EUROPEAN COMMISSION

Draft
Working Document on

COMMISSION REGULATION (EU) No …/..

of XXX

supplementing Directive 2010/31/EC of the European Parliament and of the Council on the energy performance of buildings (recast) by establishing a comparative methodology framework for calculating cost optimal levels of minimum energy performance requirements for buildings and building elements

EXPLANATORY MEMORANDUM

1. CONTEXT OF THE DELEGATED ACT

1.1. General context

The reduction of energy use in Europe's buildings is a cornerstone of the EU's policy on energy (efficiency) and climate change as well as the Europe 2020 strategy. Both the EU's recent strategy for energy policy[1] and the Energy Efficiency Plan[2] underline the need for further action in this sector, in particular regarding the existing building stock.

Directive 2010/31/EU on the energy performance of buildings (recast)[3] constitutes one of the measures announced in the Second Strategic Energy Review of 2008[4] that are necessary to remain on track for the EU's 20% energy efficiency target by 2020. However, the transformation of the EU's building stock will be completed only well after 2020 and the 20% target can only constitute an intermediate step. Indeed, the recent Commission roadmap for moving towards a competitive, low carbon economy[5] showed that emissions in the building sector could be reduced by around 90% by 2050. This represents a larger than average contribution over the long-term, due to the fact that in the building area – as opposed to, for example, the transport sector – the technological solutions needed for a low carbon society are already available today.

If the building sector is to deliver this important contribution by the middle of this century, cost-optimal energy performance requirements are needed as soon as possible. Several recent studies have demonstrated the negative long-term effects of suboptimal renovations where savings potentials are locked in for decades and the same applies for new constructions. This so-called 'lock in' effect can only be prevented by setting legal requirements at levels that capture all savings to be reaped over the estimated economic lifecycle of the building. With that, the inherent market failures in the area of energy efficiency in buildings due to the long payback times, the risk perception of lenders and the information deficit of private investors about what technologies are available, can be addressed.

The cost-optimal methodology framework can, if properly designed and applied, create a legal framework for raising Member States' minimum energy performance requirement levels to ensure that all economically rational measures are implemented. Cost optimality can also provide a good evidence base to improve the bankability of refurbishment projects, including those funded by European Investment Bank instruments and the European Regional Development Fund. Finally, the cost-optimal methodology framework can have the advantage of being technology neutral.

1.2. Objectives of the proposal

Article 5 of Directive 2010/31/EU on the energy performance of buildings (recast) requires the Commission to present, by 30 June 2011, a comparative methodology framework for

[1] COM 2010 (639) final
[2] COM 2011 (109) final
[3] OJ L 153, 18.6.2010, p. 13.
[4] COM 2008 (781) final
[5] COM 2011 (112) final

calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

Directive 2002/91/EC on the energy performance of buildings[6] (to be repealed with effect from 1 February 2012)[7] requires Member States to set minimum energy performance requirements for buildings based on a national calculation methodology. However, it does not contain requirements or guidance on how to do this. Directive 2010/31/EU now stipulates that Member States shall ensure that minimum energy performance requirements are set with a view to achieving cost-optimal levels for buildings, building units and building elements. To determine these cost-optimal levels, Member States are required to use a comparative methodology framework established by the Commission and complete this framework with the relevant national parameters. If the results of the calculations and comparison show that the current minimum energy performance requirements are significantly less efficient than the cost optimal ones, Member States are required to justify this difference in writing to the Commission. To the extent the gap is not justifiable, a plan for reducing the gap has to be established.

The comparative methodology framework is not meant to harmonise the minimum energy performance requirements per se, but to ensure that the level of ambition of every EU Member State in its given context is similar. Performance requirements are set by the Member States depending on local factors such as climate, resource availability and economic development. This ensures an equitable approach towards Member States with different levels of progress and experience. As such, it also fully respects the nature of Directive 2010/31/EU which is a framework Directive leaving the necessary scope for Member States to implement the provisions of the Directive in the most appropriate way. Such an approach can encourage a convergence of ambition levels and a peer pressure element, as was already laid out in more detail in the Impact Assessment that accompanied the proposal for Directive 2010/31/EU.[8]

1.3. Consistency with other EU policies and objectives

Consistency with related European legislation has been ensured. Directive 2010/31/EU uses the definitions of Directive 2009/28/EC on the promotion of the use of renewable energy sources and takes into account the buildings-related obligations therein.[9]

The cost-optimal framework methodology will also be used by Member States for setting minimum energy performance requirements for technical building systems. In this context, consistency with the Ecodesign requirements for building-related products such as boilers and air conditioners is ensured. Directive 2009/125/EC on establishing a framework for the setting of ecodesign requirements for energy-related products[10] allows for the setting of minimum EU requirements for such products with the aim of ensuring their free movement within the internal market. Under Directive 2010/31/EU on the energy performance of buildings, the objective of cost-effective or cost-optimal energy efficiency levels may, in certain circumstances, justify the setting by Member States of cost-effective or cost-optimal requirements which in practice would limit the installation of building products compliant with standards set by EU legislation, provided that such requirements do not constitute an unjustifiable market barrier. Directive 2009/125/EC and Directive 2010/31/EU also share a similar approach to life cycle costing, with the global cost approach being a variant of life

6 OJ L 1, 4.1.2003, p. 65.
7 See Directive 2010/31/EU, Article 29.
8 SEC (2008) 2865
9 Directive 2009/28/EC
10 OJ L 285, 31.10.2009, p. 10.

cycle costing that takes into account the use and if appropriate end of life phase, with a similar approach taken also for the discount rate. The recently adopted Regulation on construction products[11] also introduces life cycle costing when assessing the energy use of such products.

Finally, the present Commission Regulation has been drafted based on existing definitions and concepts for cost calculation that were developed for European standard EN 15459. As regards the calculation of the energy performance of building and building elements, the use of the existing CEN standards is recommended, although equivalent national procedures are accepted provided that they are in line with Annex I and Article 4(2) of Directive 2010/31/EU.

2. CONSULTATIONS PRIOR TO THE ADOPTION OF THE ACT

Extensive consultation was carried out by the European Commission in the preparation and drafting of this delegated act.

Two expert meetings were organised on 16 March 2011 and 6 May 2011 in Brussels. For both meetings, which brought together national and other experts, Member States were asked to nominate national representatives.[12] Apart from national experts, a balanced representation of stakeholders was invited, including manufactures of energy efficiency technologies (both systems and buildings related), the entire construction chain including experts for nearly zero-energy buildings, experts on EU standardisation, property owners and tenants' organisations, representatives of public banks and energy service companies. Given the heterogeneity of the building sector, participation was limited to EU umbrella organisations. Invitations were sent out based on a screening of stakeholders by the Commission services and the original list was amended upon request. Finally, academic experts, including from the International Energy Agency, were present at both meetings.

2.1. The first expert meeting on 16 March 2011

The purpose of the first meeting, which was attended by 46 participants from Member States and 43 other stakeholders, was twofold: To obtain expert input on key scope and methodology issues and to get a better understanding of current cost effectiveness methodologies applied in the Member States.

To address the issues surrounding scope and methodology, a meeting document with 23 questions was sent to the experts ahead of the meeting, covering:

- The need for consistency between the nearly zero energy target and the cost optimal requirements;
- The degree of detail needed for the reference buildings as well as other input data;
- The perspective for cost optimality (macro level or the level of the individual investor);

[11] REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (OJ L 88, 4.4.2011, p.5)

[12] These national experts could or could not be the same expert as the one representing the Member State in the Energy Performance in Buildings Committee (EDMC (buildings formation).

- Cost optimality at the building element level;
- The need to include lighting systems for the non-residential sector;
- Energy price development trends and data sources;
- The need to address demolition as part of the methodology.

Experts were free to comment during, and/or in writing before or after the meeting. In addition to comments on the specific questions, national authorities were invited to present their national approach to setting cost-effective minimum energy performance requirements, an opportunity taken by four EU Member States: Denmark, Germany, the Netherlands and Italy. All relevant working documents were circulated to the experts and stakeholders, and a simultaneous, timely and appropriate transmission of the meeting documents to the European Parliament and the Council was ensured. All meeting documents, including the presentations from the four Member States and the written contributions received, were published on the Commission's website.

Summary of responses during the first expert meeting and how they have been taken into account:

While the opinions expressed during the meeting or in writing before or after the meeting by experts and stakeholders revealed a solid majority in favour of the inclusion of lighting systems for the non-residential sector and the exclusion of the demolition phase from the scope of this delegated act, the picture was less conclusive on other scope and methodology-related questions.

On reference buildings:

Member States' presentations and interventions revealed approaches differing in methodology and degree of detail, with Germany using a rather comprehensive catalogue and the Netherlands working with only a few reference buildings in the residential sector and adjusted use patterns for the non-residential sector. Denmark does not work with full reference buildings typologies, but sample buildings. Not all Member States have a database for reference buildings currently in place.

While many stakeholders urged that the typologies for existing building should reflect as accurately as possible the actual (average) building stock, national experts pointed to the fact that a 'statistically representative' reference building might become very complex or unrealistic.

On the other hand, it seemed to be generally acceptable that for new buildings the definition of the reference building does not have to be too detailed regarding the building envelope and the building systems, as in this case one is only bound by the basic geometry and use pattern. One national expert drew attention to the fact that for new buildings the subcategories of buildings could already be used to rule out very inefficient options upfront (e.g. full glass façade). Moreover, it was pointed out that the reference building should not only be representative of the energy performance, but also of the cost structure of the national building stock.

The Commission services proposed the option to use a reporting sheet annexed to the delegated act to allow Member States to pursue current approaches, but still ensure a maximum degree of transparency for the Commission on how reference buildings are defined.

The approach finally proposed is one in which Member States have the freedom to establish reference buildings for at least single family buildings, apartment blocks and multi-family buildings, and office buildings (with a minimum of two reference buildings for existing buildings and one for new buildings for each category), and where reporting through a common template ensures transparency.

On cost optimality at building element level:

The specificities of the Ecodesign Directive and the Directive 2010/31/EU and how they interlink were discussed. Attention was drawn to the fact that the products regulated under Ecodesign are always part of a system (working under varying climatic conditions with varying heat and cooling demand), which is why national building regulations often add criteria on top of product requirements.

On other input data, in particular for the cost calculations:

The proposal of using a calculation period of 30 years met with more support than criticism. Stakeholders expressed different views on whether different calculation periods for non-residential and residential buildings are appropriate. National experts expressed different views ranging from calculation times of 60 years to less than 20. Attention was drawn to the fact that the calculation period can still use residual values if the estimated economic lifetime of the building was to be longer. One academic expert underlined that it would be very difficult to predict prices for a timeframe of more than 30 years. Taking into consideration future expected higher values for more energy efficient buildings was considered too premature by stakeholders.

As a result of these discussions, it is proposed to keep a calculation period of 30 years for residential buildings, but to allow for a shorter calculation period of 20 years for non-residential, commercial buildings given the shorter investment cycles for such buildings. Given the exemplary role of public authorities, calculations for public buildings should also use a calculation period of 30 years. Member States remain free to establish national estimated economic lifecycles of both buildings and building elements as required by the Directive.

On the question for who cost optimality would need to be defined:

An ambiguous picture emerged for Member States, with one Member State arguing for a private perspective only, one in favour of a purely societal perspective, and several for having both. Other stakeholders were also divided with property owners and social housing companies arguing for a consideration of the specifics of rented buildings and researchers claiming that the macro-level perspective is a must. According to one researcher, the cost-optimum at macro-economic level could imply 117% higher requirements than at private level, but there is no common agreement on how large the macro-perspective scope has to be. Attention was drawn to slight differences in the calculations that need to be used for each of them. Despite the different opinions on macro vs. micro level, it was common ground that all Member States should use the same approach.

On the link between cost optimality and nearly zero-energy buildings:

Participants broadly shared the Commission's view that as a general rule first the energy needed for heating and cooling should be reduced and only then renewable energy sources (RES) could be integrated. Nevertheless, in specific cases some renewable-based solutions are already today cost-optimal and more advantageous than energy efficiency based measures, with the subsequent discussion focussing mainly on issues related to system boundaries (e.g. building or neighbourhood).

Different views were expressed on whether RES-based solutions would also need to prove their cost effectiveness.

Social housing associations pointed to the fact that only the reduction of the energy demand would result in lower energy bills for tenants. Another stakeholder feared that the requirement for nearly zero-energy buildings might result in a slowdown in the construction of new buildings. While the precise details of the national applications of the nearly zero definition in all EU Member States are as yet unknown, it was generally understood that the definition of cost optimality by 2013 can be a first step towards the nearly zero-energy target by 2019 (public sector)/2021 (all new buildings) laid down in the Directive.

On the energy price developments:

Experts pointed to the importance of the electricity price and the CO_2 price to be included in the energy price predictions. The importance of an obligatory sensitivity analysis on the energy price developments was highlighted by one expert. Denmark drew attention to the fact that energy price developments are easier to predict at macro level than from a private perspective and that possible price decreases for products and services ought to be considered.

2.2. The second expert meeting on 6 May 2011

The second expert meeting on 6 May 2011 was attended by 73 participants of which most had been present already at the first meeting. A few more stakeholder associations were added to the list for the second meeting upon their request. The discussion was based on a working document with a first draft delegated act, as well as a draft reporting template. These had been circulated to all experts on 20 April and 4 May 2011 respectively, and were sent to the operational EP Mailbox and the Council contact point.

Summary of responses expressed at the 2nd expert meeting and how they have been taken into account:

Overall the opinions expressed at the expert meeting of 6 May 2011 supported the overall approach and aimed at improving the draft text. Moreover, the discussions helped to clarify and amend the following issues:

– The approach taken towards existing and new buildings should be the same, and thus a full cost approach should also be adopted for existing buildings (changed in the final proposal);

– Several Member States representatives called for a simple procedure to avoid too many calculations and reporting obligations. The following approach is now proposed:

- Reduction of the minimum number of reference buildings to be the subject of calculation from 16 to 9, with in particular a lesser burden for establishing reference buildings for the non-residential sector;

- Reduction of the requirements related to calculation and reporting on measures needed for nearly zero-energy buildings so that Member States are only obliged to include measures based on renewable energy sources and those necessary for reaching the nearly zero-energy building requirement for *new* buildings;

- Furthermore, Member States will not have to include measures in the calculation when it is obvious from the start that such measures are not (yet) cost optimal;

– With only one stakeholder disagreeing, several Member States and other stakeholders expressed the wish that the specific situation in rented buildings should not influence the setting of requirements and should only constitute a recommendation for Member States to look into. The text has been changed accordingly.

– There were interventions in favour of and against an obligatory sensitivity analysis. The approach finally proposes to require from Member States a sensitivity analysis for at least the energy price developments as well as for several discount rates given the significant influence of these parameters on the outcome of the calculations, and given the fact that such an analysis is already done in half of the Member States. Member States will be free to decide when to undertake such an analysis.

– The description of cost elements to be taken into account for investments (Directive 2010/31/EU, Annex III) was removed and will be included into the guidance document as it could never be exhaustive and do justice to all (emerging) technologies. Even in the guidance document, it can only have an indicative character.

– The definitions for cost-optimal level and investment costs were changed. The definitions for costs, market interest rate and component were removed. The following definitions were added: reference building, final/delivered energy, investment cost, running cost, energy costs, disposal cost, energy efficiency related costs, discount factor, package, variant.

– On the question of the discount rate the discussions showed a preference for a discount rate reflecting a societal perspective – or both societal and rational private perspective - on setting cost-optimal minimum energy performance requirements. It is now proposed to leave it for Member States to set the discount rate for the purposes of the cost-optimal calculations, but to impose a sensitivity analysis addressing amongst others the impact of changes in the discount rate on the calculation results.

2.3. Input from national experts through the Concerted Action

The experience in requirement-setting at national level gathered in the Concerted Action for the EPBD[13] was also drawn upon. The Concerted Action is a forum bringing together the implementing bodies of 29 countries and is supervised by the Energy Demand Management Committee. Its purpose is to exchange best practice in implementing the Directive. In the framework of the Concerted Action two extensive questionnaires on national studies and approaches towards the setting of cost-optimal requirements that were completed by national implementing bodies.

A temporary working group was set up within the Concerted Action which held sessions on this topic in September 2010 and April 2011. A representative of the Concerted Action reported the main conclusions of the working group's work during the second expert meeting on 6 May 2011. The working group focussed on implementation challenges around the establishment of reference buildings for the existing building stock, on how to derive the cost-optimal levels from the calculations and on how to establish costs and prices. It underlined the need for a simple approach at this stage that does not harmonise too many parameters and also does not require too much reporting. Furthermore, it recommended a review once more knowledge is available. The Commission clarified that a revision of the delegated act within the next years is not a feasible option, but indicated that the non-binding accompanying guidance document could be used for updates.

The presentation from the Concerted Action given at the expert meeting of 6 May 2011 (which was based on a questionnaire filled in by 20 national administrations) showed that eleven Member States calculate cost optimal levels at micro level, three at macro level and four make the calculation from both perspectives. Currently, eight Member States do not work with reference buildings, while nine do. Nine countries calculate the primary energy use, three countries delivered energy and eight use other parameters. Half of the Member States already carry out sensitivity analysis. Half of the Member States believe that measures based on renewable energy sources should be incorporated in the cost-optimal calculation. Climate data does not constitute a problem and is available in Member States. A majority of the Member States do not (fully) use EN 15459 for their cost calculations.

2.4. Other meetings and scientific support

The initiative was discussed on many occasions at meetings with stakeholders during 2010 and the first half of 2011. This also included exchanges with experts from the European Investment Bank, International Energy Agency and the World Bank.

The Commission's Directorate-General for Energy (DG ENER) was supported by the Centre for Energy at the Joint Research Centre in Ispra. Exteral studies and reports from the European Council for an Energy Efficient Economy[14], Ecofys[15] and the Buildings Performance Institute Europe (BPIE)[16], cost effectiveness approaches used in the US such as

[13] http://www.epbd-ca.org/

[14] http://www.eceee.org/buildings/cost_optimality

[15] How deep to go: Remarks on how to find the cost-optimal level for building renovation. Ecofys 2009.

[16] http://dl.dropbox.com/u/4399528/BPIE/BPIE_costoptimality_publication2010.pdf

in Florida[17] and at the US federal level[18] and existing Iintelligent Energy Europe (IEE) projects including ASIEPI[19], EPA-NR[20] and TABULA[21] were considered.

3. LEGAL ELEMENTS OF THE PROPOSAL

The delegated act supplements Directive 2010/31/EU on the energy performance of buildings (recast), in particular those provisions of the Directive requiring Member States to set minimum energy performance requirements with a view to achieving cost-optimal levels.

- **Subsidiarity principle**

The proposed comparative framework methodology retains a wide discretion for Member States such as for the calculation of energy performance requirements where national procedures are kept provided that they are in line with Annex I and Article 4(2) of Directive 2010/31/EU. Similarly, for the step of identifying reference buildings the proposal contains only limited requirements and guidance.

The proposal fixes the following input data:

- Calculation period;
- Starting year for the calculations;
- Cost categories;

Moreover, the proposal provides information about the energy price developments for oil, gas, coal and electricity.

Member States complement the framework methodology by;

- Determining the estimated economic lifecycle of buildings and building elements;
- Setting the discount rate
- Establishing cost data for energy prices, products, systems, maintenance cost, operational costs and labour costs;
- Determining energy price developments for energy carriers
- Undertaking a sensitivity analysis for key input parameters, including for the discount rate (using at least two different rates) and energy prices.

As required by Annex III of Directive 2010/31/EU, the present delegated act on a methodology framework is accompanied by guidelines outlining how to apply the framework

[17] Energy Efficiency Cost-Effectiveness Tests for Residential Code Update Processes FSEC-CR-1794-09, Florida Solar Energy Center. Final Report 2009

[18] Life Cycle Costing Manual for the Federal Energy management Programme. US Department of Commerce. Handbook 135 on: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=907459 plus its annual supplement 2010: http://www1.eere.energy.gov/femp/pdfs/ashb10.pdf

[19] www.asiepi.eu

[20] http://www.epa-nr.org/

[21] http://www.building-typology.eu/tabula.html

for the calculation of cost optimal levels. Contrary to the delegated act, the accompanying guidelines are non-binding in nature.

- **Legal basis**

The proposed Regulation is a delegated act provided for by Article 5 of Directive 2010/31/EU, which is based on Article 194(2) of the Treaty on the Functioning of the European Union.

- **Proportionality principle**

In accordance with the principle of proportionality, this measure does not go beyond what is necessary in order to achieve the objective. It offers a methodology framework which provides for the calculation of cost-optimal levels of minimum energy performance requirements for buildings. This allows Member States to identify whether their existing requirements are below the optimal levels, i.e. money from energy savings are lost every time these requirements are applied.

4. BUDGETARY IMPLICATION

The proposal has no implications for the Community budget.

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supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings (recast) by establishing a comparative methodology framework for calculating cost optimal levels of minimum energy performance requirements for buildings and building elements

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)[22] and in particular Article 5(1) thereof,

Whereas:

(1) Directive 2010/31/EU requires the Commission to establish by means of delegated acts a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

(2) It is the responsibility of Member States to set minimum energy performance requirements for buildings and building elements. Those requirements must be set with a view to achieving cost-optimal levels. The cost-optimal level shall lie within the range of performance levels where the cost-benefit analysis over the lifecycle if positive.

(3) Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products[23] provides for the establishment of minimum energy performance requirements for such products. When setting national requirements for technical building systems, Member States must take into account the implementing measures established under this Directive.

(4) Directive 2010/31/EU does not prevent any Member State from maintaining or introducing more stringent measures than set out in that Directive. Such measures must be compatible with the Treaties and must be notified to the Commission.

[22] OJ L 153, 18.6.2010, p. 13.
[23] OJ L 285, 31.10.2009, p.10.

(5) The objective of cost-effective or cost-optimal energy efficiency levels may, in certain circumstances, justify the setting by Member States of cost-effective or cost-optimal requirements for building elements that would in practice limit the installation of building products that comply with EU legislation, provided that such requirements do not constitute an unjustifiable market barrier.

(6) The steps that must compose the comparative methodology framework have been set out in Annex III of Directive 2010/31/EU and include the establishment of reference buildings, the definition of energy efficiency measures to be applied to these reference buildings, the assessment of the primary (and final) energy demand of these measures and the calculation of the costs (i.e. net present value) of these measures.

(7) For the purpose of adapting the comparative methodology framework to national circumstances, Member States should determine the estimated economic lifecycle of a building and/or building element, the appropriate cost for energy carriers, products, systems, maintenance, operational and labour costs, primary energy conversion factors; and the energy price developments on this point to be assumed for fuels used in their national context for energy used in buildings, taking into account the information provided by the Commission. Member States should also establish the discount rate to be used in the calculations, bearing in mind cost optimal levels of generally applicable minimum energy performance requirements require a broader or long-term scope than only looking at an individual's required return in particular markets.

(8) To ensure a common approach in the application of the comparative methodology framework by the Member States, it is appropriate for the Commission to establish the key framework conditions needed for net present value calculations such as the starting year for calculations, the cost categories to be considered and the calculation period to be used.

(9) Establishing a common calculation period does not conflict with Member States' right to fix the estimated economic lifecycle of buildings and/or building elements since the latter could both be longer or shorter than the calculation period fixed. The economic lifecycle of a building or building element has only limited influence on the calculation period since the latter is determined rather by the refurbishment cycle of a building, which is the period of time after which a building undergoes a major refurbishment.

(10) Cost calculations and projections with many assumptions and uncertainties, including for example energy price developments over time, are generally accompanied by a sensitivity analysis to evaluate the robustness of the key input parameters. For the purpose of the cost optimal calculations, the sensitivity analysis should at least address the discount rate and energy price developments to be used.

(11) The aim of the comparative methodology framework is for Member States to compare the results of the cost-optimal calculations with the minimum energy performance requirements in force and to use the result of the comparison to ensure that minimum energy performance requirements are set with a view to achieving cost-optimal levels. Member States should also consider setting minimum energy performance requirements for those building (sub-) categories where so far no minimum energy performance requirements exist.

(12) The results of the calculations and the input data and assumptions used are to be reported to the Commission as stipulated in Article 5(2) of Directive 2010/31/EU. These reports should enable the Commission to assess and report on the progress of Member States in reaching cost-optimal levels of minimum energy performance requirements.

(13) To limit their administrative burden, it should be possible for Member States to reduce the number of calculations by establishing reference buildings that are representative for more than one building category, without affecting Member States' duty under Directive 2010/31/EU to set minimum energy performance requirements for certain building categories.

HAS ADOPTED THIS REGULATION:

Chapter 1
Subject matter and scope

In accordance with Article 5, Annex I and Annex III of Directive 2010/31/EU, this Regulation establishes a comparative methodology framework to be used by Member States for calculating cost-optimal levels of minimum energy performance requirements for new and existing buildings and building elements.

The methodology framework specifies rules for comparing energy efficiency measures, measures incorporating renewable energy sources and packages and variants of such measures, based on the primary energy performance and the cost attributed to their implementation, and on how to apply these rules to selected reference buildings with the aim of identifying cost-optimal levels of minimum energy performance requirements.

Chapter 2
Definitions

In addition to the definitions in Article 2 of Directive 2010/31/EU, the following definitions shall apply.

(1) *Global cost* means the sum of the present value of the initial investment costs, sum of running costs and replacement costs (referred to the starting year); as well as disposal costs if applicable;

(2) *Initial investment costs* mean all costs incurred up to the point when the building or the building element is delivered to the customer, ready to use. These costs include design, purchase of building elements, connection to suppliers, installation and commissioning processes.

(3) *Energy costs* mean annual costs and standing charges for energy including national taxes;

(4) *Operational costs* mean all costs linked to the operation of the building including annual costs for insurance, utility charges and other standing charges and taxes

(5) *Maintenance costs* mean annual costs for measures for preserving and restoring the desired quality of the building or building element. This includes annual costs for inspection, cleaning, adjustments, repair and consumable items;

(6) *Running costs* means annual maintenance costs, operational costs and energy costs;

(7) *Disposal costs* mean the costs for deconstruction at the end-of-life of a building or building element and includes deconstruction, removal of building elements of which the lifetime is not yet finished, transport and recycling;

(8) *Annual cost* means the sum of running costs and periodic costs or replacement costs paid in a certain year;

(9) *Replacement cost* mean a substitute investment for a building element, during the calculation period according to their estimated economic lifetime during the calculation period

(10) *Reference building* means a hypothetical or real reference building that represents the typical building geometry and systems, typical energy performance for both building envelope and systems, typical functionality and typical cost structure in the Member State and is representative of climatic conditions and geographic location;

(11) *Inflation rate* means a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) expressed in %;

(12) *Discount rate* means a definite value for comparison of the value of money at different times expressed in real terms;

(13) *Discount factor* means a multiplicative number used to convert a cash flow occurring at a given point in time to its equivalent value at the starting point. It is derived from the discount rate;

(14) *Starting year* means the year on which any calculation is based and from which the calculation period is determined;

(15) *Calculation period* means the time period considered for the calculation usually expressed in years;

(16) *Estimated economic lifecycle of a building, building element* means the expected lifetime of a building or building element expressed in years;

(17) *Residual value* of a building means the sum of the residual values of the building and building elements at the end of the calculation period;

(18) *Price development* means the development over time of prices for energy, products, building systems, services, labour, maintenance and other costs and can be different from the l inflation rate

(19) *Energy efficiency measure* means a change to a building resulting in a reduction of the building's primary energy need.

(20) *Package* means a set of energy efficiency measures or measures based on renewable energy sources applied to a reference building;

(21) *Variant* means the global result and description of a full set of measures/packages applied to a building that can be composed of a combination of measures on the building envelope, passive techniques, measures on building systems and/or measures based on renewable energy sources;

(22) *Subcategories of buildings* means categories of building types that are more disaggregated according to size, age, construction material, use pattern, climatic zone or other criteria than those established in Annex I(5) of Directive 2010/31/EU. It is for such subcategories that reference buildings are generally established;

(23) *Primary energy* means energy from renewable and non-renewable sources which has not undergone any conversion or transformation process;

(24) *Final energy* means the total energy expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances etc.);

(25) *Delivered energy* means energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances etc.) or to produce electricity;

(26) *Energy needed for heating and cooling* means heat to be delivered to or extracted from a conditioned space to maintain intended temperature conditions during a given period of time;

(27) *Energy exported to the grid* means energy expressed per energy carrier delivered by the technical building system through the system boundaries and used outside the system boundary;

(28) *Conditioned space* means heated or cooled space;

(29) *Energy from renewable sources* means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.

Chapter 3
Comparative methodology framework

1. When calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements, Member States shall apply the comparative methodology framework laid down in Annex I of this Regulation.

2. For the purpose of the calculations, Member States shall:

   (a) Take as a starting year for the calculation the year in which the calculation is being performed;

(b) Use the calculation period in Annex I of this Regulation;

(c) Use the cost categories in Annex I of this Regulation.

3. Member States shall complement the comparative methodology framework by determining for the purpose of the calculations the:

(a) The estimated economic lifecycle of a building and/or building element;

(b) The discount rate;

(c) The costs for energy carriers, products, systems, maintenance cost, operational costs and labour costs;

(d) The energy price developments to be assumed for all energy carriers taking into account the information in Annex II of this Regulation.

4. Member States shall endeavour to calculate and adopt cost-optimal levels of minimum energy performance requirements in relation to those building (sub-) categories where so far no specific minimum energy performance requirements exist.

5. Member States shall undertake an analysis to determine the sensitivity of the calculation outcomes to changes in the applied parameters, covering at least the impact of different energy price developments and discount rates, as well as other parameters which are expected to have a significant impact on the outcome of the calculations.

Chapter 4

Comparison of the calculated cost-optimal levels with current minimum energy performance requirements

1. Member States shall compare the outcome of the calculations referred to in Article 3 with the current energy performance requirements for the same reference buildings.

Member States shall use the result of this comparison to ensure that minimum energy performance requirements are set with a view to achieving cost-optimal levels in accordance with Article 4 (1) of Directive 2010/31/EU.

2. If Member States have defined reference buildings in such a way that the result of the cost-optimal calculation is applicable to several building categories or subcategories, they shall use this result to ensure that minimum energy performance requirements are set with a view to achieving cost-optimal levels for all these building categories or subcategories.

Chapter 5

Review of the cost-optimal calculations

1. Member States shall review their cost-optimal calculations in time for the review of their minimum energy performance requirements required by Article 4(1) of Directive 2010/31/EU.

2. The results of this review shall be transmitted to the Commission in the report provided for by Article 6 of this Regulation.

Chapter 6
Reporting

1. Member States shall report to the Commission all input data and assumptions used for the calculations and the results of those calculations. This report shall include the conversion factors applied, the sensitivity analysis referred to in Article 3(5) of this Regulation and the assumed energy price developments for energy carriers referred to in Article 3(3)d of this Regulation.

2. If the result of the comparison referred to in Article 4 of this Regulation shows that the minimum energy performance requirements in force are significantly less energy efficient than cost-optimal levels of minimum energy performance requirements, the report shall include any justification for the difference. To the extent that the gap cannot be justified, the report shall be accompanied by a plan outlining appropriate steps to reduce the gap to a non-significant size by the next review.

3. Member States can make use of the reporting format provided for in Annex III of this Regulation.

Chapter 7
Entry into force and application

1. This Regulation shall enter into force on the 20th day following its publication in the *Official Journal of the European Union*.

2. It shall apply from 9 January 2013 to buildings occupied by public authorities and from 9 July 2013 to other buildings.

This Regulation shall be binding in its entirety and directly applicable in all the Member States.

Done at Brussels,

For the Commission
The President
Jose Manuel BARROSO

ANNEX I
Cost-optimal methodology framework

1. Establishment of reference Buildings

(1) Member States shall establish reference buildings for the following building categories:

1) single family buildings

2) apartment blocks and multi-family buildings;

3) office buildings.

(2) In addition to office buildings, Member States shall establish reference buildings for other non-residential building categories listed in Annex I paragraph (5)d to 5(i) of Directive 2010/31/EU for which specific energy performance requirements exist.

(3) If a Member State is able to demonstrate in the report referred to in Article 6 of this Regulation that an established reference building can be applicable to more than one building subcategory or, in case of non-residential buildings, to an entire building category, it may reduce the number of reference buildings used and with that the number of calculations. Member States shall justify this approach on the basis of an analysis showing that a reference building that is used to serve several building categories or subcategories is representative of the building stock for all the categories and subcategories covered.

(4) For each building category, at least one reference building shall be established for new buildings and at least two for existing buildings subject to major renovation. Reference buildings may be established on the basis of building subcategories (e.g. differentiated by size, age, cost structure, construction material, use pattern or climatic zone) that take into account the characteristics of the national building stock. Reference buildings and their characteristics shall correspond to the structure of current or planned energy performance requirements.

(5) Member States can make use of the reporting format provided in Annex III to report to the Commission the parameters considered in the establishment of the reference buildings. The underlying data set on the national building stock used for the establishment of the reference buildings should be communicated to the Commission as part of the report referred to in Article 6. In particular the choice of characteristics that underpin the establishment of reference buildings shall be justified.

(6) For existing buildings (both residential and non-residential), Member States shall apply at least one package of measures representing a standard renovation necessary to maintain the building/building unit (without additional energy efficiency measures beyond legal requirements).

(7) For new buildings (both residential and non-residential), the currently applicable minimum energy performance requirements shallconstitute the basic requirement to be met.

(8) Member States shall calculate cost-optimal levels also for minimum performance requirements for building elements installed in existing buildings or shall derive those from the calculations done at buildings level. When setting requirements for building elements installed in existing buildings, the cost optimal requirements should to the extent possible take into account the interaction of that building element with the entire reference building and other building elements.

(9) Member States shall endeavour to calculate and set cost optimal requirements at systems level also for lighting systems for existing non-residential buildings or derive these from the calculations done at buildings level.

2. IDENTIFICATION OF ENERGY EFFICIENCY MEASURES, MEASURES BASED ON RENEWABLE ENERGY SOURCES AND/OR PACKAGES OF SUCH MEASURES FOR EACH REFERENCE BUILDING

(1) Energy efficiency measures shall be defined for all input parameters for the calculation that have a direct or indirect impact on the energy performance of the building including for new buildings on alternative high efficiency systems such as the ones listed in article 6 of Directive 2010/31/.

(2) Measures may be bundled to packages of measures or variants. If certain measures are not suitable in a local, economic and climatic condition, Member States should indicate this in their reporting to the Commission in accordance with Article 6 of this Regulation.

(3) Member States shall also identify measures/packages/variants using renewable energy for both new and existing buildings. Binding obligations laid down in the national application of Article 13 of Directive 2009/28/EC shall be considered as one measure/package to be applied in that Member State.

(4) Energy efficiency measures/packages/variants identified for the calculation of cost optimal requirements shall include measures necessary to meet the currently applicable minimum energy performance requirements. If applicable, they shall also include measures/packages necessary to meet the requirements of national support schemes. Member States shall also include some measures/packages/variants necessary to meet the minimum energy performance requirements for nearly zero-energy buildings for new buildings as defined by Article 9 of Directive 2010/31/EU.

(5) If a Member State can demonstrate by submitting as part of the reporting referred to in Article 6 previous cost analyses that certain measures/packages/variants are far from cost optimal, these measures may be excluded from the calculation. However, such measures/packages shall be revisited in the next review of the calculations.

(6) The selected energy efficiency measures and measures based on renewable energy sources, and packages/variants, shall be comfort-compatible with a view to air quality and summer comfort, and safe with regard to occupant activity according to CEN standards for ventilation or equivalent national standards. In cases where measures produce different comfort levels, this shall be made transparent in the calculations.

3. CALCULATION OF THE PRIMARY ENERGY DEMAND RESULTING FROM THE APPLICATION OF SUCH MEASURES AND PACKAGES OF MEASURES TO A REFERENCE BUILDING

(1) Member States shall calculate the energy performance of measures/packages/variants by calculating, for the nationally defined floor area, first the final energy need for heating and cooling, and subsequently the final energy for space heating, cooling, ventilation, domestic hot water and lighting systems. Member States shall calculate the resulting primary energy use using primary energy factors established at national level. They shall report to the Commission the conversion factors used in the reporting referred to in Article 6 of this Regulation.

(2) Energy produced on site shall be deducted from the primary energy demand.

(3) Member States shall either use

a) the relevant existing CEN standards for the calculation of the energy performance,

b) or an equivalent national calculation method provided that the latter is in accordance with Article 2(4) and Annex I of Directive 2010/31/EU.

(4) Energy performance results shall, for the purpose of the cost optimal calculation, be expressed in square meters of useful floor area or living area of a reference building and refer to primary energy demand.

4. CALCULATION OF THE GLOBAL COST IN TERMS OF NET PRESENT VALUE FOR EACH REFERENCE BUILDING

4.1. Categories of costs

(1) Member States shall establish and describe the following separate cost categories to be used:

a) **Initial investment costs**.

b) **Running costs**. These include also costs for periodic replacements of building elements.

c) **Periodic replacement costs**.

d) **Disposal costs** if appropriate.

e) **Energy costs**. They shall reflect the cost of necessary capacity, not only necessary energy, and should be based on a weighted average of the basic (variable cost) and peak load (normally fixed cost) tariffs paid by the final customer including all costs, taxes and profit margins of the supplier.

(2) In projecting energy cost developments, Member States may use the energy price development forecasts in Annex II of this Regulation for oil, gas, coal and electricity, starting with the average absolute energy prices (expressed in Euros) for these energy sources in the year of the calculation exercise.

Member States shall also establish national energy price development forecasts for other energy carriers used to a significant extent in their regional/local context and if appropriate also for peak load tariffs. They shall report the projected price trends and the current shares of the different energy carriers in building energy use to the Commission.

(3) The effect of (expected) future price developments are, with the exception of energy costs, replacement of building elements during the calculation period and disposal costs where applicable, not included in the cost calculation, but needs to be taken into account when the calculations are reviewed and updated.

(4) Cost data shall be market-based and shall be coherent as regards location and time. Costs should be expressed as real costs excluding inflation. Costs shall be assessed at country level.

4.2. Calculation of global costs

(1) When determining the global cost of a measure/package/variant, the relevant prices to be taken into account are the prices paid by the customer including all applicable taxes, VAT and subsidies.

(2) When determining the global cost of a measure/package/variant, the following cost may be omitted:

a) Costs that are the same for all assessed measures/packages/variants

b) Costs related to building elements which have no influence on the energy performance of a building

All other costs need to be fully taken into account for the calculation of global costs.

(3) Global costs for building and building elements shall be calculated by summing the different types of costs and applying to these the discount rate by means of a discount factor so as to express them in terms of value in the starting year, plus the discounted residual value as follows:

$$C_g(\tau) = C_I + \sum_j \left[\sum_{i=1}^{\tau} \left(C_{a,i}(j) \times R_d(i) \right) - V_{f,\tau}(j) \right]$$

where:

$C_g(\tau)$ means global cost (referred to starting year τ_0)

C_I means initial investment costs for measure or set of measures j

$C_{a,I}(j)$ means annual cost during year i for measure or set of measures j

$V_{f,\tau}(j)$ means residual value of measure or set of measure j at the end of the calculation period (discounted to the starting year τ_0).

$R_d(i)$ means discount factor for year i based on discount rate *r* to be calculated

as :

$$R_d(p) = \left(\frac{1}{1 + R_R / 100} \right)^p$$

Where p means the number of years from the starting period and R_r means the real discount rate.

(4) The residual value shall be determined by a straight line depreciation of the initial investment or replacement cost of a given building element until the end of the calculation period discounted to the beginning to the calculation period. The depreciation time is determined by the economic lifetime of a building or building element. Residual values of building elements may need to be corrected for the cost of removing them from the building at the end of the economic lifecycle of the building.

(5) Disposal costs shall be discounted back from the estimated economic lifetime to the end of the calculation period.

(6) At the end of the calculation period, the disposal costs or the residual value of the components and building elements are taken into account to determine the final costs over the estimated economic lifecycle of the building.

(7) Member States shall use a calculation period of 30 years for residential and public buildings, and a calculation period of 20 years for commercial, non-residential buildings.

(8) Member States are encouraged to use Annex A of EN 15459 on economical data for building elements when defining estimated economic lifetimes for those building elements. If other estimated economic lifetimes for building elements are established, these should be reported to the Commission as part of the reporting referred to in Article 6. Member States shall define at national level the estimated economic lifecycle of a building.

(9) Member States shall determine the discount rate for their calculations

5. UNDERTAKING A SENSITIVITY ANALYSIS FOR COST INPUT DATA INCLUDING ENERGY PRICES

(1) The purpose of sensitivity analysis is to identify the most important parameters of a cost optimal calculation. Member States shall perform a sensitivity analysis on the main cost input data, at least for energy price development scenarios for all energy carriers used to a significant extent in buildings in their national context, as well as the discount rate (using at least two different discount rates).

6. DERIVATION OF A COST OPTIMAL LEVEL OF ENERGY PERFORMANCE FOR EACH REFERENCE BUILDING

(1) For each reference building, Member States shall compare the global cost results calculated for different energy efficiency measures and measures based on renewable energy sources (and packages/variants of those measures) with the results for the calculated primary energy demand for different energy efficiency measures and measures based on renewable energy sources (and packages/variants of those measures).

(2) In cases where the outcome of the cost optimal calculations give the same global costs for different levels of energy performance, Member States are encouraged to use the stricter requirements as the basis for the comparison with the existing minimum energy performance requirements.

ANNEX II

Information on estimated long-term energy price developments

For their calculations, Member States may take into account the estimated energy price development trends for oil, gas, coal and electricity as provided for by the European Commission on a biannually updated basis. These updates are available at the following website: http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm

These trends may be extrapolated beyond 2030 until longer-term projections become available.

ANNEX III

Reporting template that Member States may use for reporting to the Commission pursuant to Article 5 (2) of Directive 2010/31/EU and Article 6 of this Regulation

1. REFERENCE BUILDINGS

1.1. Report on the reference buildings for your chosen building categories and how they are representative of the building stock by using table 1 (existing buildings) and table 2 (new buildings). Additional information may be added in an annex

1.2. Give the definition of the m² floor area reference used in your country and how it is calculated.

1.3. Please list the selection criteria used to define each reference building (both new and existing) and the subcategories: e.g. statistical analysis based on use, age, geometry, climate zones, cost structures, construction material etc., introducing also the indoor and outdoor climatic conditions, and geographic location.

1.4. Please indicate whether your reference building is an example building, virtual building etc.

Table 1 Reference building for existing buildings (major refurbishment)

For existing buildings	**Building geometry**[24]	**Shares of window area on the building envelope and windows with no solar access**	**Floor area m^2 as used in building code**	**Description of the building** [25]	**Description of the average building technology**[26]	**Average energy performance kWh/m^2,a** (prior to investment)	**Component level requirements (typical value)**
1) Single family buildings and subcategories							
Subcategory 1							
Subcategory 2 etc.							
2) Apartment blocks and							

[24] A/V , orientation, area of N/W/S/E facade

[25] construction material , typical air tightness (qualitative), use pattern (if appropriate) , age (if appropriate)

[26] Technical building systems, U values of building elements, windows – area, U value, g value, shading, passive systems, etc

multifamily buildings and subcategories							
3) Office buildings and subcategories							
4) **Other non residential building categories**							

Table 2: Reference building for new buildings

For new buildings	**building geometry**[27]	**Shares of window area on the building envelope and windows with no solar access**	**Floor area m^2** **as used in building code**	**Typical energy performance** **kWh/m^2,a**	**Component level requirements**
1) Single family buildings and subcategories					
Subcategory 1					
Subcategory 2 etc.					
2) Apartment blocks and multifamily buildings and subcategories					

[27] A/V, area of N/W/S/E facade. To note: The orientation of the building can already constitute an energy efficiency measure in itself in the case of new buildings.

3) Office buildings and subcategories					
4) **Other non residential building categories**					

Table 3 Example of a basic reporting table for energy performance relevant data

			Quantity	Unit	Description
Calculation	method and tool(s)				short description of the calculation method adopted (e.g. with reference to EN ISO 13790) and comment on the calculation tool(s) used.
	conversion factors				values of delivered to primary energy conversion factors (per energy carrier) used for the calculation.
Climate condition	location				name of the city with indication of latitude and longitude.
	heating degree-days			HDD	to be evaluated according to EN ISO 15927-6, specifying the period of calculation.
	cooling degree-days			CDD	
	source of climatic dataset				provide references on climatic dataset used for the calculation.
	terrain description				e.g. rural area, sub-urban, urban. Explain if the presence of nearby buildings has been considered or not.
Building geometry	Length x Width x Height			m x m x m	related to the heated/conditioned air volume (EN 13790) and considering as "lenght" the horizontal dimension of the façade South oriented.
	number of floors			-	
	S/V ratio			m^2/m^3	
	ratio of window area over total building envelope area	South		%	
		East		%	
		North		%	

		West		%	
	orientation			°	azimuth angle of the South façade (deviation from the South direction of the "South" oriented façade).
Internal gains	building utilisation				according to the building categories proposed by Annex 1 of the Directive 2010/31/UE.
	average thermal gain from occupants			W/m^2	
	specific electric power of the lighting system			W/m^2	total electric power of the complete lighting system of the conditioned rooms (all lamps + control equipment of the lighting system).
	specific electric power of electric equipment			W/m^2	
Building elements	average U-value of walls			W/m^2K	weighted U-value of all walls: U_wall = (U_wall_1 · A_wall_1 + U_wall_2 · A_wall_2 + ... + U_wall_n · A_wall_n) / (A_wall_1 + A_wall_2 + ... + A_wall_n); here are : U_wall_i = Uvalue of wall type i ; A_wall_i = total surface of wall type i
	average U-value of roof			W/m^2K	similar to walls.
	average U-value of basement			W/m^2K	similar to walls.
	average U-value of windows			W/m^2K	similar as for walls; it should take into account the thermal bridge due to the frame and dividers (according to EN ISO 10077-1).
	thermal bridges	total length		m	
		average linear thermal transmittance		W/mK	
	thermal capacity per unit area	external walls		J/m2K	to be evaluated according to EN ISO 13786.

		internal walls		J/m2K	
		slabs		J/m2K	
	type of shading systems				e.g. solar blind, roll-up shutter, curtain, etc.
	average g-value of	glazing		-	total solar energy transmittance of glazing (for radiation perpendicular to the glazing), here: weighted value according to the area of different windows (to be evaluated according to EN 410)
		glazing+shading		-	total solar energy transmittance for glazing and an external solar protection device has to be evaluated according to EN 13363-1/-2
	Infiltration rate (air changes per hour)			1/h	e.g. calculated for a pressure difference inside/outside of 50 Pa
Building systems	ventilation system	air changes per hour		1/h	
		heat recovery efficiency		%	
	efficiencies of heating system	generation		%	to be evaluated according to EN 15316-1, EN 15316-2-1, EN 15316-4-1, EN 15316-4-2, EN 15232
		distribution		%	
		emission		%	
		control		%	
	efficiencies of cooling system	generation		%	to be evaluated according to EN 14825, EN 15243, EN 14511, EN 15232
		distribution		%	
		emission		%	

Building Setpoints and Schedules	efficiencies of DHW system	control		%	to be evaluated according to EN 15316-3-2, EN 15316-3-3.
		generation		%	
		distribution		%	
	temperature setpoint	winter		°C	indoor operative temperature.
		summer		°C	
	humidity setpoint	winter		%	indoor relative humidity, if applicable: "Humidity has only a small effect on thermal sensation and perceived air quality in the rooms of sedentary occupancy" (EN 15251).
		summer		%	
	operation schedules and controls	occupancy			provide comments or references (EN or national standards, etc.) on the schedules used for the calculation.
		lighting			
		appliances			
		ventilation			
		heating system			
		cooling system			
Energy building need/use	(thermal) energy contribution of main passive strategies implemented	1) …		kWh/a	e.g. solar greenhouse, natural ventilation, day-lighting, etc.
		2) …		kWh/a	
		3) …		kWh/a	
	energy need for heating			kWh/a	heat to be delivered to or extracted from a conditioned space to maintain the intended temperature conditions during a given period of time.
	energy need for cooling			kWh/a	

	energy need for DHW			kWh/a	heat to be delivered to the needed amount of domestic hot water to raise its temperature from the cold network temperature to the prefixed delivery temperature at the delivery point.
	energy need for other (humidification, dehumidification)			kWh/a	latent heat in the water vapour to be delivered to or extracted from a conditioned space by a technical building system to maintain a specified minimum or maximum humidity within the space (if applicable).
	energy use for ventilation			kWh/a	electrical energy input to the ventilation system for air transport and heat recovery (not including the energy input for preheating the air) and energy input to the humidification systems to satisfy the need for humidification.
	energy use for internal lighting			kWh/a	electrical energy input to the lighting system and other appliances/systems.
	energy use for other (appliances, external lighting, auxiliary systems, etc.)			kWh/a	
Energy generation at the building site	thermal energy from RES (e.g. thermal solar collectors)			kWh/a	energy from renewable sources (that are not depleted by extraction, such as solar energy, wind, water power, renewed biomass) or co-generation.
	electrical energy generated in the building and used on-site			kWh/a	
	electrical energy generated in the building and exported to the market			kWh/a	
Energy consumption	delivered energy	electricity		kWh/a	energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances etc.).
		fossil fuel		kWh/a	
		other (biomass, district heating/cooling, etc.)		kWh/a	
	primary energy			kWh/a	energy that has not been subjected to any conversion or

				transformation process
	(net) primary energy		kWh/a	difference between primary energy and the primary energy associated with the energy exported to the market

2. SELECTING VARIANTS/MEASURES/PACKAGES

2.1. Report in table format the characteristics of selected variants/measures/packages that are applied for the cost optimal calculation. Please start with the most common technologies and solutions and move then towards the more innovative ones. If there is evidence from previous calculations that measures are far from being cost optimal, no table has to be filled in but this should be reported separately to the Commission. The format below can be used, but please note that the examples listed are purely illustrative.

Table 4: Illustrative table for listing selected variants/measures

Each calculation should refer to the same comfort level. Pro forma each variant should provide the acceptable comfort. If different comfort levels are taken into account, the base of the comparison will be lost.

Measure	**Reference case**	**Variant 1**	**Variant 2**	**Etc….**
Roof insulation				
Wall insulation				
Window	5.7 W/m^{2}K (description)	2.7 W/m^{2}K (description)	1.9 W/m^{2}K (description)	
Share of window area				
Building-related measures (thermal mass etc)				
Heating system				
DHW				
Ventilation system (incl. night ventilation)				
Space cooling system				
Measures based on RES				
Change of energy carrier				
Etc.				

The listing of measures is purely illustrative.

For the building envelope: in W/m^2K

For systems: efficiency

Several levels of improvements can be selected (for example: different thermal transmittance values for windows)

3. CALCULATION OF THE PRIMARY AND FINAL ENERGY DEMAND OF THE MEASURES

3.1. Energy Performance Assessment

3.1.1. Report the calculation procedure for the energy performance assessment that is applied to the reference building and the adopted measures/variants

3.1.2. Give references to relevant legislation, regulation, standards and norms

3.1.3. Fill in the calculation period (20 or 30 years), the calculation interval (annual, monthly or daily) and the used climate data per reference building

3.2. Energy demand calculation

3.2.1. Please report the results of the energy performance calculation for each variant for each reference building differentiated to at least energy need for heating and cooling, energy use, delivered energy and primary energy demand.

Insert also the energy savings.

Table 5 Energy demand calculation output table

Please fill out one table for each reference building and building categories, for all of the introduced measures.

Reference case								
Measure/ package of measures (as described in table 4)	Energy need		energy use					Delivered energy specified by source
	heat demand	cooling demand	Heating	cooling	ventilation	DHW	lighting	

Please fill out one table for each reference building

Reporting can be limited to the most important measures/packages but it should be indicated how many calculations have been carried out in total. One measure/package for achieving nearly zero energy buildings in new built should be part of reporting. If there is evidence from pervious calculations that measures are far from being cost optimal, no table has to be filled in but this should be reported separately to the Commission.

3.5. Report the summary of conversion factors used in the country in a separate table.

3.6. Indicate the delivered energy per carrier in an additional table.

4. GLOBAL COST CALCULATION

4.1. Calculate the global cost for each variant/measure using the following tables referring to low, medium and high (energy price) scenario. The cost calculation for the reference building shall be put to 100%.

4.2. Report the source of the applied energy price development

4.3. Report the applied discount rate and explain the underlying reason for setting it at that level.

Table 6 Output data and global cost calculations

Please fill out one table for each reference case. Please insert the cost data in national currency.

Variant/ Measure as given in Table 5	Initial investment cost (referred to starting year)	Annual running cost			Calculation period[28] 20, 30 years	Residual value	Discount rate	estimated economic lifetime	Disposal cost (when applicable)
		Annual maintenance cost	Operational cost	Energy cost[29] by fuel With the medium energy price scenario					

4.4. Please report your input parameters used for the calculation of the global cost (e.g. labour cost, cost of the technology, etc.)

4.5. Perform calculation on the sensitivity analysis for the main costs and for energy costs and the applied discount rate. For each variation of cost use a separate table like Table 9.

5. COST OPTIMAL LEVEL FOR REFERENCE BUILDINGS

5.1. Report the economic optimal energy performance level in primary energy (kWh/m2 year, or if a component level approach is followed in the relevant unit, e.g. U value) for each case in relation to the reference buildings.

6. COMPARISON

6.1. In case the difference is significant, please indicate the reason that justifies the gap and also a plan with the appropriate steps to reduce the difference if the gap cannot be justified (fully)

[28] For residential and public buildings 30 years of calculation period shall be taken into account, for commercial, non residential buildings at least 20 years

[29] The effect of (expected) future price developments have to be taken into account if it is about of replacement of components during the calculation period

Table 6 Comparison table for both new and existing buildings

Reference building	Cost optimal range/level (from-to) kWh/m2,a (for a component approach in the relevant unit)	Current requirements for reference buildings kWh/m2,a	Gap

Justification of the gap: Plan to reduce the non-justifiable gap: