the development of personnel to certify a building's performance: qualification of raters; training the workforce (see e.g. http://www.buildupskills.eu/); development of standards for the field and performance testing verification; definition of quality assurance requirements; and the definition of insurance requirements.

Today, many governments have dedicated agencies and staff working for the promotion of energy efficiency. According to a survey of 70 countries conducted by the World Energy Council and ADEME in 2008, about two thirds of the countries surveyed have a national energy efficiency agency and over 90 percent have a Ministry Department dedicated to energy efficiency [8]. The European Union has even created an "Intelligent Energy Europe" Agency to manage energy efficiency projects including for buildings, as well as help establish local and regional energy efficiency agencies (European Commission Intelligent Energy Europe web site). These agencies often play a coordinating role to facilitate consultative processes and communications between stakeholders, including between different branches of the government itself.

Many policy instruments were not only found to be effective in achieving emission reductions, but they also resulted in net savings, in some cases of up US$ 200 per ton of CO_2 eq. avoided, if the benefits of saved energy and the associated avoided expenses are factored into the cost-benefit assessment. Regulatory and control instruments were found to be effective in terms of emission reductions as well as cost. Economic and market-based instruments also scored fairly well on both counts, as did one fiscal instrument (tax exemptions and reductions).

To select the most appropriate policies for the "carbon emissions" scenario of the Building Sector of their countries, governments should consider what policy objective they wish to target. Broadly speaking, the five major policy objectives, or targets, for reducing greenhouse gas emissions from buildings could be:

- Target 1: Increase the energy efficiency of new & existing buildings (both the physical envelope, and the operational aspects such as energy systems for heating, ventilation and other appliances);
- Target 2: Increase the energy efficiency of appliances (white goods, entertainment, personal computers and telecommunication equipment);
- Target 3: Encourage energy and distribution companies to support emission reductions in the Building Sector;
- Target 4: Change attitudes and behavior;
- Target 5: Substitute fossil fuels with renewable energies.

4. Final remarks

The definition of a strategy for energy savings and for carbon emission optimization requires that people involved in retrofitting interventions (in the Annex 56 proposals, policy makers and "professional owners") shall address their efforts in a same direction. These Guideline report outlines key drivers for building retrofit and use and the resulting impacts on energy consumption and the policy objectives that should be pursued.

The guidelines addresses especially to policy makers and building owners, but the main scope is to show a general overview of the reachable targets for all the actors in renovation of existing buildings.

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