Introducing cost-optimal levels for energy requirements

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Introduction

The recast of the Directive on the Energy Performance of Buildings (EPBD) states that Member States (MS) must ensure that minimum energy performance requirements for buildings are set "***with a view to achieve cost-optimal levels***", and that the cost-optimal level must be calculated in accordance with a comparative methodology. The ultimate goal of this is to achieve a cost-optimal improvement of buildings' energy performance (new and existing) in reality.

Methodology for calculating cost-optimal levels

EPBD recast and Comparative Methodology Framework

According to the EPBD recast "***assure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels***". MS must also: "***take the necessary measure to ensure that minimum energy performance requirements are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels***" (EPBD Art. 4.1 and also in Recital 14).

Cost-optimal levels are defined as "***the energy performance level which leads to the lowest cost during the estimated economic lifecycle***". MS will determine this level taking into account a range of costs like investments, maintenance, operating costs and energy savings. The economic lifecycle is defined by each MS. It refers to the estimated economic lifecycle of a building or building element.

The EPBD requires MS to report on the comparison between the minimum energy performance requirements and the calculated cost-optimal levels using the Comparative Methodology Framework provided by the Commission (EPBD Arts. 5.2, 5.3, 5.4 and Annex III). The report must also provide all input data and assumptions made. The Comparative Methodology Framework from the Commission consists of a Regulation document accompanied by Guidelines to enable MS:

- To define reference buildings.
- To define energy efficiency measures.
- To assess the final and primary energy needs of the reference buildings and the impact of the improvement measures.
- To calculate the cost of the energy efficiency measures by applying the principles of the comparative methodology framework.

The Commission also provides information on the estimated long-term energy price developments.

In case that the comparison shows that the requirements are significantly less than the cost-optimal level, MS need to justify this to the Commission. In case the gap cannot be justified, a plan has to outline steps to reduce the gap significantly. The Commission will publish a report on the progress of the MS.

The EPBD recast does not demand that MS set their minimum performance requirements at levels that are cost-optimal. It does however require them to report how their requirements differ from cost-optimal levels (implicitly as far as underperformance is concerned). If there are "significant" differences, i.e. exceeding 15% (meaning that their energy requirements are more than

15% above the cost-optimal level) MS should justify their existing energy requirements or describe how to reduce the difference.

Timeline

- A proposal for the framework was adopted by the European Commission on 16 January 2012.
- The Council voted by 1 March 2012 and there were no objections.
- This framework has to be accepted by the European Parliament and the Council.
- MS need to submit their reports to the Commission at regular intervals of maximum five years, with the first report due by June 2012 according to the recast. This date will be extended.

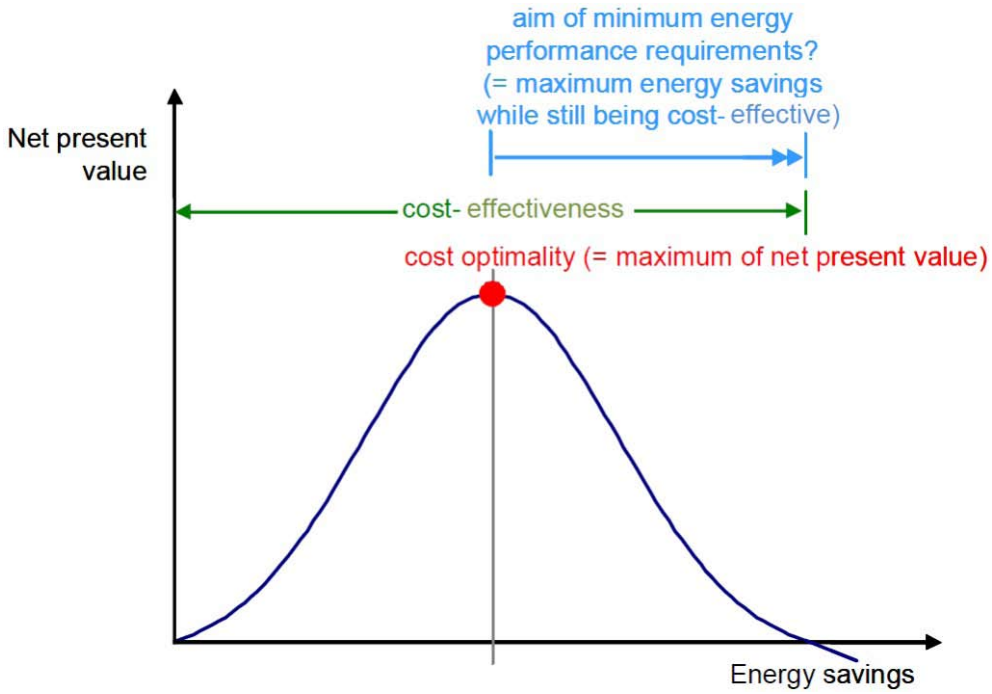

Figure 1. Scheme presenting cost optimality and cost effectiveness.

Cost effectiveness vs. cost optimality

The concepts of cost efficiency and cost optimality are related, but different. Cost optimality is a special case of cost effectiveness. A measure or package of measures is cost-effective when the cost of implementation is lower than the value of the benefits that result over the expected life of the measure. Both are based on comparing the costs and (priced) savings of a potential action - in this case, of introducing a particular level of minimum energy performance requirements for buildings. Future costs and savings are discounted, with the final result being a "net present value". If this is positive, the action is "cost-effective" (for the particular set of assumptions used in the calculation). The "cost-optimal" result is that action or combination of actions that maximises the net present value.

Cost optimality is relatively easy to determine for single measures operating in well-defined conditions - for example, the optimal insulation thickness for pipework operating at a constant temperature in a constant-temperature environment. It is a considerably more difficult process for complete buildings, and even more so for combinations of buildings such as a national building stock.

Figure 1 illustrates the principles of cost optimality and cost effectiveness. In reality, the distribution may not be uni-modal (it may have several local optima). Typically, the optimal level is less clear-cut than in the illustration and may be sensitive to data uncertainties. For each building type there is also a cloud of curves, depending on the real building and the cost-optimal measure combination.

Early experience

In December 2010, a working group of the Concerted Action EPBD was established to study the proposed first draft of the methodology for calculating cost-optimal levels and give feed-back to the Commission. Some main results from this work can be summarised as:

- Comparative framework can be a powerful instrument to guide MS and improve their energy requirements
- Excessively rigid comparison methodology can have a negative effect on setting national requirements
- To define reference buildings, there is a distinction between new and existing buildings
- The reference buildings should become as representative as possible for the national building typologies and changes in building tradition

- There is hardly any experience in setting up reference buildings for the existing stock
- In many cases, there is no sound statistical bases for "reference buildings"
- Should we create realistic buildings that are recognisable or should we focus on simplified schematic buildings reflecting some basic characteristics?
- How do we take into account the actual energy performance of the building (element) when applying measures?

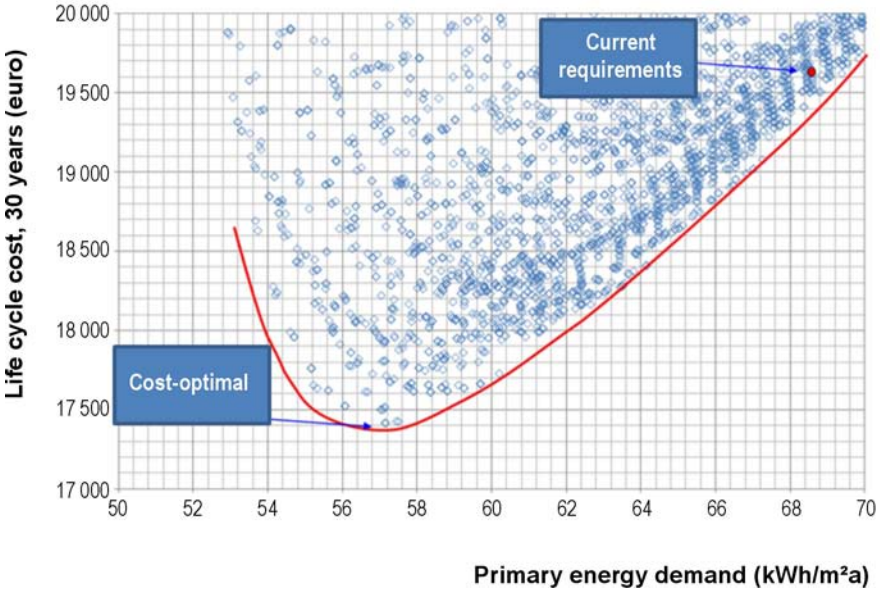

Figure 2. Example calculations for a country with current building energy requirements far from the cost-optimum point. It is clear that cost optimality can be improved significantly compared with the current requirements.

A summary report ("Cost-optimal levels for energy performance requirements") from this work is available at www.epbd-ca.eu or www.buildup.eu/publications.

Some MS have carried out calculations of cost-optimal levels in order to investigate the implications on their national energy regulations. In the illustrations below, part of this early experience is presented. If the current building energy regulation requirements are far above cost-optimal levels, calculations will show a curve with a clear optimum. On the other hand, if the current building energy requirements are already near the optimum, cost calculations seems to present flat curves.

Cost-calculation perspective

Cost effectiveness and cost optimality can be considered from several different perspectives, each of which will usually provide a different result. We summarise three important perspectives:

- of societal as a whole: the "macro" economic perspective
- of individual end-users
- of idealised end-users (private): the "micro" economic perspective

Each of these serves a different purpose and MS will, no doubt, assign a different importance to each of them when setting requirements.

Macroeconomic calculation levels include costs of greenhouse gas emissions and exclude taxes and subsidies. MS must determine the discount rate in the macro-economic calculation after having performed a sensitivity analysis with at least two different rates, one of which should be with 3%.

MS must carry out both the micro and the macro calculations, but MS still have the prerogative to decide which perspective will be the final national benchmarks.

Reference buildings

Article 5 of the EPBD (recast) requires MS to establish the comparative methodology framework in accordance with Annex III and to differentiate between different categories of buildings. Annex III states that MS must define reference buildings that are characterised by and representative of their functionality and geographic location, including indoor and outdoor climate conditions. The reference buildings must cover residential and non-residential buildings, both new and existing ones.

MS has to establish at least 9 reference buildings – one for new and two for existing buildings, for respectively single-family, multi-family, and office buildings. Yet, Annex I includes a list of building categories into which buildings should be adequately classified for the purpose of the energy performance calculation:

- single-family houses of different types
- blocks of flats
- offices
- educational buildings

- hospitals
- hotels and restaurants
- sports facilities
- wholesale and retail trade services buildings
- other types of energy-consuming buildings.

Ideally reference buildings are defined based on the characteristics of the building stock and the research purpose they are intended for. They can have two main purposes: to represent the aggregate stock of buildings affected by regulation; and to identify sectors that would be disadvantaged by requirements that might, nevertheless, be cost-optimal overall. Due to the limited statistical knowledge about the building stock, the choice of reference buildings has a more arbitrary nature. This arbitrary element in picking reference buildings might be a source of deviation and inconsistency in the cost-optimum comparison. Also the use of different service systems in comparably constructed buildings and as well as different user typologies will multiply the number of reference buildings.

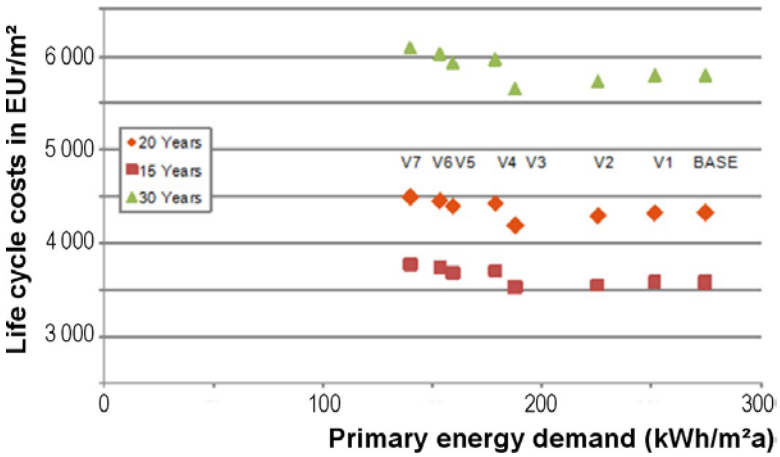

Figure 3. Calculations of cost-optimal levels for a country with current requirements (base) already near the cost-optimal point. The curves show that it is difficult to identify the cost optimal level if the current requirements are near the optimal point.

There have been several EU projects in the past dealing with this issue, but also some actual projects collect information on existing national reference buildings or try to develop national sets of reference buildings with IEE TABULA being one of them. TABULA aims to create a harmonised structure for European building typologies with focus on residential buildings (www.building-typology.eu).

Existing building stock

In addition to energy performance requirements for new buildings, MS must also set requirements for cost-optimal levels for the existing building stock. Some issues for consideration regarding procedures for achieving cost-optimal levels for the existing building stock can be emphasised:

- Acceptance can be a problem as the user knows the energy bill, the investments and savings – and if they do not converge, it will raise discussions.
- Multi-criteria vs. single-criteria performance decision-making will become an issue as other aspects than energy play a very important role in the investment of improvements.
- Private vs. societal perspective needs to be addressed. Different outcomes from the different approaches may raise a discussion on which perspective should become decisive.
- There may be competing investments to investments in energy-saving measures like lifestyle improvements (kitchen, garden, roof, etc.), new home electronics; education of children, etc.
- Split incentive between actors, within large companies, in case of selling (added property value).
- Whole building or component requirements can result in different solutions with the risk that one optimal solution identified e.g. on component level will be a hindrance for a better (later) solution on whole building level.
- Many of the energy improvements in the existing building sector will be driven by major renovation, and information on the combination of other planned works and energy improvements is crucial to communicate in a proper way to ensure cost-optimal solutions.

Final remarks

MS must compare their national minimum requirements with cost-optimal levels and report on the outcome. In case there is a significant gap that cannot be justified, MS should take measures to bring the requirements in line with cost-optimal levels. It is important to understand that a too rigid comparison methodology can have a negative effect on setting national requirements, e.g. exposing that a MS prescribe requirements that are stricter than those calculated by using the methodology for calculating the cost-optimal levels, even though

there may be well substantiated reasons why a MS should impose stricter requirements. A rigid EU methodology can reduce the reliability on the national level and also the flexibility to modify the national approach. The emphasis of justification of requirement levels towards the Commission by means of reference buildings and lists of measures may increase the risk that reality is too easily confused with reference buildings and seemingly cost-optimal levels based on reference buildings turn out to be sub-optimal in reality. It is thus important that the reference buildings developed in MS become as representative as possible for the national building typologies and changes in building tradition.

Without doubt, a Comparative Methodology Framework is a powerful instrument to guide MS in the process of checking the level of their minimum energy performance requirements and to improve the energy performance of their building stock. Sharing of knowledge and experience between MS will also be stimulated through the common procedure laid down in the Framework.

From the experience of several countries, it seems a satisfactory approach to have experts, in consultation with the market, define a number of not too complicated reference buildings for different user typologies. Based on these buildings, sensitivity studies can lead way to cost-optimal levels.

In comparing minimum energy performance requirements, extensive cost effectiveness studies can be executed for all building categories and related reference buildings. However it is of great importance also to allow a more comprehensive set of references and provide the flexibility in the framework to do so. Of course the reduction to a more comprehensive, but consistent set should be justified to the Commission regarding its validity for all relevant building categories.

Analysing the cost effectiveness of measures in the existing building stock is common practice in consultancy for specific buildings. For the purpose of setting or comparing energy performance requirements, measures have to be judged in a more general and transparent way in order to be valid for enforcing requirements. There is hardly any experience of how to do this properly. It is therefore of great importance to organise knowledge exchange and share experience.