Towards nearly zero-energy buildings

Definition of common principles under the EPBD

Final report

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Date: 14 February 2013

Project number: BESDE10788

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1 Introduction

The building sector has been identified as one of the key sectors to achieve the 20/20/20[1] targets of the EU. Beyond these targets, Europe also aims at bringing about drastic greenhouse gas emission reductions in the building sector of 88 to 91% compared to 1990 by 2050 [COM(2011) 112][2].With the recast of the Energy Performance of Buildings Directive (EPBD), the framework and boundaries have been set to proceed along this track. Among other items of the recast, two mechanisms will be decisive for the development of the building sector:

- The principle of nearly zero energy buildings (Article 9 and article 2.2). According to article 2.2. "'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;" Annex I, article 1 stipulates that "The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs." Article 9.1. regulates that "Member States shall ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings (1a) and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings."
- The principle of cost optimality (Article 5, article 2.14 and Annex I of the EPBD recast), giving guidance for the energy performance requirements of new and existing buildings undergoing major renovation

In both cases, Member States (MS) have to report to the Commission regarding the related activities, progress and results. The EC on the other hand has to set out rules in both cases regarding methodology (explicitly for the methodology to calculate cost optimal levels, but in a guiding sense also for the principle of nearly zero energy buildings) and the EC also needs to facilitate, steer and evaluate the reporting and implementation activities of the MS.

Following these necessities and the request from the invitation to tender, the project and the description of the activities in the following chapters are targeted to support the European Commission in its activities to:

- Give guidance to the MSs on how to interpret the requirements for nearly zero energy buildings as stated in article 2.2 of the recast
- Develop a common reporting format on nearly zero energy buildings to be used by MS and evaluate the adequacy of measures and activities reported by MS in their national plans on nearly zero energy buildings

[1] 20% of greenhouse gas emissions compared to 1990, 20% energy savings by 2020 (compared to a business as usual scenario) and 20% share of renewables in 2020.
[2] A roadmap for moving to a competitive low carbon economy in 2050

- Link cost optimality and the nearly zero energy buildings principle in a consistent way and facilitate their convergence until 2021.

For this purpose, the current comprehension of nearly zero-energy building principles in the scientific and political landscape concerned with the topic must be assessed. Therefore, in a first step it is necessary to identify and review the status quo of studies, principles and projects related to nearly zero-energy buildings. The main existing studies and their findings that were taken into account within this project will be briefly described in the following section.

A major study on principles for nearly zero-energy buildings has been conducted by Ecofys for the Buildings Performance Institute Europe (BPIE). In their report, they identify ten major challenges related to setting a practical nearly zero-energy building definition, derive implications and propose principles for a suitable nearly zero-energy building definition. According to the BPIE study, many aspects need to be considered in a consistent and practical nearly zero-energy building definition. The conclusions of the study can be summarized as follows.

The definition must be in line with general EU targets regarding CO2 emissions, energy efficiency and renewable energies. As the definition should contribute to both energy and CO2 emission reductions, it should as well incorporate a “nearly zero carbon” definition for buildings.

Local and temporal disparities between production and consumption of renewable energy in buildings should be considered properly by including all on-site, nearby, and off-site production and by accepting monthly or annual balances. To avoid lock-in effects and allow for a later definitional expansion towards energy-positive buildings, the definition should be flexible towards system boundaries and balancing timeframes for energy performance, as well as distinguish and assess the quality of energy used for heating/cooling and electricity. Flexibility should be also allowed for different climates, building types, building traditions and the existing building stock.

The BPIE study suggests that a nearly zero-energy building definition should include a threshold for household electricity (plug load) used for integrated building equipment (e.g. lifts and fire-protection systems) going beyond the building services (heating, cooling, ventilation and lighting) included under the current EPBD. Electricity for appliances should eventually be included in subsequent revisions of the EPBD. For a future recast also a life-cycle assessment (LCA) should be required under a nearly zero-energy building definition as energy used for the production and disposal of building components becomes more important when the energy consumption during the use phase decreases.

It is stressed that a common energy balance for a group of buildings would require the separate assessment of energy demand and the energy supply. This would allow for compensating for disadvantages of individual buildings such as reduced solar gains through shading. However, according to the BPIE study, the energy related or financial synergies from pooling buildings are not sufficient to justify the clustering of buildings under a nearly zero-energy building definition.

For achieving a balance of energy efficiency and renewable energy within the nearly zero-energy building definition, a threshold for maximum energy demand as well as a requirement for the minimum percentage of renewable should be set. Only active supply systems should be able to contribute to the renewable energy share while passive systems should be associated with reductions in energy need.

EU Member States may determine their national requirement for the buildings' energy demand within the limits of a corridor taking into account the national context. This would allow a specific balance of the most convenient and affordable technologies for reducing energy demand and increasing the renewable energy share. A more detailed description of the identified challenges and principles for a practical nearly zero-energy building definition within the BPIE study is summarized in section 10.1.1.

Further input for this project was taken from the current IEA Task SHCP Task 40 / ECBCS Annex 52 "Towards Net Zero Energy Solar Buildings" (www.iea-shc.org/task40). Access to information is facilitated as two consortium members, Wuppertal University and Politecnico di Milano are involved in the IEA task as experts. Findings are drawn from the review of international literature on definitions and calculation methodologies in 2009/2010. Furthermore, a comprehensive data base on nZEB projects of all typologies and climates was developed by Wuppertal University and allows the cross analysis of the experiences and data from realized Net ZEBs. Here, a (Net) ZEB is conceptually understood as an energy efficient building that balances its energy demand on an annual basis by generating energy on-site. However, it is recognized that this definition suffers from some limitations, as (Net) nearly zero-energy building should be defined in interaction with grids and should allow for flexibility with regard to national (political and climate) conditions and comfort definitions. The importance of the choices on boundaries, metrics and associated weighting system, requirements on energy efficiency and the hierarchy of energy supply is stressed. According to the findings from the IEA task, for an easily verifiable definition it additionally seems preferable to consider all operational energy uses in a building (incl. plug loads,..). For more details see section 10.1.2.

Several studies conducted under the IEE programme such as the Commoncense and Keepcool projects revealed the importance to assess boundary conditions of different dimensions when designing and defining low and zero energy buildings. These dimensions include outdoor and indoor conditions, the level of electric plug loads and square meters per person. A description of some of the considered projects under the IEE programme can be found in the section 10.1.3.

Moreover, the present project considers studies that have analysed cost-optimal methodology frameworks. Supporting the development of a cost optimality methodology framework, eERG-PoliMil, among others, has developed guidelines for assessing energy flows in buildings in order to calculate energy needs for space heating, cooling and hot water. The 'direction' of the calculation is from the building's energy needs to the source, i.e. to the primary energy. Electrical systems (such as lighting, ventilation, auxiliary) and thermal systems (heating, cooling, domestic hot water) are considered separately inside the building's boundaries. This calculation framework is presented in section 6.2, drawing on recital 15 of the EPBD which requires that energy needs be clearly identified and addressed: *"As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs for heating and cooling are reduced to cost optimal levels."*

2 Objectives

To ensure a successful implementation of the recast of the EPBD from 2010 by the Member States, a number of issues require further clarification and analysis. One of the issues relates to article 9 of the recast EPBD that asks the Member States to ensure that by 31 December 2020, all new buildings are nearly zero- energy buildings and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

Article 2 defines a nearly zero-energy building as "'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby" . According to Annex I, article 1, "The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs. Within these sentences, there are several terms that need further clarification, interpretation and development. This is one of the core tasks of this project, dedicated to support the Commission in ensuring a proper implementation of this regulation that fits to the overall energy and climate targets of the EU.

Member States also need to draw up national plans to increase the number of nearly zero-energy buildings. The national plans shall include inter alia the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, the intermediate targets for improving the energy performance of buildings by 2015, and any policies and financial or other measures to promote nearly zero-energy buildings. The Commission will evaluate the national plans and shall by 31 December 2012 and every three years thereafter publish a report on the progress of Member States in increasing the number of nearly zero-energy buildings. So far, a common reporting approach for the Member States has not been developed. To facilitate the monitoring and reporting task of the Commission, a common approach for the reporting of national plans should therefore be developed within this project.

During the evaluation, in particular the Commission shall look at the adequacy of the envisaged measures in relation to the objectives of the recast EPBD. For this purpose a suitable framework is required. Therefore, a common analytical framework including appropriate benchmarks will be developed on the basis of which the Commission can assess the adequacy of such measures and, if necessary, issue recommendations.

In addition to the nearly zero-energy requirement, the recast EPBD also introduces a benchmarking mechanism for national energy performance requirements. The purpose is to determine cost-optimal performance levels to be used by Member States for comparison with their current regulations and to set new requirements with a view to achieving at least cost optimal performance levels. (see Articles 4 and 5 as well as Annex 3 of the recast EPBD). For a possible interaction of these requirements, more information is needed on the differences, consistencies between and convergence of national cost optimal levels and national nearly zero-energy buildings. The proposed project will shed light on the relationship between cost-optimality and nearly zero-energy and will develop an argumentation how to ensure a smooth transition/development of polices and markets from one system to the other.

3 Approach

As the project members have different specialisation and experience in specific research fields, the four main tasks are allocated to the different members according to their main fields of expertise.

- Task 1 is led by the University of Wuppertal and deals with existing definitions for nearly zero-energy buildings in the Member States. This tasks contains three sub-tasks, first the identification of existing concepts, second the development of a comparative taxonomy and third an analysis about the practical application of the nearly zero-energy building definition.
- Task 2, task 4 and the overall project coordination are led by Ecofys. Task 2 has the aim to develop respectively make recommendations for a harmonized nearly zero-energy building reporting format. To achieve this, current national plans are identified and analysed and based on the results and the EPBD requirements on national plans, common elements and recommendations for the template are made.
- Task 3 is led by the end-use Efficiency Research Group of Politecnico di Milano and aims to develop an explicit methodology for analysing building variants in terms of energy performance and global costs over 30 years, for detailing the inputs and assumptions of such an analysis and for clearly reporting the results; it also aims to present examples of representative benchmarks for nearly zero-energy building in different European climate regions and based on the results suggest an analytical framework for analysing national plans.
- Task 4 analyses the link and consistency between the definition of nearly zero-energy performance of buildings and the cost-optimal levels of minimum energy performance requirements. Within this task, the current and future technological and cost gaps between the two concepts are assessed and also the role of renewable energies including specifics around the maximum contribution of these with nearly zero-energy building are analysed.

Complementary to this experienced core team, the consortium consists of seven other partners from different EU regions and furthermore three partners from outside the EU (see Table 1).

Table 1. International pool of experts

Country	Partner
Austria	E7
Czech Republic	Enviros
Greece	IASA – NKUA
Hungary	András Zöld
Spain	CIMNE
Sweden	Arne Elmroth Byggteknik AB
Europe	ECEEE
Norway	SINTEF
Switzerland	Armin Binz
USA	Danny Parker

All those partners are leading experts in applied building's research. Each of them will be involved in his specific field of expertise. Above, quality will be ensured by internal reviews. Thus the team includes or covers respectively

- Carefully selected, high level expertise for all project tasks,
- links to numerous relevant European and international groups related to the project's topic of nearly zero-energy building,
- all European climates, all European regions.

In addition to the project team, we maintain a close relation to other key stakeholders and involve them during the study in the research process and discourse. For this purpose we embedded ECEEE as dissemination partner into the consortium. ECEEE comes with a wide network of building related stakeholders from different disciplines and interest and is very well known and also very experienced in organizing workshops, conferences etc. Thus, ECEEE will also organize, in close co-operation with the Commission, a stakeholder workshop during the project with the aim to obtain a 'combined' input from different stakeholders. Amongst other stakeholders, the Member States (e.g. Concerted Action), interested parties such as consumer organizations (e.g. ANEC), industry representatives (e.g. business federations) and other stakeholders (e.g. BPIE, CEN) will be invited. Other experts have been consulted and provided useful data and comments, e.g Jurg Nipkov, S.A.F.E. Switzerland. Additionally to this wide spread network, we also aim to integrate other Commission services in the project process. For this purpose we envisage it will be necessary to manage this through the lead service (i.e. DG ENER C.3). The stakeholder workshop has taken place between the interim and the final project meeting, as can be seen in the project flow chart in Figure 1.

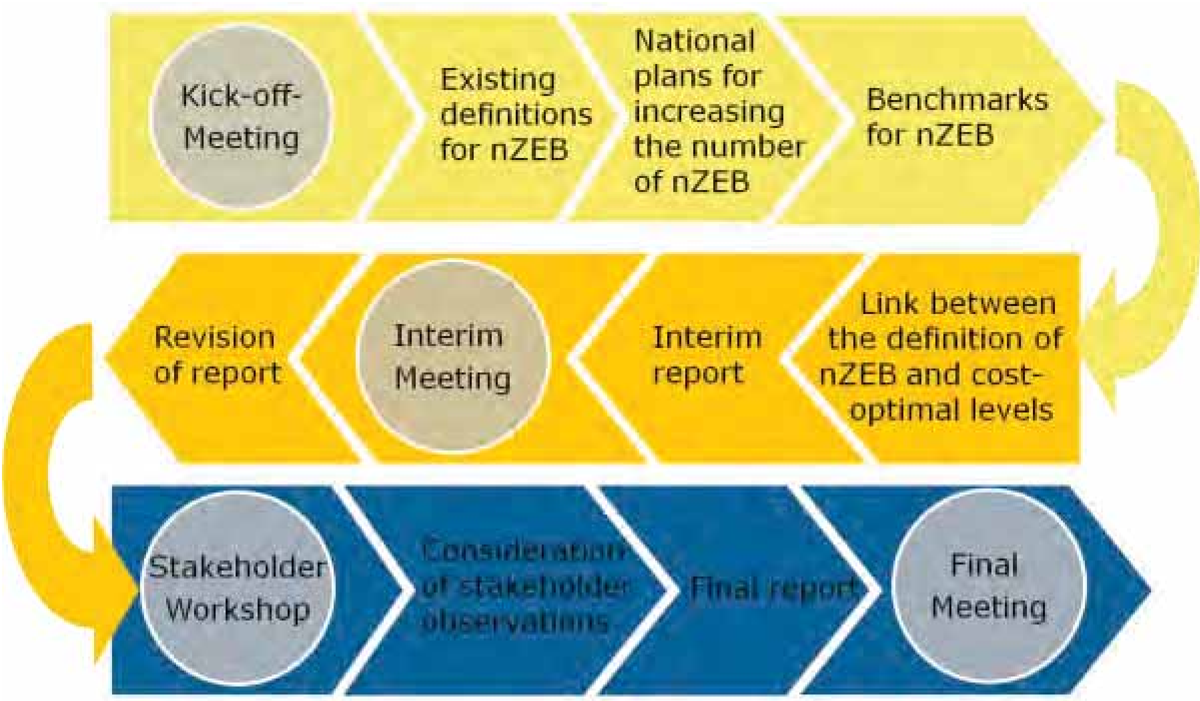

Figure 1. Project flow chart

The workshop has taken place on September…., 2012 within the European Commission's premises.

During the complete project period, we will maintain a close working relationship with the responsible services of the Commission (i.e. DG ENER C.3) and will be flexible to adapt to changing circumstances. For this purpose we plan regular communication with the commission (e.g. one time a month). The organisation of work is visualised in Figure 2.

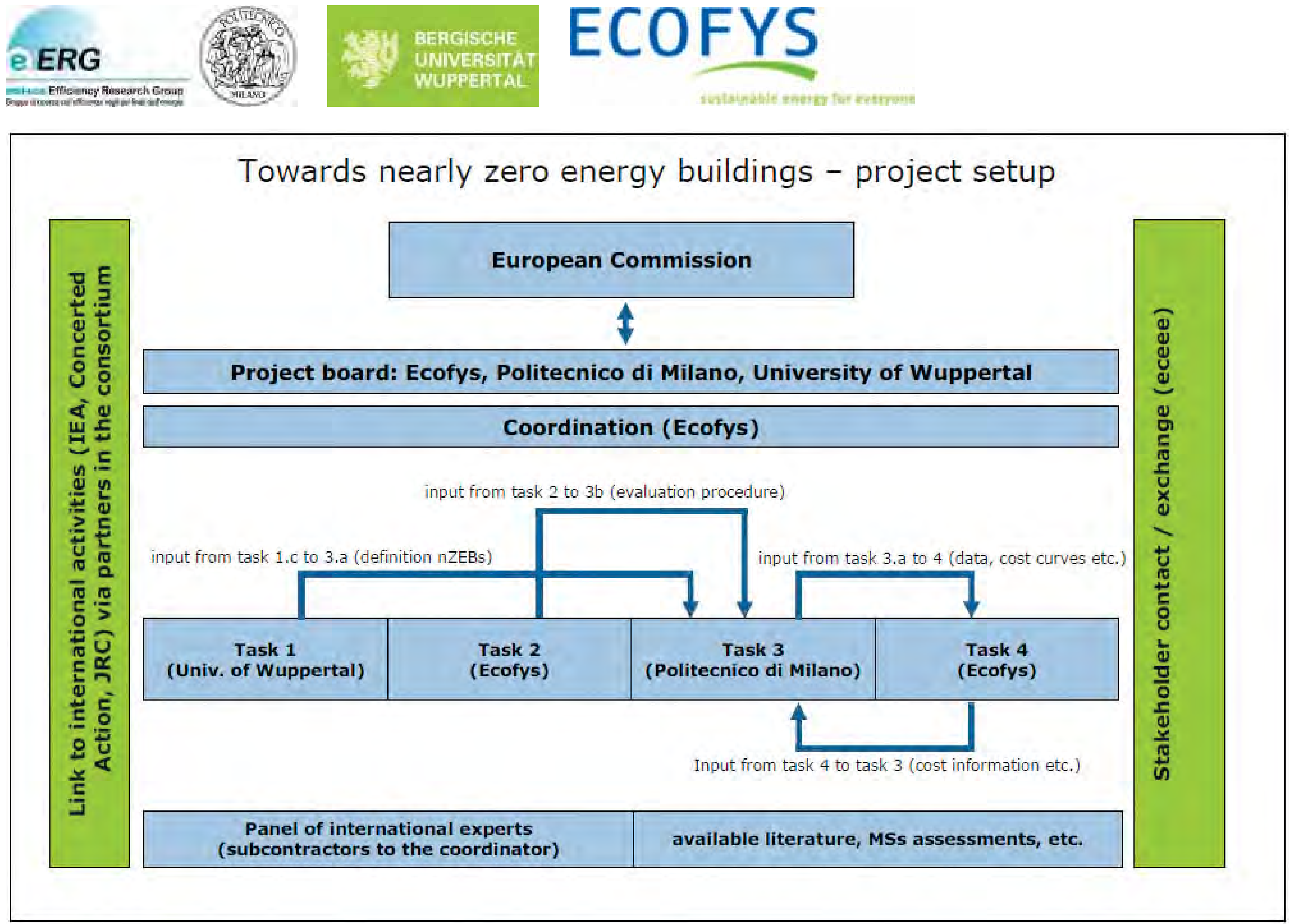

Figure 2. Organisation of work

4 Task 1: Existing definitions for nearly zero-energy buildings in the Member States

4.1 Task 1a: Identification of existing concepts for (nearly) zero-energy buildings

4.1.1 Step 1: list of relevant literature

Based on available knowledge from comparable research projects (current: IEA SHCP Task 40 / ECBCS Annex 52 “Towards Net Zero Energy Solar Buildings”; finished: Buildings Performance Institute Europe (BPIE) “Principles for Nearly Zero-Energy Buildings”) and an already published book on Net Zero Energy Buildings (German edition from May 2011; English version from October 2011, see e.g. [Voss Musall 2011a]) the work started with complementing an existing literature review on already known definitions, labels and calculations methodologies. The basis was a literature list which was developed in the above mentioned research project “Towards Net Zero Energy Solar Buildings” between 2009 and mid 2010 [Marszal 2011]. It was updated with recent reports, references and extended queries. This included latest news and publications about planned and existing definitions or methodologies from private actors (e.g. Plusenergiesiedlung am Schlierberg, Freiburg DE), institutions or companies (e.g. zeroHaus DE, zero carbon hub UK, etc.), certification measures (e.g. Passive House, MINERGIE CH) as well as official building code procedures in progress within EU member states (e.g. code for sustainable homes UK) and abroad. 17 countries and two international associations were included by sending out the queries to 15 “country experts” (see Table 2). This was continued steadily until the end of this research project because in the beginning the feedback from the participating country partners was partly slower than expected and more publications or recent definitions were publicized by the end of 2012.

Table 2. List of countries and experts included in the research on known definitions
The European countries of this set cover approximately 85 % of the EU27 population including Eastern Europe (Hungary, Czech Republic), a well balanced mix of different European climates (between Norway and Greece or Spain) and even contents from outside of the European Union (USA, Canada, Switzerland).

Country	Partners	Responsible persons / National experts
Europe	ECEEE	
The Netherlands, United Kingdom	Ecofys International	Thomas Boermans, Andreas Hermelink, Sven Schimschar
Germany		Thomas Boermans, Andreas Hermelink, Sven Schimschar, Karsten Voss, Eike Musall
Italy	Politecnico di Milano	Lorenzo Pagliano
Canada, Denmark, Finland, European Union, International associations	University of Wuppertal	Karsten Voss, Eike Musall
Czech Republic	Enviros	Jan Pejter
Hungary	András Zöld	András Zöld
Austria	E7	Klemens Leutgöb
Greece	IASA – NKUA	Mattheos Santamouris
Spain	CIMNE	Jordi Cipriano
Sweden	Arne Elmroth, Byggteknik AB	Arne Elmroth
France	Universitét de La Reunion, ADEME	François Garde
Switzerland	Hochschule für Architektur, Bau und Geomatik - Institut Energie am Bau	Armin Binz, Monika Hall
Norway	SINTEF	Igor Sartori
United States of America	Florida Solar Energy Center	Danny Parker
Luxemburg	Boblet Lavandier & Associes S.A.	Markus Lichtmess

Most of the known publications from the initial literature review focus on national goals or document different Nearly or Net ZEB demonstration buildings and results from such projects from all over the world whereas the focus in this task was given to literature related to the discussion on understanding, explaining and clarifying different Nearly or Net ZEB definitions and methodologies. For this purpose many individual examples were found having very different content and definition approaches (see Table 3). This explains the variety of methodological approaches identified under Step 2. Beside such reports and presentations a large number of publications were found showing an overview of these, mostly voluntary concepts or try to collect and summarize ideas to help to develop further (governmental) directives for Nearly Zero-Energy Buildings [BPIE 2011; REHVA 2011; Marszal 2010; Musall 2012b; Sartori 2010; Sartori 2012a; Voss 2011; Sartori 2012b]. In these cases no national directives for Nearly Zero-Energy Buildings exist until now and researches try to describe ways how to define it with respect to local conditions like climate or energy infrastructure [Lund 2011; Voss 2010; Salom 2011]. In most cases the focal point is given to concepts with the aim of an equalized annual energy balance or in some cases even to Energy Plus Buildings. Ideas similar to the Passive House with a solely consideration of the energy efficiency and without any requirements for on-site renewable energy generation were neglected as this does not fit to Article 2.2 of the EPBD in which is described that a “[...] nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]” [EU 2010]. It has also been recognized in previous studies that a lot of labels and definitions with the aim of an equalized energy balance take up the efficiency idea (of the passive house), because a neutral energy balance is almost impossible without energy efficiency. An assortment of the 25 most relevant publications is shown in Table 3 whereas more than 50 additional publications are shown in the Appendix in chapter 10.2.1.

One of the most relevant reports, which is referenced frequently in other publications, is written by Paul Torcellini, et al. in 2006 [Torcellini 2006]. The item “zero energy” is split in four different definitions influenced by the main factors like the project goals, the intention of the investor, the concern about the climate change, respectively greenhouse gas emissions or the energy costs. Therefore, four different definitions for Zero Energy Buildings are proposed: site ZEB, source ZEB, emissions ZEB and cost ZEB. Advantages and disadvantages are also highlighted.

The paper [Marszal 2010] focuses on the review of the most relevant existing definitions for Net Zero Energy Buildings and various approaches towards possible calculation methodologies. It presents and discusses possible answers to the abovementioned issues in order to facilitate the development of a consistent Net ZEB definition and a robust energy calculation methodology. The included approaches for computing the Nearly Net ZEB balance are for the most part based on known methodologies proposed by participating researchers of the IEA SHC Task 40/ECBCS Annex 52 ‘Towards Net Zero Energy Solar Building’. Beside a check of the twelve methods against the metric of the balance, the balancing period, the type of energy use included in the balance, the type of energy balance, the accepted renewable energy supply options, the used primary energy and/or CO2 conversion factors, the connection to the energy infrastructure and unique features like requirements for energy efficiency, indoor climate or the building–grid interaction they are also compared to other publications known from the literature review [Marszal 2011]. Additionally an overview of possible renewable energy supply options for generation on-and off-site is shown (see Figure 3).

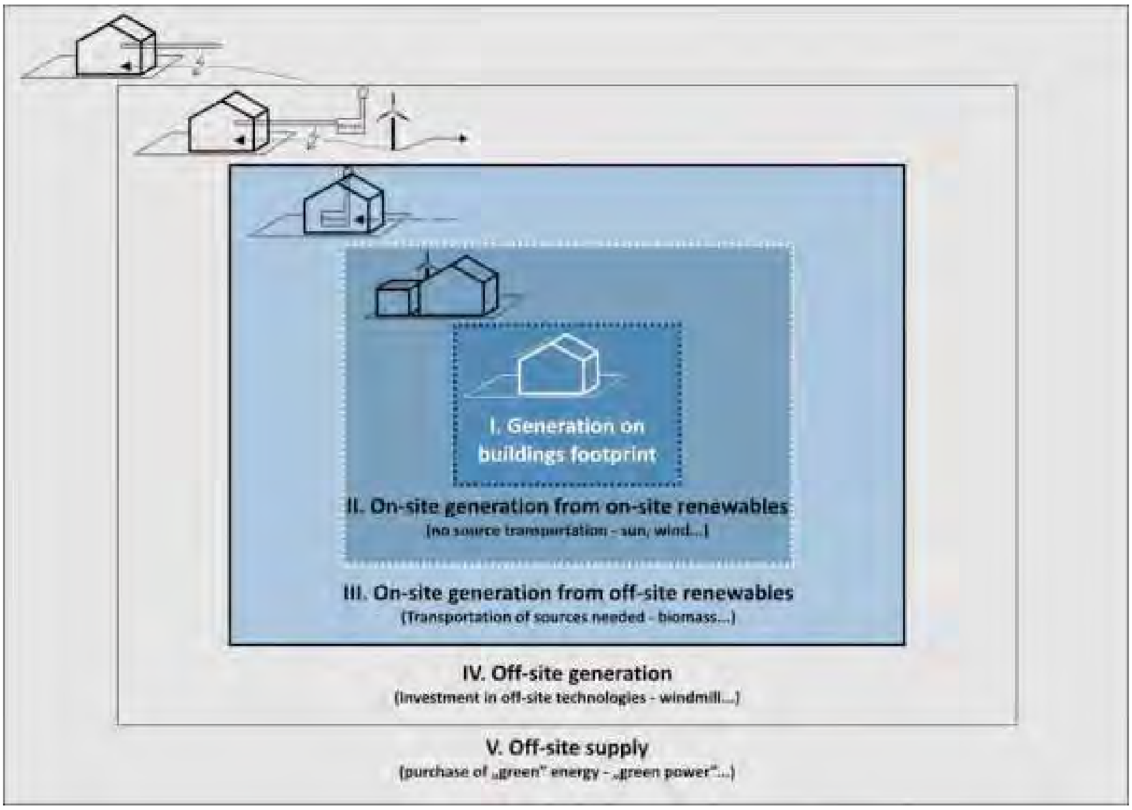

Figure 3. Overview of possible renewable supply options which were found in descriptions for nearly zero energy buildings. Source [Marszal 2011]

[Voss 2011] reports on the background and the various effects influencing energy balance approaches. After explaining focal points of the methodology and discussing the national energy code framework in Germany, a harmonised terminology and balancing procedure is proposed covering the German energy saving directive (EnEV 2009) and its calculation procedure according to EPBD (DIN V 18599). This takes not only the energy balance but also energy efficiency and load matching into account.

Another important publication from Igor Sartori, et al. was published in early 2012 and presents results which have been largely developed in the context of the joint IEA SHC Task 40 / ECBCS Annex 52 "Towards Net Zero Energy Solar Buildings" program [Sartori 2012a]. It is understood as a summary of more than two years of work within the field of the methodology of Net ZEBs. The paper presents a consistent framework for setting Net ZEB definitions. It shows the evaluation of criteria in the definition framework and describes a selection of the related options (building system boundary, weighting system, type of Net ZEB balance, balancing period and temporal energy match characteristics; described in more detail under task 1c to set Nearly Net ZEB definitions in a systematic way). Two major types of balance are identified, namely the import/export balance and the load/generation balance. As compromise between the two a simplified monthly net balance is also described. Beside it indicates Net ZEBs as buildings which are connected to energy grids but it is also recognized that the sole satisfaction of an annual balance is not sufficient to fully characterize Net ZEBs and that the interaction between buildings and energy grids need to be addressed.

Table 3. Choice of relevant literature for known definitions, calculation methodologies and labels for nearly zero energy buildings (please find additional publications in the Annex)

Nr.	Country	Publication	Specific content, definition
1	EU	European Parliament and the Council of the EU (2010): Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (EPBD 2010)	International directive
2	EU	European Parliament and the Council of the EU (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (RED 2009)	International directive
3	EU	European Council for an Energy Efficient Economy ECEEE (2009): Net zero energy buildings: definitions, issues and experience. Published by ECEEE, Brussels	Overview
4	EU	Boermans, Thomas; Hermelink, Andreas; Schimschar, Sven; Grözinger, Jan; Offermann, Markus; Engelund Thomsen, Kirsten et al. (2011): Principles for nearly zero-energy buildings. Paving the way for effective implementation of policy requirements: Buildings Performance Institute Europe (BPIE)	Summary, Overview
5	INT	Kilkis, Siir: A new metric for net-zero carbon buildings, in: Proceedings of Energy Sustainability 2007, Long Beach, California, 2008, page 219–224	methodological Explanation
6	INT	Kurnitski, Jarek; Allard, Francis; Braham, Derrick; Goeders, Guillaume; Heiselberg, Per; Jagemar, Lennart et al. (2011): How to define nearly net zero energy buildings nZEB. REHVA proposal for uniformed national implementation of EPBD recast. In: REHVA Journal (May), page 6–12	Summary, Overview Exemplification
7	INT	Laustsen, Jens (2008): Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings. Published by International Energy Agency (IEA).	Overview
8	INT	Marszal, Anna; Bourrelle', Julien; Musall, Eike; Heiselberg, Per; Gustavsen, Aril; Voss, Karsten (2010): Net Zero Energy Buildings - Calculation Methodologies versus National Building Codes. Published by EuroSun Conference 2010. Graz	Summary, Overview
9	INT	Marszal, Anna; Heiselberg, Per; Bourrelle', Julien; Musall, Eike; Voss, Karsten; Sartori, Igor; Napolitano, Assunta (2011): Zero Energy Building - A Review of definitions and calculation methodologies. In: Energy and Buildings 43 (4), page 971–979, published by Elsevier, Oxford	Summary, Overview
10	INT	Musall, Eike; Voss, Karsten (2012): Nullenergiegebäude – ein Begriff mit vielen Bedeutungen. In: detail green 1/12 2012 (1), page 80–85, published by Institut für internationale Architektur-Dokumentation, München	Summary, Overview
11	INT	Salom, Jaume; Widen, Joakim; Candanedo, Jose A.; Sartori, Igor; Voss, Karsten; Marszal, Anna J. (2011): Understanding Net Zero Energy Buildings: Evaluation of Load Matching And Grid Interaction Indicators. Published during proceedings of Building Simulation 2011: 12th Conference of International Building Performance Simulation Association. Sydney	methodological Explanation
12	INT	Sartori, Igor; Napolitano, Assunta; Marszal, Anna; Pless, Shanti; Torcellini, Paul; Voss, Karsten (2010): Criteria for Definition of Net Zero Energy Buildings. Published by EuroSun Conference 2010. Graz	Summary, Overview
13	INT	Sartori, Igor; Napolitano, Assunta; Voss, Karsten (2012): Net Zero Energy Buildings: A Consistent Definition Framework. In: Energy and Buildings, 2012.	methodological Explanation
14	INT	Voss, Karsten; Musall, Eike (2011): Net zero energy buildings. International projects of carbon neutrality in buildings. Birkhäuser Verlag, Basel	Summary, Overview

15	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2011): klima:aktiv Basiskriterien 2011 für Wohngebäude und Dienstleistungsgebäude Neubau/Sanierung, Wien	Exemplification to "klima:aktiv"
16	**AT**	Bundesministerium für Verkehr, Innovation und Technologie (2011): Haus der Zukunft plus, 3. Ausschreibung 2011, Wien	Exemplification to "Haus der Zukunft plus"
17	**CH**	MINERGIE® (2010): MINERGIE-A®. Definition des neuen Gebäude-Standards - Vernehmlassung. Bern	Exemplification to "Minergie©-A"
18	**DE**	Bundesministerium für Verkehr, Bau und Stadtentwicklung (2011): Wohnhäuser mit Plusenergie-Niveau - Definition und Berechnungsmethode, Anlage 1 zum BMVBS Förderprogramm. Published by Bundesministerium für Verkehr, Bau und Stadtentwicklung. Berlin	Exemplification to ""EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard")"
19	**DE**	dena Deutsche Energieagentur (2011): dena - Modellvorhaben „Auf dem Weg zum EffizienzhausPlus" Klimaneutrales Bauen und Sanieren. Conditions for Participation. In collaboration with Stefan Schirmer. Berlin	Exemplification to "Auf dem Weg zum EffizienzhausPlus"
20	**DE**	solares bauen (2005): QS-Heft für die Zertifizierung von Nullemissionsgebäuden. Published by zeroHaus. Freiburg	Exemplification to "zeroHaus"
21	**DE**	Voss, Karsten; Musall, Eike; Lichtmeß, Markus (2011): From Low Energy to Net Zero-Energy Buildings: Status and Perspectives. In: Journal of Green Building 6 (1), page 46–57	methodological Explanation
22	**GR**	Kolokotsa, D.; Rovas, D.; Kosmatopoulos, E.; Kalaitzakis, K. (2011): A roadmap towards intelligent net zero-and positive-energy buildings. In: Solar Energy 2011	Summary, Overview
23	**NO**	Sartori, Igor et al.: Proposal of a Norwegian ZEB definition: assessing the implications for design, Journal of Green Buildings 6/3 (2010), page 133–150	Exemplification to Norwegian ZEB definition
24	**UK**	Gaze, Christopher; Walker, Andrew F.; Hodgson, Gavin; Priaulx, Mike (2010): The Code for Sustainable Homes simply explained. Published by IHS BRE Press on behalf of the NHBC Foundation. Amersham	Exemplification to "CSH"
25	**US**	Torcellini, Paul; Pless, Shanti; Deru, Michael; Crawley, Drury (2006): Zero Energy Buildings: A Critical Look at the Definition. Published by National Renewable Energy Laboratory NREL, U.S. Department of Energy DEO. Golden	methodological Explanation

4.1.2 Step 2: Completed spread sheet for nearly zero-energy building concepts and definitions

University Wuppertal created an Excel spread sheet used to collect information from the group of national experts within the project team (see Table 2) and to make the different contents of the definition descriptions comparable. Before this spread sheet was distributed to the experts it was pre-filled as far as possible based on the available knowledge at University of Wuppertal. It was distributed for comments and testing in the core project group (Ecofys Germany, Politecnico di Milano Italy and SINTEF Norway).

The spread sheet contains detailed information about the actors and their intentions, the integration or consideration in national plans as well as energy benchmarks, addressed typology, building examples, balance conditions (balance boundary for energy demand and supply options, weighting system) and superior requirements of the balancing procedure (buildings efficiency, energy supply, comfort & IAQ, economics). Corresponding standards and data sources have been included.

Based on this survey and the already described literature review the spread sheet was extended up to the content and issues of 75 (partly voluntary) certification schemes, definitions, descriptions, calculations methodologies or labels from nearly all target countries (currently 17 different nations and two international definitions; see Figure 4.).

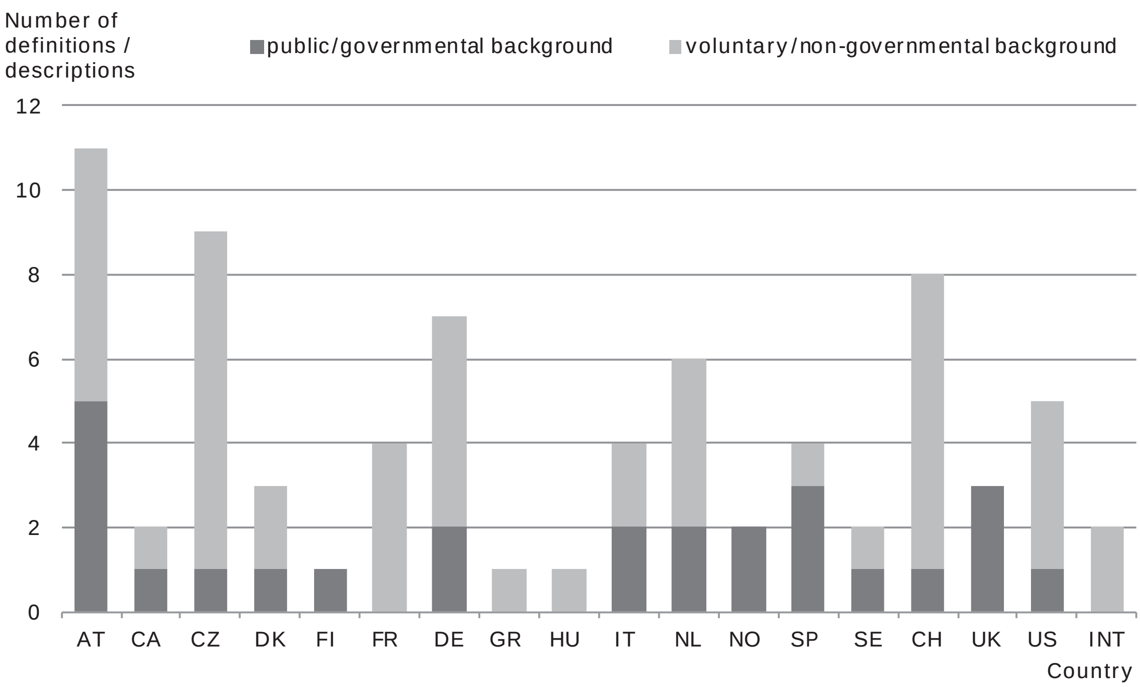

Figure 4. Number of known definitions and descriptions with public/governmental or voluntary/non-governmental background per country.
The biggest groups are from Austria, the Czech Republic, and Switzerland where the national implementation of the 2002 EPBD is still in progress (CZ, AT) and inhomogeneous between regions (AT). In the most cases the public or governmental "definitions" are based on initial demonstration programs and no legal initiatives. Only one of the found definitions represents a current national directive (DK). Source University of Wuppertal

The completed spread sheet contains too much information to be published in this report (around 65 A4-sheets). Therefore, a summary is shown in Table 4. It is noticeable that some definitions address and highlight by their names, the efficiency of the building.

Table 4. Overview on available definitions/descriptions from 17 countries.

Country	Name of definition or label	Type of institution	Year	Purpose	Energy benchmark	Consi-dered in national plans
AT	Plusenergiehaus	Architect	2006	demonstration program	plus energy building	no
	Nullenergiehotel	Engineer	2010	marketing	zero energy building	no
	klima:aktiv house basic criteria	Researcher	2012	governmental program	efficient building	yes
	klima:aktiv passive house	Researcher	2012	governmental program	nearly zero emission building	yes
	Plusenergiehaus	Ministry	2008	research program	plus energy building	yes
	Mustersanierung	Public authority	2012	governmental program	nearly zero emission refurbishment	yes
	Passivhausbank Murau	Engineer	2010	marketing	nearly zero-energy building	no
	Raiffeisen Klimaschutzhochhaus	Engineer	2011	marketing	nearly zero emission building	no
	Energiebewusstes Bauen für Dienstleistungsgebäude in Wien, new buildings	City council	2012	demonstration program	nearly zero-energy building	no
	Energiebewusstes Bauen für Dienstleistungsgebäude in Wien, retrofit buildings	City council	2012	demonstration program	nearly zero-energy building	no
	Betriebsgebäude Fronius	Engineer	2011	ecological consideration	nearly zero-energy building	No
CA	Equilibrium building	Researcher		demonstration program	zero energy building	yes
	R-2000 Standard – EnerGuide	Public authority		demonstration program	efficient building	yes
CZ	Nearly zero-energy building	Public authority	2011	governmental program	nearly zero-energy building	yes *
	Nearly zero-energy building	Public authority	2010	marketing	nearly zero-energy building	no
	Passivhaus	Researcher	2011	research program	efficient building	no
	Zero energy building	Researcher	2011	research program	zero energy building	no
	Nearly zero-energy building	Researcher	2011	research program	efficient building	no
	Energy plus solution	Researcher	2011	research program	plus energy building	no
	Energy efficient building in the zero	Researcher	2011	research program	nearly zero-energy building	no

	neighbourhood					
	Building with increased energy independence	Researcher	2011	research program	nearly zero-energy building	no
	Building energy independent	Researcher	2011	research program	nearly zero-energy building	no
DK	BOLIG+	Researcher	2008	demonstration program	zero energy building	yes
	Modelhome 2020	Business company	2009	demonstration program	zero emission building	no
	Danish Building Regulation 2010 (BR10)	Researcher	2011	National directive	nearly zero-energy building	Yes ***
FI	Net zero energy house	Public authority		demonstration program	zero energy building	yes
FR	Bâtiment à énergie positive	Researcher		research program	plus energy building	
	BBC Bâtiment Basse Consommation	Researcher		research program	low energy building	
	Green office	Business company	2010	marketing	zero energy building	no
	PERENE	Researcher		ecological consideration	zero energy building	
DE	"EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard")	Ministry	2011	demonstration program	plus energy building	no
	EffizienhausPlus	Public authority	2011	demonstration program	efficient building	yes
	Plusenergiehaus@	Architect	1996	marketing	plus energy building	no
	zeroHaus	Engineer	2005	marketing	zero carbon emission building	no
	NEH	Researcher	2010	research program	zero energy building	no
	TripleZero©	Engineer	2009	marketing	zero energy, emission and waste	no
	Das Sonnenhaus	Business company	1989	marketing	efficient building	no
GR	Green Pilot Urban Neighbourhood	Researcher	2010	demonstration program	nearly zero-energy building	No
HU	Low energy building	Researcher	2013	governmental program	efficient building	No
IT	Rendimento energetico in edilizia	Ministry		demonstration program		Yes
	Zero Emissions	Business company	2008	Marketing	zero emission building	No
	CasaClima	Researcher	2012	demonstration program	zero emission building	No
	Casa Zero Energy	Business company		marketing	zero energy building	No
NL	Zero Energy and Zero Carbon Building	Public authority	2009	demonstration program	zero energy building	
	Nul-energiewoning	Researcher			zero energy	No

					building	
	CO2 neutrale woning	Researcher			zero carbon emission building	No
	Klimaatneutrale woning	Researcher			zero carbon emission building	No
	EPG/ EMG: new EPC standards	Ministry	2011	governmental program	efficient building	yes *
	Nulwoning	Engineer		research program	zero energy building	
SP	NZEB evaluation and certification	Public authority	2011	research program	zero energy building	No
	Nearly Zero energy consumption	Public authority	2011	research program	nearly zero-energy building	No
	nearly zero-energy building	Public authority	2011	research program	nearly zero-energy building	No
	nearly zero-energy building	Public authority	2011	research program	nearly zero-energy building	No
SE	under development	Ministry	2012	demonstration program		No
	Nollenergihus	Researcher	2012	demonstration program	zero energy building	
CH	Minergie-A	Public authority	2011	ecological consideration	zero energy building	yes *
	low ex zero emission	Researcher	2010	marketing	zero emission building	No
	Plusenergiebauten Nullheizenergiebauten	Public authority	2010	marketing	plus energy building	no **
	Plusenergie-Gebäude 1	Public authority	2009	ecological consideration	plus energy building	no **
	Plusenergie-Gebäude 2	Public authority	2009	ecological consideration	plus energy building	no **
	Plusenergie-Gebäude 3	Public authority	2009	ecological consideration	plus energy building	no **
	Plusenergiegebäude	Ministry	2012	govermental program	plus energy building	no **
	Direktgewinnhaus	Architect	1996	research program	zero heating demand building	No
NO	Powerhouse	Public authority	2011	marketing	zero energy building	
	Zero Emission Building	Public authority	2012	demonstration program	zero emission building	yes *
UK	Zero carbon home	Ministry	2007	governmental program	zero emission building	No
	Scotland Sustainability labelling	Ministry		governmental program		
	Zero carbon standard	Ministry	2009	governmental program	zero carbon emission building	Yes
US	Net Zero Site Energy	Researcher	2007	research program	zero site energy building	No

	Net Zero Source Energy	Researcher	2007	research program	zero source energy building	No
	Net Zero Energy Emissions	Researcher	2007	research program	zero emission building	No
	Net Zero Energy Costs	Researcher	2007	research program	zero energy costs building	No
	Builder's Challenge Label	Ministry	2009	governmental program	zero energy building	No
INT	zero energy building	International association	2008	marketing	zero energy building stock	
	nearly net zero energy building	International association	2011	demonstration program	nearly zero-energy building	

**will be considered*

*** will possibly considered*

**** is current directive*

As a summary it is noticeable that in Europe a large variety of (non-governmental) concepts and examples for nearly zero-energy buildings exist (like the "zeroHaus, "Plusenergiehaus©" or "Minergie©-A") beside those programs which address "only" the efficiency like the "Passive House" (which is known and used in Germany, Austria, Belgium, Italy, France, Czech Republic, Denmark, Netherlands, Norway, Poland and United Kingdom and USA, see [Thomsen 2008]) or mostly government-initiated programs for Low-energy or efficient buildings (e.g. German KfW-building standard or Minergie from Switzerland). Whereas the "low-energy" ones ask for higher efficiency compared to minimum standards according to governmental directives (which in the most cases should be in line with former standards of the EPBD) and claim for 30 to 70 % lower energy demands (corresponds to 10 - 70 kWh/m²y for heat demand), the definitions for (Nearly) Zero Energy Buildings mostly do not make requirements for an energy rating (except UK what gives a value of 100 % in the Level 6 of Code for sustainable homes, which is the aim since 2016) or set an energy performance indicator. They focus on a more or less equalized yearly energy balance whose calculation procedure differs in basic assessment categories which in addition do not fit in every case to EPBD formulations: The found definitions refer e.g. to different metrics (site energy, source energy, cost or emissions; see Figure 5), different balance boundaries for energy demand/consumption respectively renewable supply/generation options (see Figure 7 and Figure 8), and have a different normalization (Figure 6). Obviously the qualitative nature of criteria in the mentioned Nearly Net ZEB definition leaves room for interpretation [BPIE 2011] which is due to the fact that even the EPBD does not prescribe a uniform approach for implementing nearly zero-energy buildings and neither does describe the assessment categories in detail. Beside "internal" determinations also the energy infrastructure with its variation in the use of fossil, atomic and renewable sources causes differences. Hence the conversion factors for primary energy and equivalent carbon emissions vary in Europe (see 10.1.2) and in the implemented calculation methodologies. Beside the varying factors the decision on the consideration of the renewable part of an energy carrier has an important impact.

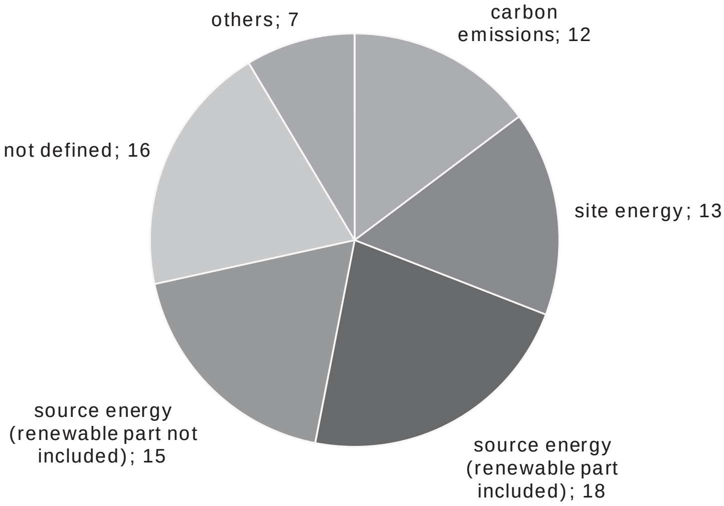

Figure 5. Overview on chosen metrics of the known 75 international balance methodologies. In some cases more than one metric is considered. Source University of Wuppertal

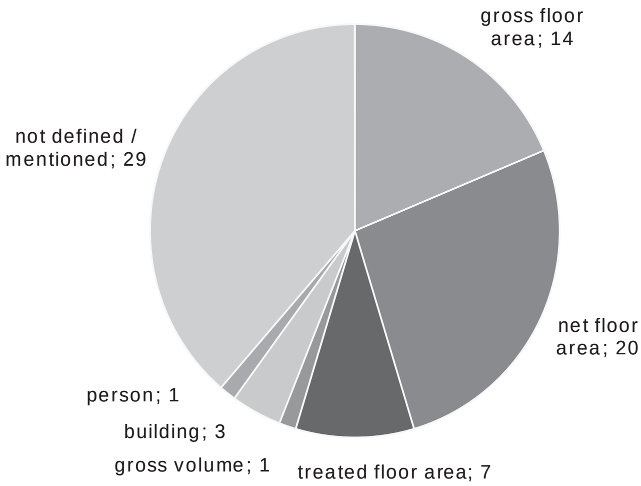

Figure 6. Parallel to the findings of the known Net Zero Energy Buildings in a lot of the balance descriptions the normalization (energy reference area) is not explicitly defined. Source University of Wuppertal

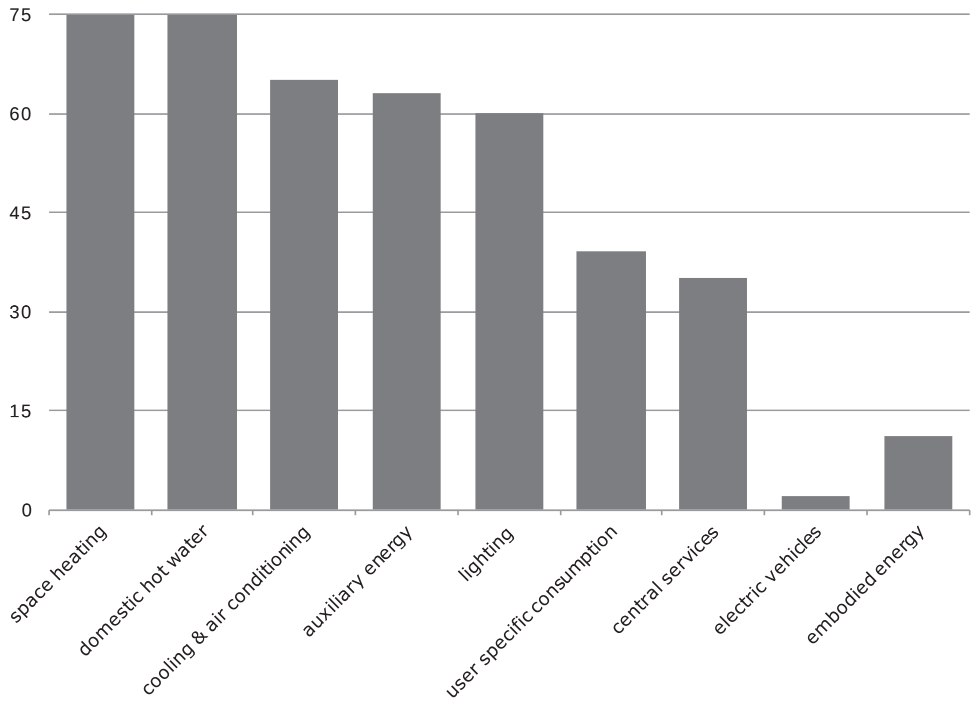

Figure 7. Allocation of the different demand sectors which are included in the energy calculation of the different methodologies (balance boundary for energy demand / consumption). Source University of Wuppertal

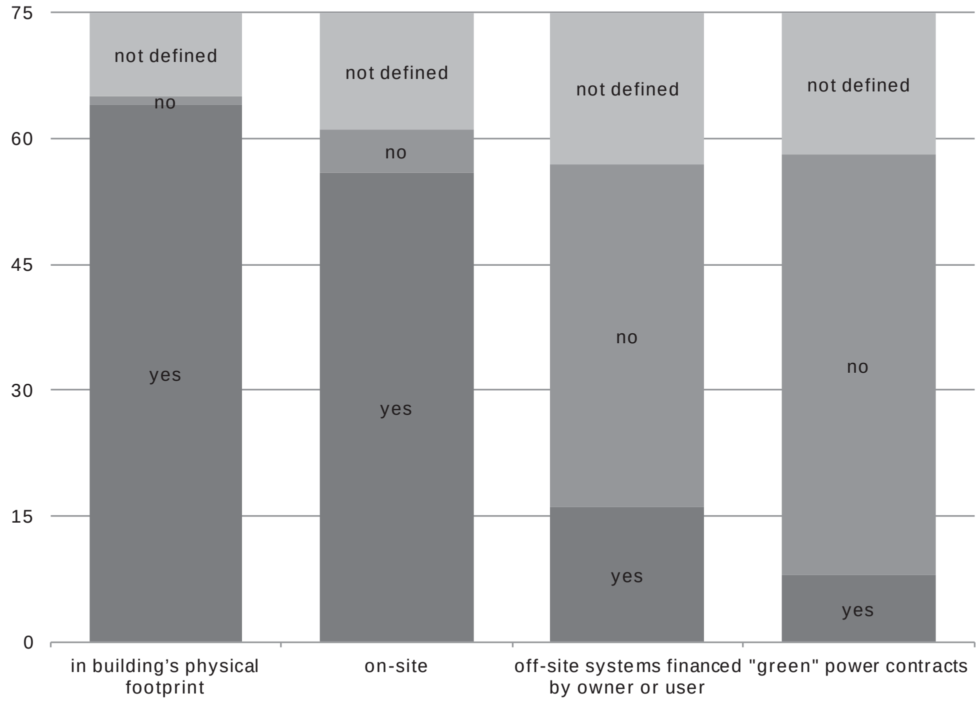

Figure 8.Defined balance boundary for energy generation possibilities (compare to figure 3). Source University of Wuppertal

4.1.3 Step 3: List of existing example buildings related to the known definitions

During the above mentioned research project “Towards Net Zero Energy Solar Buildings” a comprehensive data base with more than 330 buildings from the past two decades and with an aim of an (nearly) equalized energy balance of all typologies and climates was developed by Wuppertal University (see Figure 9). First cross section analysis were shown in [Musall 2010] and [Voss Musall 2011a].

Figure 9.World map which localizes more than 330 known Net Zero Energy Buildings. (each typology has an own colour). The map and additional information which is available under [Musall 2012a] for every project gives an impression about the database.

The definitions and calculation methodologies summarized in Table 4 are partly assigned to the buildings listed. Even though for most of the building examples no exact description about their energy balance calculation procedure is available. They use own names like the “PassivhausPlus” in Hamburg (DE) or the “energy+Home” in Mühltal (DE). Some definitions are not associated with constructed building examples, because they originate in theoretical considerations for the development, and literature (e.g. NEH from Germany, Bolig+ from Denmark or Powerhouse from Norway).

A variety of actors have been involved in creating initial projects and definitions. While at the beginning scientifically initiated experimental projects or technically oriented demonstration buildings took the leading role, ecologically interested building owners later developed their own ideas for smaller residential buildings. Architects and engineers forced then the built climate protection as the demand for (Nearly) Zero Energy Buildings increased due to the increase of energy costs, the desired independence from energy supply companies and the rising scarcity of resources. Companies are now trying to use marketing advantages. All these projects normally follow a simple energy balance between energy import from the grids and energy export to the grid by using normal meters (thereby all energy consumptions are included and mostly only electricity feed-in is implicated). Therefore the best-practice examples in Table 5give only an impression on the collected building details and their link to some of the most relevant definitions or labels.

Table 5. Selected best-practice buildings according to above shown labels and definitions.

Typology		Project name	Location	Year	Net FA m²***	Web link	Label, Definition	Main features in energy concept
residential buildings	**single house**	Home for Life	Aarhus, DK	2008	190	www.activehouse.info/cases/home-life	Modelhome 2020	- all-electric building* - PH concept** - solar collectors - efficient day lighting - natural ventilation
	single house	Lighthouse	Watford, UK	2008	93	www.kingspanlighthouse.com	Code for sustainable homes level 6	- woodchip boiler - solar collectors - PV system
	single house	ÉcoTerra Alouette Home	Eastman, CA	2007	234	www.maisonalouette.com/english/ecoterra2/	EQuilibrium building	- all-electric building* - hybrid PV/thermal system
	single house	D10	Biberach an der Riss, DE	2011	182	www.wernersobek.de/index.php?page=252&modaction=detail&modid=448	TripleZero©	- all-electric building* - fully recyclable - big window proportion
	single house	EffizienzhausPlus mit Elektromobilität	Berlin, DE	2011	130	www.bmvbs.de/DE/EffizienzhausPlus/effizienzhaus-plus_node.html	EffizienzhausPlus	- all-electric building* - PH concept** - battery storage - e-mobility
	single house	House Sagiweg	Ross-häusern, CH	2009	227	www.minergie.ch/buildings/de/details.php?gid=BE-	Minergie-A	- PH concept** - woodchip boiler - solar collectors

						001-A-ECO		- PV system
	apart-ment block	Kleehäuser	Freiburg, DE	2006	2519	www.kleehaeuser.de	zeroHaus	- PH concept** - natural gas CHP - solar collectors - PV system - share in wind park
	apart-ment block	Blaue Heimat	Heidel-berg, DE	2006	3374	www.zero-haus.de/blaue-heimat.html	zeroHaus	- refurbishment - natural gas CHP - PV system - share in wind park
	estate	Plus energy houses - Weiz	Weiz, AT	2006	856	www.tanno.at	Plusenergiehaus	- PH concept** - all-electric building* with decentral heat pumps
	estate	Solarsiedlung	Freiburg, DE	2008	7890	www.solarsiedlung.de	Plusenergiehaus®	- PH concept** - CHP district heat - PV roofs - estate balance

non-residential buildings	**school**	Enerpos building	St. Pierre, La Reunion, FR	2008	1300	www.enerpos.univ-reunion.fr	Bâtiment à énergie positive	- all-electric building* - focus on shading and natural ventilation/cooling
	office	NREL - Research Support Facility	Golden, US	2010	20350	www.nrel.gov/	Net Zero Site and Net Zero Source Energy	- focus on shading and daylight - PV - wood fuelled CHP
	factory	Solvis	Braun-schweig, DE	2000	8215	www.solvis.de/sol_nullemissionsfabrik.php	zeroHaus, Nullemissions-fabrik	- PH concept** - use of waste heat - solar collectors - rapeseed-oil CHP - PV system

** PV and heat pump*

*** Passive House concept*

**** FA = Floor Area*

The 13 building examples in Table 5 show an assortment of the most known labels and some best practice buildings. The biggest group is the Swiss Minergie-A label, which has been applied to more than 30 buildings until end of 2012. All are located in Switzerland. It is followed by seven Canadian "EQuilibrium buildings" and again seven "zeroHaus"-buildings in Germany. Figure 10 and Figure 11 show some results from a cross section analysis with currently approx 330 buildings.

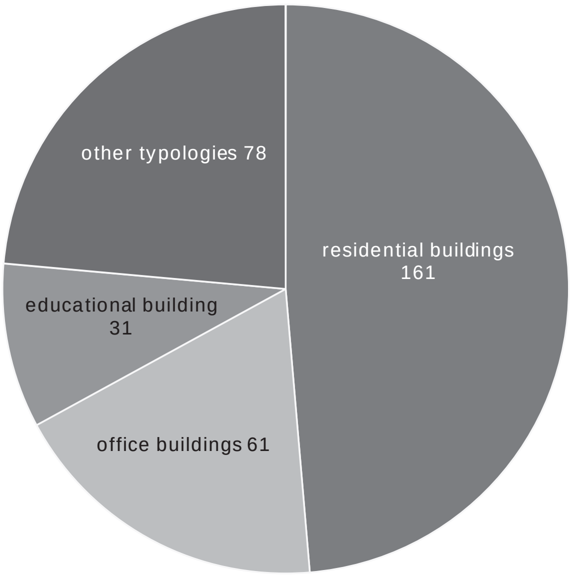

Figure 10.Frequency of different typologies of more than 330 known (Net) Zero Energy Buildings. Source University of Wuppertal

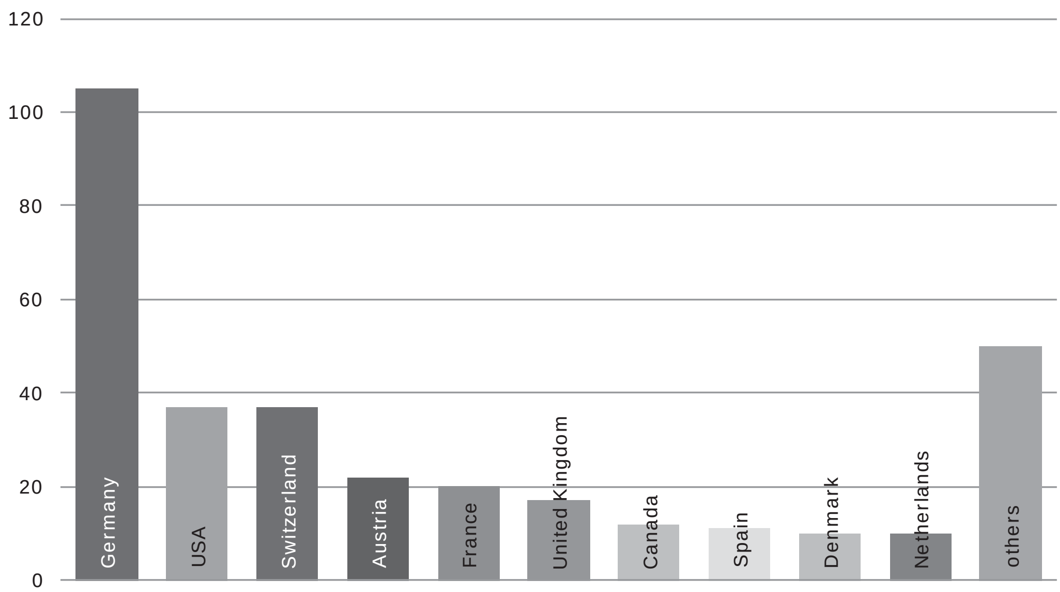

Figure 11.Frequency of known Zero Energy Buildings per country. Source University of Wuppertal

As a short summary it is noticeable that for mid-European climates energy efficiency measures are given the highest priority. In most built cases the heating demand is drastically reduced by following the strategy of the Passive House (high level of insulation, very energy efficient windows, high tightness of the envelope and mechanical ventilation with heat recovery). Beside increased day lighting levels passive solar gains are provided by a higher level of windows compared to standard buildings (passive solar building design). Overheating is avoided by efficient shading devices (fixed or moveable) and passive cooling measures (thermal mass activation, higher ventilation rate during night times). Solar thermal collectors, increased HVAC efficiencies and partly waste water heat recovery reduce energy demands. On-site energy generation from renewable sources (most commonly by PV, only a few examples with on-site windmills) cover lowered demands of heat pumps, HVAC systems and other consumers (lighting, central services or plug loads) or balance delivered energy like district heat/cold or biomass (for boilers or CHPPs).

In high consuming non-residential buildings or those with a renovation background sometimes the balance boundary (see explanation in section 4.2) is expanded to off-site energy generation measures. In these cases investments in wind turbines are external CHPPs are done. The generation options confront to the energy consumptions which are accounted in the balance calculation. In the very most cases these are the buildings related consumptions which are also defined in the most buildings codes (see Figure 12). Due to ecological beliefs of the building owners and the simple recording over a few or even only one (electricity-) meter(s) often also the user related consumption sectors are included. To make different energy carriers comparable the balance calculations which are done in building practice focus on primary energy or energy emissions using national weighting factors. They are mentioned in national directives or scientific publications. In a very few demonstration projects asymmetric weighting is done to privilege technical solutions or penalize some energy carriers (explanations in section 4.2).

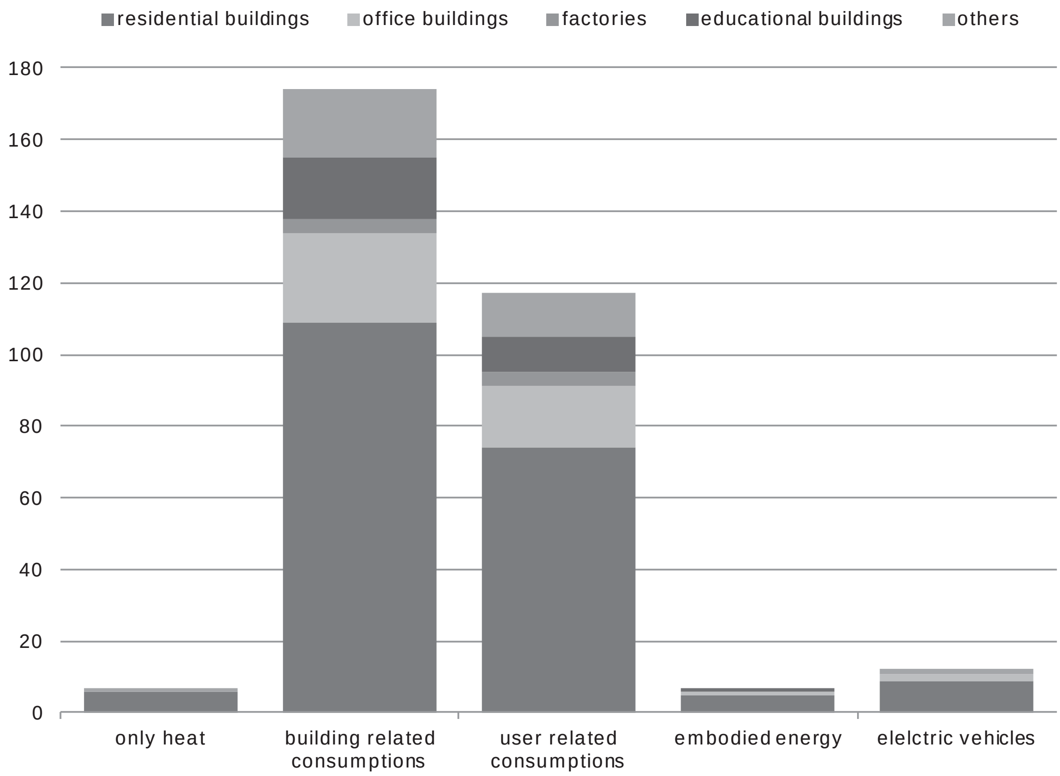

Figure 12.Breakup of the energy demands sectors which are included in the balances of the known Net Zero Energy Buildings per building typology.
Only heat means energy consumption for heating and hot water. Building related consumptions are space heating, domestic hot water, cooling & air conditioning, auxiliary energies and lighting (in case of non-residential buildings) whereas user related consumptions mean e.g. appliances, plug loads, central services, information systems, etc.. Source University of Wuppertal

Typically the above mentioned balance procedure is done on the level of energy import and export due to the comparison of metered (almost always yearly) results. High resolution metering results show that the buildings export the major part of energy during summer times while they import more energy in winter (seasonal mismatch, see section 4.3, Task 1c) [Musall 2011; Musall 2010; Voss Musall 2011b; Musall 2012].

4.2 Task 1b: Development of a comparative taxonomy

4.2.1 Step 1: Distillation of categories from actually available definitions and concepts from task 1a to a taxonomy for evaluating these categories and whether they are in line with the basic EPBD requirements

National strategies towards climate neutral buildings have to reflect the (future) climate, the building standard and energy system as well as the associated (future) energy grid infrastructure. Individual strategies differ depending on the climate, the resources for renewable power in the grid and the heating and cooling grid infrastructures but have to keep in mind the development towards a more networked European energy grid of the future (smart European grid).

The study of the relevant documents supplied for Task 1a (step 1), other valuable contributions from the scientific community, the knowledge of the case study research (Task 1a step 2), and the group's own investigations show that the known definitions and labels for nearly zero-energy buildings come up with a lot of differences in their balance calculations (see section 4.1.2 and Figure 5 to Figure 8). They are essential to move towards a harmonized framework of national Nearly Net ZEB definitions within the EU member states. Beside a few very specific topics they differ in the below listed assessment categories, which are seen as basic principles by [Sartori 2012a; REHVA 2011; Marszal 2011; BPIE 2011; Voss 2011; Voss 2010] to set up a definition or national directive (see also Figure 13). Therefore these categories are mandatory content of an EU reporting matrix and are explained in detail.

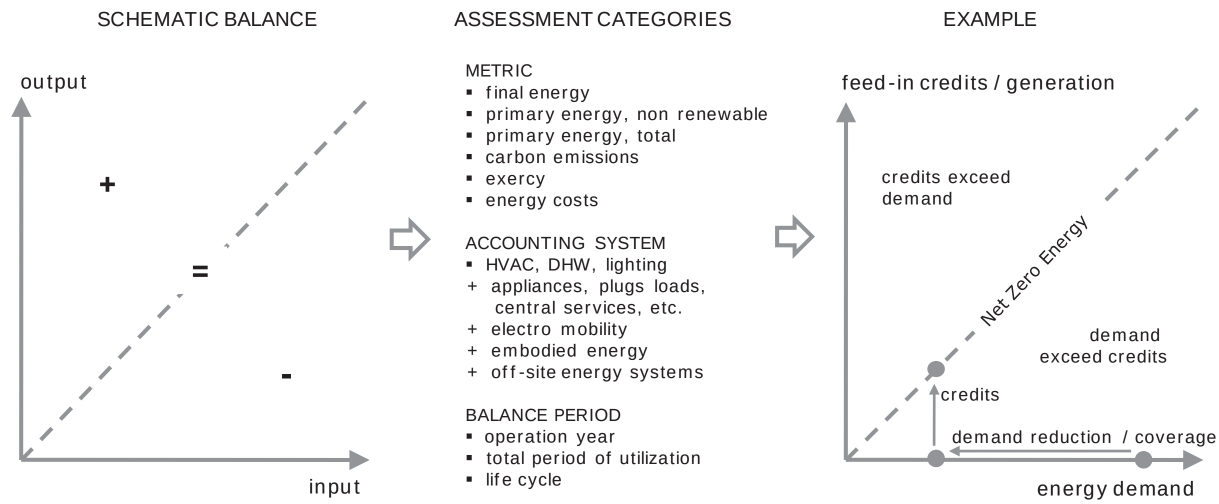

Figure 13.Schematic input / output balance.
The left diagram shows a schematic input / output balance. The balance calculation needs the definition of a metric and an accounting system, the system boundary and the balancing period. As an example, the right diagram uses primary energy (non-renewable fraction only), a system boundary similar to the German energy saving directive (EnEV 2009) for a non-residential building (HVAC, DHW, lighting) and one year of operation. The primary energy demands are balanced by primary energy generation (e.g. only on-site generation). Source University of Wuppertal

To follow the need of analysing the basic categories they were interrogated in detail during the survey in task 1a (step 2, completed spread sheet for concepts and definitions) beside the information shown in Table 4. The analysis below gives (1) a short description of how they could be understood (based on the work from IEA Task 40/Annex 52 [IEA 2008]), (2) short examples from most relevant, partly non-governmental frontrunner definitions or the building practice to show how they are implemented and (3) an evaluation to check if they are in line with the Energy Performance of Buildings Directive (EPBD) and the Renewable Energy Directive (RED). It is noticed that due to the variety in building culture and climate throughout the EU, the EPBD does not prescribe a uniform approach for implementing nearly zero-energy buildings and neither does it describe a calculation methodology for the energy balance. To conserve flexibility, it requires Member States to develop specific plans for increasing the number of nearly zero-energy buildings reflecting national, regional or local conditions (see [BPIE 2011]).

1. Metric of balance:

Description	Definition of a suitable reference figure for balancing demands and credits such as site energy, primary energy non renewable, primary energy total, exergy, equivalent carbon emissions, energy costs, environmental credits and politically/strategically decided factors with respect to the strategic aims (climate change, resources, energy costs, etc.).
Implementation	- The definition of a "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") in the German research, demonstration and funding program of the Federal Ministry of Transport, Building and Urban Development defines site and source energy to address the efficiency of the building (site energy) as well as the energy sources and therefore their renewable fractions or finite nature. - The UK approach "Code for Sustainable homes" – level 6 is an example of a governmental definition using the zero-energy emission - During the last international Passive House conference in Hannover in May 2012 it was discussed to take the net energy beside primary energy to address the efficiency of the building first. - [Torcellini 2006] state that the choice of the metric system effects on how buildings are designed to achieve a equalized energy balance, e.g. the emphasis of the definition will impact on which Zero Energy Buildings designs are chosen and developed.
EPBD/RED	- Article 9.3a defines the metric as primary energy by "[…] including a numerical indicator of primary energy use expressed in kWh/m²y. Primary energy factors used for the determination of the primary energy use may be based on national or regional yearly average values […]. - Article 2.5 of EPBD goes more in detail by saying "primary energy means energy from renewable and non- renewable sources which has not undergone any conversion or transformation process".

2. Accounting System:

Description	Classification of the energy demands sectors to be included in the balance: space heating, domestic hot water, cooling & air conditioning, auxiliary energies, lighting, central services, user specific consumption (e.g. appliances, plug loads, information systems, etc.) embodied energy (e.g. for erecting, recurring or complete life cycle), and electric mobility.
Implementation	- The Federal Ministry of Transport, Building and Urban Development includes beside the "normal" demand sectors for residential according to the Energieeinsparverordnung 2009 (HVAC, DHW) also the consumption for lighting and appliances in their definition of a domestic "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard"). They are calculated with a value of 20 kWh/m²y (cooking 3 kWh/m²y; maximum value of 2.500 kWh/y per residential unit). Electric mobility can be part of the energy balance. In this case the vehicles are seen as appliances. - The "zeroHaus" standard includes all consumers which are related to personnel belongings (HVAC, DHW, lighting, plug loads, etc.). This is because of the background idea of the 2000 Watt society [2000-Watt 2012a; 2000-Watt 2012b]. - The architects balance of the "Plusenergiehaus©" -settlement in Freiburg included all consumers (HVAC, DHW, lighting, plug loads, etc.) to avoid the installing of several meters. Embodied energy and electric mobility is not included. - "Minergie-A" includes the embodied energy not in the balance however a maximum value of 50 kWh/m²y must be met by all the MINERGIE-A-Buildings.
EPBD/RED	- Article 2.4 of the EPBD states "energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting." Important seem the words "inter alia", because this opens the chance to include user related consumptions in the balance boundary. But "associated with a typical use of the building" aims more to the typical demand sectors like HVAC and DHW, perhaps plus lighting or auxiliary energy. - Acting in accordance with the ordinary legislative procedure and the position of the European Parliament and the Council means that "the energy performance of buildings should be calculated on the basis of a methodology, which may be differentiated at national and regional level. That includes, in addition to thermal characteristics, other factors that play an increasingly important role such as heating and air-conditioning installations, application of energy from renewable sources [...]" (preamble of EPBD, recital 9).

3. System Boundary:

Description	Definition of generation sectors to clarify which renewable energy options are considered: in building's physical footprint like PV on the roof, on-site renewables like PV on roofs of parking lots, near-by renewables like systems close-by financed

by owner or user, off-site renewables like biomass, purchased green power from power contracts or off-site wind turbines, fossil and biomass by CHPPs, imported or exported heat and cold.

Beside the system boundary even the physical boundary could be a question. If instead of a single building a cluster of buildings, a settlement, or quarter or a city is considered, miscellaneous buildings could strive as a unit for a common balance. Buildings with a positive energy balance (probably by having more useable area for PV than necessary or running a CHP unit) would compensate such ones with a negative balance (e.g. due to a renovation background, etc.).

Implementation	- “Minergie-A” allows only generation of renewable energy by systems which are installed on or in the building itself. In implementing this may lead either to a combination of solar thermal collectors with wood boilers (plus PV for any other compensation) or to all-electric houses with a heat pump and PV. - The EPC standard from the Netherlands contains district heating, PV, wind turbines within a range of 10 km, if they are financed by the project owner. - The approach of the Plusenergiesiedlung in Freiburg (“Plusenergiehaus©”) enables the balance on the settlement level (row houses with a positive energy balance compensate buildings with a negative balance). Investments of outsiders in the photovoltaics are permitted. - The Norwegian “Powerhouse” accounts exported energy only if it has at least the same quality (=exergy) of energy delivered to the building. That means exported heat can only balance imported heat, but not contribute to balance electricity. Electricity export, instead, can balance all other carriers. - In the “EffizienzhausPlus” (formerly “Plus-Energie-Haus-Standard”) definition of The Federal Ministry of Transport, Building and Urban Development the site on which the house is built must be recognized as a balance boundary. In extension to the balance boundary of EnEV (immediate spatial context of the building), the sum of the generated energy from renewable sources on site of the evaluated building is creditable ("on-site generation"). - The Austrian definition of "Plusenergiehaus" from the research programme “Haus der Zukunft plus” defines that the yearly primary energy demand has to be below on-site energy production from renewable sources where on-sight production means production within the system boarders of the house of in “immediate vicinity”.
EPBD/RED	- In article 2.2 of the EPBD is written “[…] the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”, what means that both renewables from on-site and off-site could be included. It is not described what “very significant extent” and “nearby” mean. - Article 13.4 of the RED formulates that “[...] Member States shall permit […] minimum levels […], inter alia, through district heating and cooling produced using a significant proportion of renewable energy sources”. - The EPBD-statement in article 2.6 “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" opens the system boundary to nearly every renewable energy source and pushes the need of more renewable energy to the grids (normally hydrothermal and ocean energy or hydropower can´t be generated at a building). This is underlines by a statement in article 13.4 in the RED: "Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building sector", where "all kinds" is again very unspecific but the term "in the building sector" givers at least a link to buildings. Therefore the calculation could contain on-site and off-site generation although it must be said that off-site sources are incorporated by the factors of the grids (see below) and their proportion can´t be determined at the building. They also can´t be measured at the building such as own generation by a photovoltaic system. Passive solar gains are not included above, as they are considered as energy efficiency measures. This is often discussed in the engineering sector.

- The RED allows that installations that produce energy from renewable sources are used and owned by third parties (Article 13.5: "Member States may, inter alia, allow that obligation to be fulfilled by complying with standards for zero energy housing, or by providing that the roofs of public or mixed private-public buildings are used by third parties for installations that produce energy from renewable sources").

4. Weighting factors:

Description	Determination of suitable conversion factors for energy demand and energy generation with respect to the metric chosen (national average, EU average, political factors, etc.). Identification of adequate sources and advanced concepts to allow asymmetric (using different weighting factors for delivered and exported energy) or time dependent conversion factors in future smart grids (availability of renewable energy will vary over time) to be dealt with.
Implementation	- The Federal Ministry of Transport, Building and Urban Development defines special primary energy factors (different from the Energieeinsparverordnung) for "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard"). Only the non-renewable fraction is integrated. The electricity fed into the grid is to be evaluated analogous to the electricity mix of the grid. Weighting factors differ for import and export of electricity but are considered constant. - For the Norwegian Zero Emission Building CO_2 equivalent values from the ZEB centre have to be used. They are based on existing literature, ad-hoc studies and scenario studies on the EU electric grid towards 2050. - The Swiss approach applies weighting factors for biomass different from calculated primary energy factors to take the limitation of biomass resources into account. - In the REHVA description for nearly zero-energy buildings primary energy factors

based on national or regional annual weighted averages according to EN 15603:2008 or specific value for energy carriers which are produced on-site are suggested.
- In the very most cases national conversion factors are used. Partly they are based on the GEMIS (Global Emission Model of Integrated Systems).

EPBD/RED
- Article 9.3a proposes "[…] Primary energy factors used for the determination of the primary energy use may be based on national or regional yearly average values […]".
- Article 8.2 prepares the way to include asymmetric or time dependent weighting factors: "Member States shall encourage the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation […]".

5. Normalization:

Description
Agreement of a suitable reference area as internal (usable floor area, net floor area, treated floor area) or overall internal (area of internal walls is also considered) or external (gross floor area). Also a completely other value is possible like a complete building (as total unit), a single person or gross volume respectively net volume.

Implementation
- The "Powerhouse" form Norway uses treated floor area, what is also known for the Passive House concept.
- The most non-governmental definitions from Germany (like "Plusenergiehaus©" or "TripleZero©") use net floor area, what is mostly not deeper defined.
- The methods suggested from "klima:aktivhaus" in Austria relate their energy balance to gross floor area.
- The publication [BPIE 2011] gives an overview of how area is defined in calculation methods in a range of the European countries. In 18 countries examined five use gross floor area and eight net floor area.

EPBD/RED
- By saying "[…] including a numerical indicator of primary energy use expressed in kWh/m²y […]" in article 9.3a, the EPBD refers to an area in m², even if it is not described exactly how to calculate this area and if it is e.g. gross or net floor area.

6. Balance period:

Description
Regulation of the time in which a (nearly zero energy) aim should be achieved. A yearly balance would include all consumptions and gains and allows e.g. summer yields to compensate higher consumptions during the heating phase. Shorter time spans such as a seasonal or monthly balance focus on a smaller stress of the (electricity) grid (see below) and call for higher energy efficiency, energy storage or more stable supply systems, in order to reach the target in times without high solar gains. A life cycle balance allows including embodied energies. Even if [Sartori 2012a] points out that embodied energy can be annualized and counted in addition to operational energy uses.

Implementation
- The non-governmental labels "Minergie-A", "Powerhouse", "zeroHaus" as well as the official one like "EffizienzhausPlus" or "Equilibrium building" can be seen as

representatives for the most known definitions and labels. They all have a yearly energy basis.

- The approach "NEH" from Germany stipulates a monthly calculation (according to the calculation of the official norm DIN V 18599) where the residuals are summed up to the annual balance (life cycle could be included by counting it as an annualized value in addition to operational energy uses). Similar approaches can be found in the "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") and "Auf dem Weg zum EffizienzhausPlus" definitions which are also accorded to the norm mentioned above.
- Only two labels suggest a life cycle balance: "low ex zero emission" from Switzerland and a definition for Zero Energy and Zero Carbon Building projects from the Netherlands. In both cases no further description is shown.
- "Model home 2020" from Denmark is a yearly balance which takes into account the embodied energy by an annualized value.

EPBD/RED — - Article 9.3a EPBD defines the balance period as a year by the "y" in "[...] expressed in kWh/m²y [...]" instead a shorter or longer season. The overall description in the preamble of the EPBD, recital 9 underlines this statement ("[...] the methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance of a building [...]"). With respect to energy cost and the cost optimal approach it seems necessary to include longer time spans up to the life cycle. But it is not mentioned if the embodied energy could or something else could be included by an annualized value.

7. Minimum requirements:

Description — Meaning of the efficiency and comfort standard a building has to achieve. What does "nearly zero" or "very low amount of energy" stand for (building efficiency requirements)? How to interpret and define the "significant extent" of energy use to be covered by renewable energy (requirements for energy supply)? What are minimum or maximum indoor temperatures, daylight coefficients, and air qualities (comfort & IAQ requirements)?

Implementation — - "Minergie-A" has several additional requirements beside the zero energy balance. The heating and hot water demand is limited to 30 kWh/m²y. Combinations of solar thermal collectors and biomass boilers must have 50 % of heat from the collector systems (the leftover of biomass must not exceed 15 kWh/m²y). The embodied energy is limited to a maximum value of 50 kWh/m²y. Household and office appliances and lights shall be of the highest efficiency classes.
- The "zeroHaus" certificate exacerbates the efficiency requirements of the German EnEV with its own limits: it requires, in particular an improvement of the average U-value of the building envelope by 45 % and a maximum primary energy demand of 100 kWh/m²y.
- In Level 6 of the "Code for Sustainable Homes" a maximum U-value of the opaque building envelope of 0.11 W/m²K is required

- The Norwegian "Powerhouse" standards calls for extremely high energy efficiency for appliances and generation systems
- The Danish "Bolig+" label sets a limit for the electricity consumption of appliances at 1600 kWh/y per dwelling. Energy delivered back to the utility grid must be of at least the same usability and quality as energy taken from the grid.
- The Swedish "Nollenergihus" claim for a Passive House standard as efficiency aim.
- The average U-value of the envelope must be 45 % lower than the one of a reference building according to DIN 18599 (renovation min. 30 % lower) in the German label "EffizienzhausPlus". The Primary energy demand and the end energy demand have to be min. 60 % lower than the one of a reference building according to DIN 18599 (renovation 45 % respectively 35 % lower).
- The most known definitions don´t formulate a minimum share of renewable energy on their consumption due to their aim of a net zero energy balance (in which the energy demand is equalized by own generation). Otherwise some national directives do that (like EEWärmeG in Germany).

EPBD/RED

- The EPBD says in article 2.2 "nearly zero-energy building means a building that has a very high energy performance [...]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby." Thereby here no efficiency target as an explicit specific value is given (according to different climates and local conditions all over Europe) but "nearly zero" or "very low" address the efficiency of the building. A part of article 13.4 of the RED "[...] Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings" names "passive buildings".
- A description about "very significant extent from renewable sources" is also lacking. An advice to a requirement of a specific fraction of renewable energy supply could found in article 13.4 of the RED "By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation" and in the preamble of the EBPD, recital 15: "[...] As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs for heating and cooling are reduced to cost- optimal levels." This give also a tip that renewables should first cover the buildings demands instead of a full export to the grids. If solar thermal systems should be seen as efficiency measures or as renewable supply systems – as often discussed in the scientific community - is not fully answered [Sartori 2010a].
- Indoor climate requirements should also be included: "[...] the improvement of the energy performance of buildings within the Union, taking into account outdoor

climatic and local conditions, as well as indoor climate requirements [...]" (article 1.1, EPBD) and "The energy performance of buildings should be calculated on the basis of a methodology, which may be differentiated at national and regional level. That includes, in addition to thermal characteristics, other factors that play an increasingly important role such as heating and air-conditioning installations, application of energy from renewable sources, passive heating and cooling elements, shading, indoor air-quality, adequate natural light and design of the building" (preamble of EPBD, recital 9).
- A focus on the avoiding of overheating is to be found in the preamble of the EPBD, recital 25: "[...] Priority should be given to strategies which enhance the thermal performance of buildings during the summer period. To that end, there should be focus on measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques."

The following categories show more advanced agreements and do not only focus on the needs of new buildings but instead on the practical implementation of such buildings, the energy infrastructure and the building stock. They are more or less not defined in the EPBD or RED and were invoked by current scientific discussions or political debates.

8. Balance approach/ type of balance:

Description — With respect to engineering practice a balance might be based on an independent comparison of "energy generation versus load" or "feed-in versus delivered energy" approach (see Figure 14)explicitly taking into account matching of on-site load by on-site energy generation. Initial investigations have shown that results are in most cases not identical.

Implementation — - While the "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") and "Auf dem Weg zum EffizienzhausPlus" definitions from Federal Ministry of Transport, Building and Urban Development respectively Deutsche Energie Agentur as typical balance approaches with a calculation background claim for a "load vs. generation balance" the non-governmental "Plusenergiehaus©" idea bases on a "import vs. export balance" as a typical example of a realized building project where the energy supply and the energy export is metered.

EPBD/RED — - In the very most cases the calculation method of the found definitions and descriptions base on the comparison of generated and consumed energy or imported and exported energy. All those four values can be measured by "normal" energy meters. The EPBD definition in article 2.6 describes renewable sources as wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. To capture their influence in the energy system of a building more effort in monitoring and further explanation are needed. E.g. it is not defined, whether the use of electricity by a heat pump is only reduced by a solar thermal yield of a solar thermal system or may also be compensated in the energy balance. Figure 15 tries

to give a possible interpretation variation.
- To monitor the net energy flow at the point of grind interaction during operation, smart meters are necessary. Those are asked for in article 8.2 of the EPBD ("Member States shall encourage the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation [...]"). But more is currently not described.

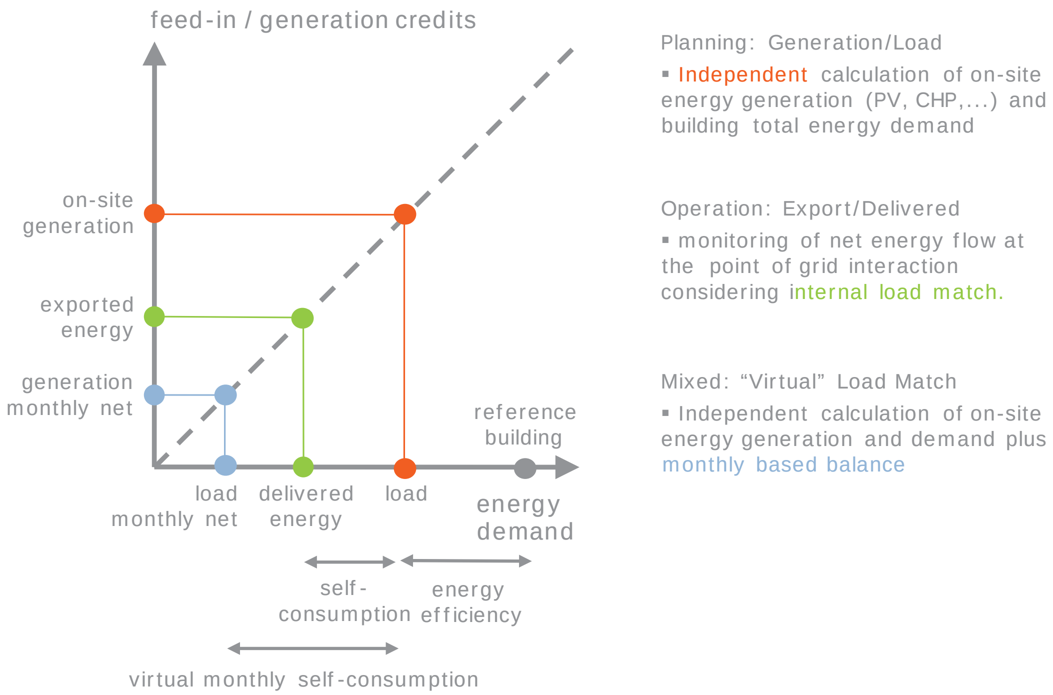

Figure 14.Different energy balance approaches. Source [Sartori 2012a]

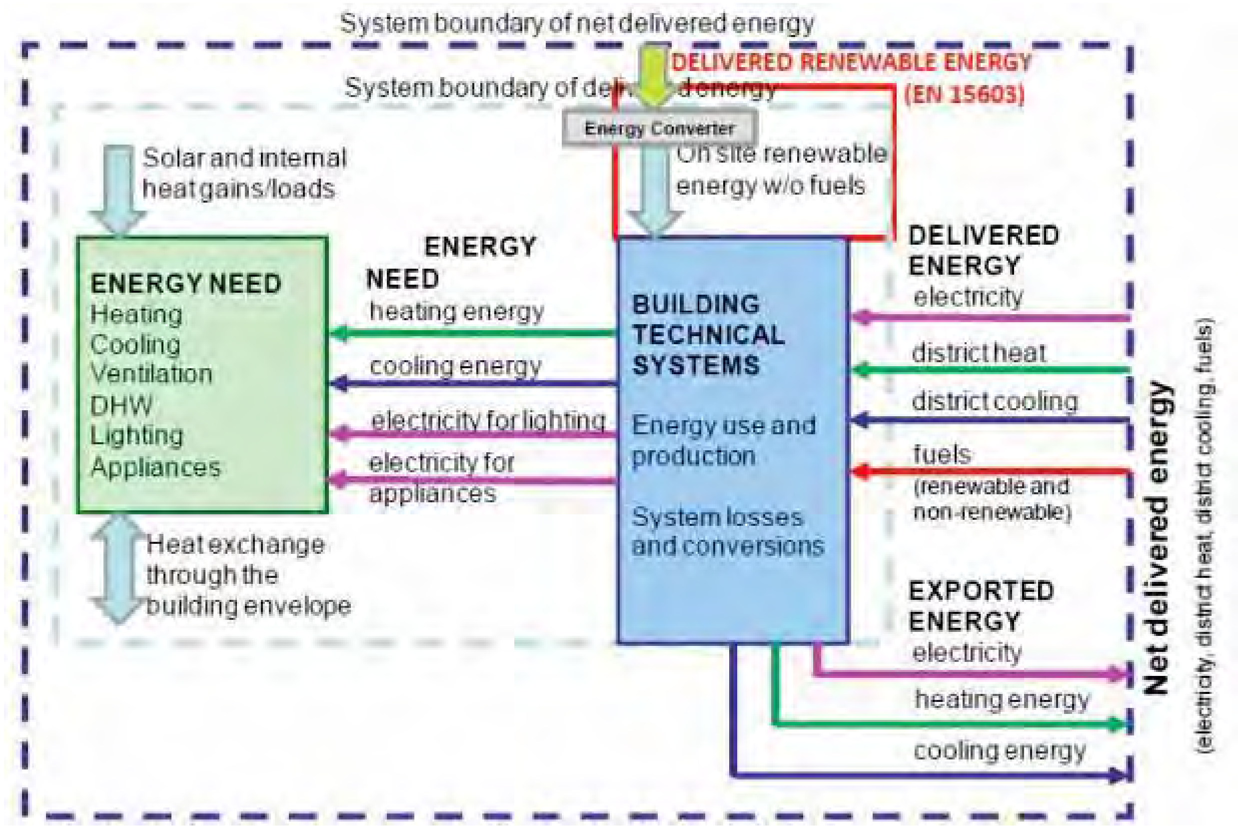

Figure 15.Detailed energy boundary of net delivered energy for nearly zero-energy buildings The box of "Energy need" refers to rooms in a building and both system boundary lines may be interpreted as the building site boundary. Source [REHVA 2012]

9. Load matching and Grid Interaction (temporal performance):

Description — In addition to the chosen definition, a load match and grid interaction index seems an appropriate measure to describe the variety of solutions towards buildings with an own energy generation systems with respect to the positive or negative interaction with the (local) energy infrastructure. These indexes are not part of any known definition until know but [Lund 2011; Salom 2011; Sartori 2012a; Voss 2010] describe the need of those factors, especially when more and more decentral systems in or on buildings feed energy into the grids.

Implementation — - The "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") from Federal Ministry of Transport, Building and Urban Development in Germany claims that the relation of consumed and renewable-generated energy within the balance boundary should be expelled. The calculation is based on the monthly evaluation of EnEV.

- Like the one above the scientific approach of "NEH" is also based on the German calculation methodology DIN V 18599. According to that here no requirement is presented but a monthly load match is calculated and named by an index, which shows the primary energy credit, which is required and achieved to obtain a balanced annual energy budget. The primary energy credit is determined on the

	basis of the monthly balancing procedure, taking the priority of consumption on-site into account. - During the last international Passive House conference in Hannover in May 2012 it was highlighted that the match in winter times ("winter performance") is important and therefore possible reductions during winter (efficiency) are necessary. It will be included in future considerations of the passive House Institute.
EPBD/RED	- no items found

10. Fraction of renewables

Description	Guidelines could be given for any fraction of renewable energy. Herewith it would be indicated how or at which level a certain fraction of renewable energy is calculated (e.g. solar thermal heat might be a fraction of energy use, electricity from PV a fraction of delivered energy).
Implementation	- "Minergie-A" formulates the requirement that a limited heating and hot water demand (30 kWh/m²y) must have 50 % of heat from the collector systems of a combination of solar thermal collectors and a biomass boiler is chosen (the leftover of biomass must not exceed 15 kWh/m²y).
EPBD/RED	Article 13.4 of the RED tells that "Member States shall introduce [...] appropriate measures [...] to increase the share of all kinds of energy from renewable sources in the building sector [...]. By 31 December 2014, Member States shall [...] require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings [...]. In article 2.2 of EPBD is written that "[...] the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]".

11. Influenced weighting:

Description	Influencing the balance with respect to national needs – national approaches with the intention to favour certain technological solutions.
Implementation	- The "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") from Federal Ministry of Transport, Building and Urban Development in Germany arrogates "asymmetric" weighting of electricity by special weighting factors for electricity supply (2,4) and generation (2,8). - In Switzerland in general "political weighting factors" for biomass are used. The supply of biomass is weighted with 0,7 instead of 0,05. - In scientific publications a "seasonal weighting" by changing or dynamic weighting factors is proposed to react on variations of renewables in the energy grids and to promote external renewable energy generation during the colder seasons.
EPBD/RED	- no items found

12. Positive Energy Buildings:

Description	The value of exported excess electricity (or heat) has to be carefully checked to avoid double accounting of the positive effect of renewable electricity. Exported power is normally seen as part of the grid thereby reducing its overall primary energy or emission factor. This leads to a decreased primary energy and emissions factor of grid electricity supplied to the building.
Implementation	- Both the German demonstration program “EffizienzhausPlus” (formerly “Plus-Energie-Haus-Standard”) as well as the voluntary concept “Plusenergiehaus©” of the architect Rolf Disch (Freiburg) claim a positive primary energy balance. In the first definition also a positive site energy balance is the target. - The Austrian definition of "Plusenergiehaus" from the research programme “Haus der Zukunft plus” defines that the yearly primary energy demand has to be below on-site energy production from renewable sources.
EPBD/RED	- no items found

13. Existing buildings:

Description	Any definition framework should consider the need for Nearly Net ZEB options for the renovation of existing buildings. This is of special relevance with respect to CHP applications to cover higher heat demands while generating electricity for self consumption of export.
Implementation	- The most recognized definitions and descriptions incorporate both new and renovated buildings and don´t differ in their requirements - The buildings standards related to the Austrian initiative “Mustersanierung” have been developed as basis of a specific subsidy programme to support the high quality refurbishment of non-residential buildings. The scheme has several mandatory criteria (net heating and net cooling demand 60 % below the minimum requirement for other renovations, minimum share of renewable energy sources in energy supply of the building and minimum requirement for air tightness) - The “Auf dem Weg zum EffizienzhausPlus” standard sets lower conditions for renovations (average U-value of the envelope 30 % lower than reference values according to DIN 18599, the primary energy demand and the end energy demand should be 45 % respectively 35 % lower than the one of a reference building according to DIN 18599. A special program called “EffizienzhausPlus im Altbau” is under development in mid 2012 by Federal Ministry of Transport, Building and Urban Development.
EPBD/RED	- The topic of refurbishment is often articulated: E.g. in preamble of EPBD, recital 15: “Buildings have an impact on long-term energy consumption. Given the long renovation cycle for existing buildings, new, and existing buildings that are subject to major renovation, should therefore meet minimum energy performance requirements adapted to the local climate.”

14. Performance Monitoring:

Description	As in the end it is the actual consumption which determines the degree of target

achievement, any definition framework has to consider the possibility of verification of any kind of a Net or Nearly Net ZEB status in real building operation. Energy balance boundaries have to be set according to the monitoring practicability (meters) in practice.

Implementation	- The Norwegian "Powerhouse" and the Swiss Minergie-A labels claim for metered data. - A complete monitoring guide is available for the "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") from the Federal Ministry of Transport, Building and Urban Development. It should be checked in the occupied status, whether the requirements are met in practice. For the evaluation of the building to the amounts of supplied energy (electricity, gas, oil, etc.) and the energy which is fed into the grid (electricity, heat, etc.) are measured continuously. The climatic conditions and user behaviour should be recognized, too. - In the "Auf dem Weg zum EffizienzhausPlus" program planning data are a prerequisite to participate in the program, afterwards measurements for energy have to be done but they are not a prerequisite to have the label. - The "zeroHaus" certification is based on three steps: 1. calculated data during planning phase, 2. proof of compliance with planned building characteristics, 3. measured data after the first year of operation (then label valid is for 20 years). - For the different standards in the Austrian "klima:aktivhaus" demonstration program the building projects have to be measured due to its demonstration character and the desired publications.
EPBD/RED	- The sentence "energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building [...]" in article 2.4 of the EPBD gives an advice to that topic, whereas article 8.2 states, that "member States shall encourage the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation […]" what introduces the need of (smart) metering.

Beside these 14 points the EPBD provides efficiency stipulations for heat pumps, solar thermal collectors or biomass fired systems (e.g. article 13.6) or further requirements which are mostly not defined in the descriptions of well-known voluntary definitions and labels. This is probably because most of these definitions exist in addition to state directives, which fix these things. For example the inspections of the technical systems are addressed in the preamble by recital 26 "[...] an independent assessment of the entire heating and air-conditioning system should occur at regular intervals during its lifecycle […]." The publication of the energy performance by certificates is named in article 12.1. "[…] Member States shall ensure that an energy performance certificate is issued […]" and article 11.1 "[…] the energy performance certificate shall include the energy performance of a building and reference values such as minimum energy performance requirements in order to make it possible for owners or tenants of the building or building unit to compare and assess its energy performance." Those facts are not in the focus of the (voluntary) ideas for nearly zero-energy buildings because of their marketing, research or demonstration background.

4.2.2 Step 2: Matrix filled with exemplary frontrunner definitions and their evaluation for illustration purposes

A first draft of reporting matrix was set up, allowing the Commission to check whether national definitions or approaches are in line with basic EPBD requirements. For this purpose basic assessment categories were distilled and compared with according EPBD/RED requirements. An initial version of the reporting matrix template was checked in a first round with known „frontrunner" definitions by the core research group to demonstrate the applicability of the matrix. Beside the 2011 published "MINERGIE-A" standard from Switzerland, the German approach for the demonstration program "EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard") from the Federal Ministry of Transport, Building and Urban Development and a newly developed standard of the Norwegian Zero Emission Building Centre established at Trondheim University were analyzed (Table 6).

Table 6.Evaluation of conformity of exemplary definitions with the EPBD requirements.

Country	EU	CH		NO		DE	
Definition / Label	**EBPD / RED**	**Minergie-A**		**Zero Emission Building**		**"EffizienzhausPlus" (formerly "Plus-Energie-Haus-Standard")**	
Metric of balance	Primary energy (renewable and non- renewable part)	Source energy (renewable part not included)	–	Carbon emissions	–	Site energy and source energy (non renewable part)	√
Accounting System	Minimum building related demands (heating, cooling, ventilation, DHW and lighting)	Building related demands (HVAC, DHW)	–	Minimum HVAC, DHW, lighting, central services	√	HVAC, DHW, lighting, central services, plug loads	√
System Boundary	Minimum share of renewable sources on-site or nearby	On-site generation	√	not yet decided, possibly minimum share from on-site renewables	√	On-site generation	√
Weighting factors	National or regional yearly average primary energy factors	Own weighting; symmetrical and static factors	–	CO_2 eq. values from the ZEB centre (symmetrical and static)	–	Primary energy conversion factors according to DIN 18599	√
Normaliza-tion	Floor area with unit m²	Heated gross floor area	√	Treated floor area	√	Net floor area	√
Balance period	Annual energy performance	Yearly	√	Yearly	√	yearly - monthly residuals are summed up to from the annual balance	√
Minimum require-ments	Zero or very low amount of energy; very significant use of renewable energy; indoor climate requirements (adapted locally)	Heating and DHW demand max. 30 kWh/m²; air tightness n50 ≤ 0,6 h-1; maximum value for embedded energy (50 kWh/m²y); appliances, office equipment and lamps from highest efficiency classes	√	Extremely high energy efficiency for appliances and generation systems; load match index by monthly values; indoor climate to national standard	√	Use of appliances with highest efficiency class (maximum 20 kWh/m²y for household appliances; smart meters	√

√ fulfilled

– not fulfilled

After the above mentioned intermediate step it became clear that the matrix could not meet the goal of a proposal for reporting and to help member states with their reporting requirements on their national application of Nearly Net Zero Energy Buildings. A template should be created that is flexible enough to allow the member states explaining what the country is doing. It should not guide or limit the definitions being proposed. Therefore it should reflect much more than the most frequently asked requirements of known definitions and possible national directives. Furthermore the desired result should work as a comparative reporting template to assist the Commissions internal reporting. Therefore an external query was developed reflecting more than the most important requirements and assessment categories which were found out so far (task 1a step 2 and task 1b step 1).

The reporting template was created as an “active” Excel based spread sheet including all before mentioned assessment categories and items which are mandatory due to the EPBD or RED descriptions. Each category is referenced to the appropriate EPBD section

Where possible a number of the most likely options was compiled from the found and already implemented certification methodologies and is now given under nearly each category in a combo box (see Figure 16). This predefined possibility of implementation shall speed up the process of filling in the template as it enables users to quickly pick the according content. The use of similar answers allows a comparable analysis by the European Commission. If the national used option is not given in the combo box, own entries are also possible. For each assessment category helping comments and explanatory figures are shown by a click in the according cells to avoid confusion while filling the reporting template (see Figure 16). The wording is related to official EU nomenclature. To enable a specification of the given declarations a comment field is provided on the right of the spread sheet in which explanations should be entered. Typical definition categories that are not mandatory EPBD requirements are included to give the possibility to explain what is defined beside and beyond the EPBD and RED (see point 8-14 task 1b step 1). These categories are differentiated in the reporting matrix by colour (dark grey letters).

Beside the supporting comments and prepared choices among different assessment categories in combo boxes an advantage of the Excel based structure is the flexibility of the comment fields which a flexible sizing according to the individual comments and inputs given by the user.

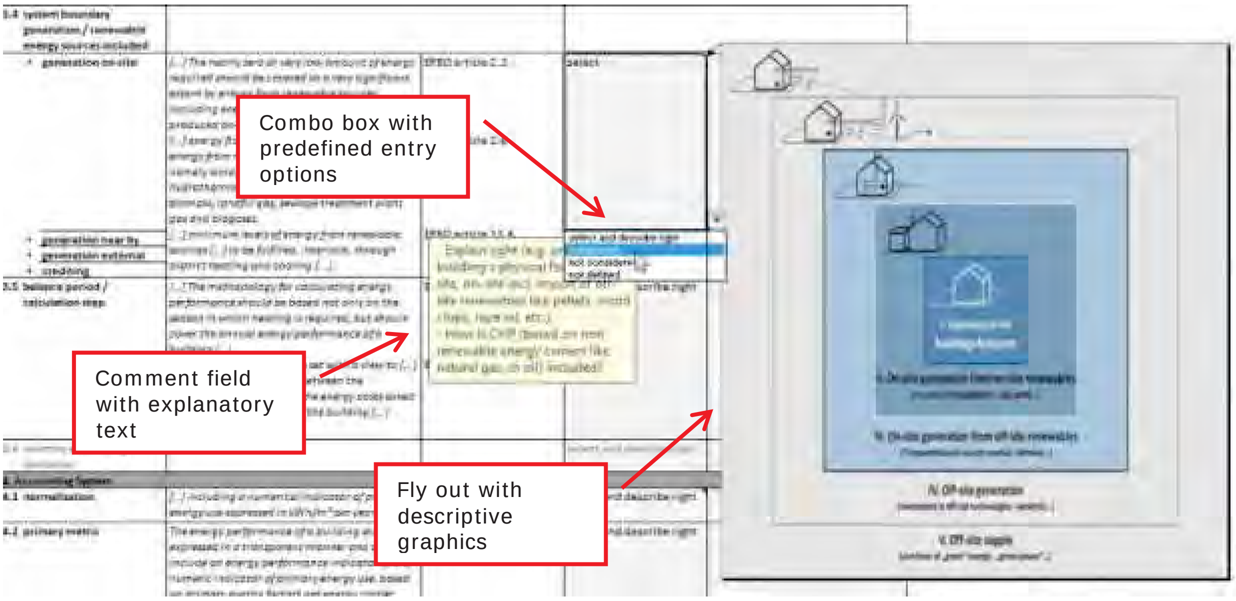

Figure 16.Screen shot of a part of the final version of the reporting template with an exemplary click in one cell to demonstrate the combo box with predefined entries, a comment field with explanatory text and a descriptive graphic.
Source University of Wuppertal

During the development process a draft version of the excel file was tested by the core research group to get feedback on the application, comprehensibility, and wording. It was used with known implemented definitions for (Nearly) Zero Energy Buildings. After some overall comments, small bugs have been fixed and suggestions were incorporated.

In a second round of testing external project partners from ten countries (AT, CH, CZ, DE, DK, NO, IT, SP, SE, US) gave feedback after they have filled in and tested the reporting template with their current national directives. As the Danish example is the only one that could be filled with an already implemented directive according EPBD 2010 (Danish Building Regulation 2010 BR10), this template (intermediate version) is shown as an example in appendix 10.2.3. The impression of all users was, that the reporting template with its “active” helps facilitate the process of reporting and that it takes very little time to complete the template and give all specifications.

Last feedback was given after a presentation of the reporting template during a stakeholder meeting which was coordinated by the European Commission in Brussels. The parent opinion was that the template looks helpful and easy to understand. Because of some questions according to the wording the help texts were updated and additional graphics were added.

The mentioned desire to have additional pages in the template to describe different approaches for e.g. new/renovated or public/non-public buildings has been fulfilled. Additional sheets can be added automatically (button in line 2.4 in of the template, see Figure 17) and completed accordingly. Hence the focus of the template is not anymore only on new buildings but also meets the requirements to transform existing ones.

The final version of the reporting template will be hand over to the European Commission as a digital file.

Reporting template of the European Union on the Member States application of national definitons of Nearly Zero Energy Buildings

Items and assessment categories which are mandatory due to the EPBD or RED are explained or referenced by an example in the column "EPBD / RED requirement". The source is given in the column to its left. Additional typical definition categories that are not mandatory EPBD requirements are included to give the possibility to explain what is defined beside and beyond the EPBD and RED. These categroies are differentiated by colour (dark grey letters). For each aspect a number of possible choices is given in a combo box. Explanatory texts and figures are shown by a click in the according cells. Comments and explanations should be entered in the cells on the right.

1. General information				
Country			select	
Name of regulation, directive, certification scheme				
Editor of regulation, directive, certification scheme				
Year of introduction of current version			select	
Energy benchmark of current version			select	
Integration and consideration in national directive			select and describe right	
2. Field of application	**EPBD / RED requirement**	**EPBD / RED reference**	**Content in Member States national definition**	**Explanation, comment, source**
2.1 building category	*Member States shall ensure that all new buildings are nearly zero- energy buildings by 31 December 2020 respreciuely after 31 December 2018 (occupied and owned by public authorities).*	EPBD article 9.1a/b	select and describe right	
• **single-family houses**			select	
• **apartment blocks**			select	
• **offices**			select	
• **educational buildings**	*For the purpose of the calculation buildings*		select	
• **hospitals**	*should be adequately classified into the [...]*	EPBD annex I	select	
• **hotels and restaurants**	*categories*		select	
• **sports facilities**			select	
• **wholesale and retail trade service buildings**			select	
• **other types of energy-consuming buildings**			select	
2.2 new/retrofit buildings	*New, and existing buildings that are subject to major renovation, should meet minimum energy performance requirements adapted to the local climate.*	EPBD preamble recital 15	select	
	Member States shall furthermore [...] stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings	EPBD article 9.2		
2.3 private/public buildings	*Member States shall ensure that by 31 December 2020, all new buildings are nearly zero- energy buildings and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.*	EPBD article 9.1a/b	select	
2.X [illegible]			[illegible]	
3. Energy Balance / Calculation				
3.1 balance type	*[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources*	EPBD article 2.2	select and describe right	
	Energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand [...]	EPBD article 2.4		
3.2 physical boundary	*This directive lays down requirements as regards the common general framework for [...] buildings and building units.*	EPBD article 1.2a	select and describe right	
	[...] building' means a roofed construction having walls, for which energy is used to condition the indoor climate.	EPBD article 2.1		
3.3 system boundary demand / energy uses included				
• **space heating, domestic hot water**	*[...] energy performance of a building means the calculated or measured amount of energy needed*	EPBD article 2.4	select	
• **ventilation, cooling, air conditioning**	*to meet the energy demand associated with a typical use of the building, which includes, inter*		select	
• **auxiliary energy**	*alia, energy used for heating, cooling, ventilation,*		select	
• **lighting**	*hot water and lighting.*		select	
• **plud loads, appliances, IT**			select	
• **central services**			select	
• **electric vehicles**			select	
• **embodied energy**			select	

Figure 17.First part of the empty final version of the reporting template. An already filled version (with content of Danish BR10) is shown in the appendix. Source University of Wuppertal

3.4 system boundary generation / renewable energy sources included				
• **generation on-site**	*[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.* *[...] 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.*	EPBD article 2.2 EPBD article 2.6	select	
• **generation near by**	*[...] minimum levels of energy from renewable sources [...] to be fulfilled, inter alia, through district heating and cooling [...]*	EPBD article 13.4	select	
• **generation external**			select	
• **crediting**			select	
3.5 balance period / calculation step	*[...] The methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance of a building [...]* *[...] requirements should be set with a view to [...] the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building [...]*	EPBD preamble recital 9 EPBD preamble recital 10	select and describe right	
[illegible]			[illegible]	
4. Accounting System				
4.1 normalization	*[...] including a numerical indicator of primary energy use expressed in kWh/m² per year*	EPBD article 9.3a	select and describe right	
4.2 primary metric	*The energy performance of a building shall be expressed in a transparent manner and shall include an energy performance indicator and a numeric indicator of primary energy use, based on primary energy factors per energy carrier which may be based on national or regional annual weighted averages or a specific value for on- site production.* *[...] including a numerical indicator of primary energy use expressed in kWh/m 2 per year* *[...] primary energy' means energy from renewable and non- renewable sources which has not undergone any conversion or transformation process*	EPBD Annex 1 EPBD 9.3a EPBD article 2.5	select and describe right	
[illegible]			[illegible]	
[illegible]			[illegible]	
4.5 time dependent weighting	*Primary energy factors [...] may be based on national or regional yearly average values and may take into account [...] European standards*	EPBD 9.3a	select and describe right	

Figure 18.Second part of the empty final version of the reporting template. Source University of Wuppertal

5. Further requirements				
5.1 fraction of renewables	*Member States shall introduce [...] appropriate measures [...] to increase the share of all kinds of energy from renewable sources in the building sector [...]. By 31 December 2014, Member States shall [...] require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings [...]* *[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]*	RED article 13.4 EPBD article 2.2	select and describe right	
[illegible]				
[illegible]			[illegible]	
[illegible]			[illegible]	
5.3 energy performance or rating requirements	*nearly zero-energy building means a building that has a very high energy performance [...]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]* *The energy performance [...] shall [...] include an energy performance indicator and a numeric indicator of primary energy use [....]*	EPBD article 2.2 EPBD Annex 1	select and describe right	
• **energy performance indicator**				
• **numeric indicator of primary energy use**				
5.4 general framework / prescriptive requirements	*The methodology shall [...] take into consideration: thermal characteristics (thermal capacity, insulation, passive heating, cooling elements, and thermal bridges), heating installation and hot water supply, air-conditioning installations, natural and mechanical ventilation, built-in lighting, the design, positioning and orientation of the building, outdoor climate, passive solar systems and solar protection, [...], internal loads*	EPBD Annex 1	select and describe right	
5.5 definition of comfort level & IAQ requirements (for winter and summer season, beside other national directives)	*This Directive [...] takes into account [...] indoor climate requirements [...]* *The methodology shall [...] take into consideration: [...] indoor climatic conditions [...]* *That includes [...] indoor air-quality, adequate* [illegible]	EPBD article 1.1 EPBD Annex 1 [illegible]	select and describe right	
5.6 monitoring procedure	*[...] energy performance of a building means the calculated or measured amount of energy needed [...]* *Member States shall encourage the introduction of intelligent metering systems [...] and the installation of automation, control and monitoring systems [...]*	EPBD article 2.4 EPBD article 8.2	select and describe right	

Figure 19.Third part of the empty final version of the reporting template. Source University of Wuppertal

4.3 Task 1c: Practical application of the nearly zero-energy definition

Report on testing of Nearly Net ZEB definitions with example buildings

The previous studies (task 1a) as well as the distillation of categories from currently available definitions and concepts developed in task 1b show that for each criterion different options are available on how to deal with that specific characteristic. This created a basis for a test of four possible definition sets to allow detailed recommendations for future building codes in terms of a minimum of harmonization. A study was undertaken with an already developed small testing tool called “Net ZEB evaluator” (see below) to analyse some of these topics with calculated energy data from a set of seven well documented (Nearly) Net Zero Energy Buildings. The buildings are described in Table 7, pictures are shown in appendix 10.2.4. The choice covers various sizes, standards, building typologies, technical solution sets and climates across Europe (Denmark, Germany, Spain and Sweden) and was made on the knowledge of available adequate energy data and contacts. Special acknowledgments are given to Jaume Salom (IREC - Catalonia Institute for Energy, Barcelona, SP), Søren Østergaard Jensen (Danish Technological Institute, Taastrup, Denmark) and Bjorn Berggren (Dept of Architecture and Built Environment - Energy and Building Design, Lund University, Sweden) for their contributions and help to analyse the energy performances of the different buildings by Net ZEB evaluator tool.

Table 7. Chosen and analysed (Nearly) Net Zero Energy buildings (pictures are inserted in appendix).

Typology		Project name	Location	Year	Net floor area in m²	Purpose of building / Zero energy concept	energy benchmark, Label, Definition
residential buildings	**Single house**	EnergyFlex Family	Taastrup, DK	2009	168	Test and demonstration	Net ZEB standard
	Five dwelling terraced house	Glasbruket	Malmö, SE	concept stage	705	Test and demonstration	Energy plus standard
	Apart-ment block	Kleehäuser	Freiburg, DE	2006	2519	Ecological conviction of private assembly	zeroHaus
non-res. buildings	**Office building**	Väla Gård	Helsingborg, SE	concept stage	1665	Test and demonstration	Plus-/Zero energy building
	Office building	Circe	Zaragoza, SP	2010	1743	Research and Development	Zero Emission standard
	Nursery	Kindergarten "Die Sprösslinge"	Monheim, DE	2009	969	Marketing and demonstration	Eco Commercial Building Program
	School	Primary School "Niederheide"	Hohen Neuendorf, DE	2011	6563	Costs and Demonstration	Energy plus standard

"Net ZEB evaluator" is an Excel-based tool calculating balance results for energy, emissions, and operating costs for four different Net ZEB definitions (see below and appendix) as well as a virtual monthly load match index for electricity and heat (if heat is fed into a grid). The tool is based on the work within the IEA research program "Towards Net Zero Energy Solar Buildings". The tool is used internal since mid 2012 and will be published in early 2013 together with a manual and supported by a FAQ-list. The support will then be done by EURAC research Bozen, Italy. The aim of the research project to describe the relevant characteristics of Net ZEBs [IEA 2008] and the awareness that a variety of Net ZEB definition are available has led the developers not to select a unique definition but to show the available options and translate them into different possible but also reasonable balance methodologies. Beside significant criteria which are crucial for Net ZEB definitions it includes four Net

ZEB definitions resulting from the combination of selected criteria and options (see below). By implementing calculations relevant to the different definitions, the tool inter alia aims at showing how different definitions respond to the same entered building data. It could also be used to evaluate solutions adopted in new building design (for building designers) or to assess the balance in monitored buildings (for energy managers) with respect to the selected Net ZEB definitions [Belleri 2012].

The number of Net ZEB definitions in the tool has been reduced by the following assumptions (derived from [Sartori 2012a]):

1. The term Net Zero Energy Buildings (Net ZEB) refers to single buildings.
2. Net ZEB are buildings connected to any energy infrastructure with which they exchange energy.
3. The building can feed the grid with electricity from PV, cogeneration units, wind turbines, fuel cells, as well as district heating/cooling networks with heat/cold flows. Fuels like gas, oil, biomass and others are usually imported by the building, but it is not excluded that the building feeds the grid with them as well (in future e.g. hydrogen).
4. The connection to an energy infrastructure introduces the issue of the building/grid interaction. The profitability of exported or delivered energy, hence the profitability of the instantaneous load match or the feeding-in is strictly related to the local grid features and regulations.
5. Given the interaction with external energy infrastructures, the core of the Net ZEB issue is the balance between delivered and exported energy. Whereas in the real operation of the building, the net metering outputs the actual values of delivered and exported energy, in the design phase estimates of delivered and exported energy may be available depending on tools or set assumptions to estimate self-consumption of energy carriers generated on-site. However, most building codes do not require design calculations to estimate self-consumption, consequently only generation and load are available and a load/generation balance can be calculated. In this case, it is assumed that the load is entirely satisfied by delivered energy while the generation is entirely fed into the grid.

The combination of each option shown in task 1b and described in [Sartori 2012a] generates several definitions. For the tool not all the options have been considered and only four definitions have been selected considering different aspects:

A. **Net ZEB limited** (minimum requirements in compliance with the EPBD): A low energy building, which offsets the yearly weighted energy use for heating, DHW, cooling, ventilation, auxiliaries and built-in lighting (for non-residential buildings only) by the weighted energy supplied by on-site generation driven by on- or off-site sources. Static and symmetric primary energy factors are possible.

B. **Net ZEB primary**: A low energy building, which offsets the yearly weighted energy use for heating, DHW, cooling, ventilation, *auxiliaries and lighting and every kind of plug loads* (electrical car possibly included), and the weighted energy supplied by on-site generation driven by on- or off site sources. Static and symmetric primary energy factors are again possible.

C. **Net ZEB strategic**: A building which offsets the weighted energy use for heating, DHW, cooling, ventilation, auxiliaries, built-in lighting and every kind of plug loads and the weighted energy supplied by on- and off-site generation systems driven by on- or off-site sources. Weighting factors could be static and *asymmetric, varying on the basis of the energy carrier, the technology used as energy supply system and its location*.

D. **Net ZEB emission**: A building which offsets the yearly balance between its CO_2 equivalent emissions due to energy use for heating, DHW, cooling, ventilation, auxiliaries, built-in lighting and every kind of plug loads and the weighted energy supplied by on-site generation systems driven by on- or off-site sources. Static emission factors are used. They can be symmetric or asymmetric, depending on the energy carrier, technologies used as energy supply systems and their location.

The four different definitions of the tool were transferred to the reporting matrix developed and described in task 1b, to compare them to the EPBD/RED clauses and to explain their differences and calculation ideas (see Figure 20). The colour code of the filled and somewhat minimum adapted matrix accords to the frame cell colours of the four balance options in the tool (see figures below).

1. General information										
Country			International		International		International		International	
Name of regulation, directive, certification scheme			Net ZEB limited		Net ZEB primary		Net ZEB emission		Net ZEB carbon	
Editor of regulation, directive, certification scheme			IEA Task40/Annex52 "Towards net Zero Energy Solar Buildings" Subtask A		IEA Task40/Annex52 "Towards net Zero Energy Solar Buildings" Subtask A		IEA Task40/Annex52 "Towards net Zero Energy Solar Buildings" Subtask A		IEA Task40/Annex52 "Towards net Zero Energy Solar Buildings" Subtask A	
Year of introduction of current version			2012		2011		2012		2012	
Energy benchmark of current version			net zero energy building		net zero energy building		net zero energy building		other	
Integration and consideration in national directive			not considered	Theoretical balance procedure	not considered	Theoretical balance procedure	not considered	Theoretical balance procedure	not considered	Theoretical balance procedure
2. Field of application	**EPBD / BED requirement**	**EPBD / BED reference**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.1 building category	Member States shall ensure that all new buildings are nearly zero-energy buildings by 31 December 2020 [illegible]	EPBD article 9.1a,b	residential/non-residential		residential/non-residential		residential/non-residential		residential/non-residential	
• single-family houses	For the purpose of the calculation buildings should be adequately classified into the [...] categories	EPBD annex I	included in directive		included in directive		included in directive		included in directive	
• apartment blocks			included in directive		included in directive		included in directive		included in directive	
• offices			included in directive		included in directive		included in directive		included in directive	
• educational buildings			included in directive		included in directive		included in directive		included in directive	
• hospitals			included in directive		included in directive		included in directive		included in directive	
• hotels and restaurants			included in directive		included in directive		included in directive		included in directive	
• sports facilities			included in directive		included in directive		included in directive		included in directive	
• wholesale and retail trade services buildings			included in directive		included in directive		included in directive		included in directive	
• other types of energy-consuming buildings			included in directive		included in directive		included in directive		included in directive	
2.2 new/retrofit buildings	New and existing buildings that are subject to major renovation, should meet minimum energy performance requirements [illegible]	EPBD preamble recital 15	new and retrofit		new and retrofit		new and retrofit		new and retrofit	
	Member States shall [illegible] stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings	EPBD article 9.2								
2.3 private/public buildings	Member States shall ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings; and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings	EPBD article 9.1a,b	private/public		private/public		private/public		private/public	
[illegible]			[illegible]							
3. Energy Balance / Calculation										
3.1 balance type	[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources [illegible]	EPBD article 2.2	energy demand vs. energy generation		energy demand vs. energy generation		energy demand vs. energy generation		energy demand vs. energy generation	
	Energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand [...]	EPBD article 2.4								
3.2 physical boundary	This directive lays down requirements as regards the common general framework for [...] buildings and building units	EPBD article 1.2a	building site	buildings site could also include more than one building	building site	buildings site could also include more than one building	building site	buildings site could also include more than one building	building site	buildings site could also include more than one building
	[...] 'building' means a roofed construction having walls, for which energy is used to condition the indoor climate	EPBD article 2.1								
3.3 system boundary demand / energy uses included										
• space heating	[...] energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting	EPBD article 2.4	considered		considered		considered		considered	
• domestic hot water										
• ventilation, cooling, air conditioning			considered		considered		considered		considered	
• auxiliary energy			considered		considered		considered		considered	
• lighting			considered	only for non-residential buildings	considered		considered		considered	
• plug loads, appliances, IT			not considered		considered		considered		considered	
• central services			not considered		considered		considered		considered	
• electric vehicles			not considered		possible to add		possible to add		possible to add	
• embodied energy			not considered		not considered		not considered		not considered	
3.4 system boundary generation / renewable energy sources included										
• generation on site	[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby	EPBD article 2.2	considered	Generation on site with on-site and off-site renewables is included	considered	Generation on site with on-site and off-site renewables is included	considered	Generation on site with on-site and off-site renewables is included	considered	Generation on site with on-site and off-site renewables is included
	[...] 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	EPBD article 2.6								
• generation near-by	[...] minimum levels of energy from renewable sources [illegible]	EPBD article 13.4	not considered		not considered		considered		not considered	
• generation external			not considered		not considered		considered		not considered	
• crediting			not considered		not considered		not considered		not considered	
3.5 balance period / calculation step	[...] The methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance of a building [...]	EPBD preamble recital 9	yearly		yearly		yearly		yearly	
	[...] requirements should be set with a view to [...] the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building [...]	EPBD preamble recital 14								
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 20.The four different definitions of the tool illustrated in the reporting matrix. The additional colour code accords to the colours of the four balance options of the tool. Source University of Wuppertal

The tool enables (Nearly) Net ZEB evaluation and calculation by entering building energy data (demand and supply), weighting factors (only static factors, symmetric or asymmetric) and energy costs (costs calculations are exclude in this research). Depending on the selected building type, different calculations are implemented. The first definition, Net ZEB limited, excludes plug loads and built-in lighting (in case of a residential building). In order to allow checking the balance with different kind of input data, the building data sheet is divided into three sections (see more information in the appendix):

1. Building design data (used in the considerations in task 1c)
2. Estimated building - grid interaction data
3. Monitored building - grid interaction data

To get an overview of the criteria selected for each definition, a comparison table is provided, as shown in Figure 21. Each section can be easily opened or closed by clicking on a button. The tool enables to enter yearly values of delivered and exported energy or load and generation, what requires monthly values.

A Net Zero Energy Building is the "building system" delimited by set physical boundaries, connected to any energy infrastructure, which balance between its weighted energy loads and supplies is zero.

		Net ZEB limited	Net ZEB primary	Net ZEB strategic	Net ZEB carbon
Building system boundary	Balance boundary	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING (only non residential buildings)	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS
Weighting system	Metric	PRIMARY ENERGY	PRIMARY ENERGY	Whichever metric desired	CARBON EMISSION
	Symmetry	SYMMETRIC	SYMMETRIC	SYMMETRIC or ASYMMETRIC	SYMMETRIC or ASYMMETRIC
	Time dependent accounting	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC
Net ZEB balance	Energy efficiency	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED
	Energy supply	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON/OFF SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES

Figure 21.Overview of the criteria selected for each definition.

The balance results are shown in one of four sheets. It is called the “Net ZEB evaluation sheet”. This sheet is shown in appendix 10.2.5 for each of the seven buildings. Balance results are reported for each of the four definitions, identified by a frame cell colour, in the upper part of the section. A positive number means that the weighted annual energy supply is higher than the weighted annual energy demand. Balance equations are shown by clicking on the link button. Balance results are represented in graphics. On the X-coordinate is the energy consumption whereas the Y-coordinate shows the energy generation. If energy generation equals the energy consumption, the point falls to the bisector (dashed green line). If the balance is positive, the point falls upon this line and vice versa. Monthly values of electricity/thermal energy demand and supply are shown in the column graphs on the upper/lower right side of the section. Resulting electricity and thermal load match are reported in the respective cells. In the lowest part of the section operating costs are reported for each definition (not shown in figures in appendix as this part was excluded in task 1c), again identified by the frame cell colour.

Show/hide buttons allow showing or hiding different balance results from different kind of input data:

1. Generation/load balance estimated with building design data
2. Estimated building - grid interaction balance estimated with the simulation data
3. Monitored building – grid interaction balance calculated with monitored data

Performance data for energy demand and energy generation (design data) were calculated for the seven buildings and their specific technical solution sets in external tools (taking into account specific climate data, etc.). These design data were entered in the Net ZEB evaluator tool to calculate the balance results according to the different approaches. In all seven cases monthly data could be entered to also check virtual monthly load matches which indicate the monthly coverage ratio between energy generation and demand.

First overall conclusions show the dissimilarity between the different balances of each building The performances vary a lot between the seven buildings even if they all have a similar aim of being energy neutral. Otherwise some buildings are not able to reach every of the four balance types depending on their technology and building concept (e.g. Kleehäuser reach the Net ZEB strategic balance but does not reach the other balances because here off-site generation is not considered).

The comparison of the testing results underlines the effect of the accounting system and system boundaries. Figure 22 indicates the four different balance results of the seven tested buildings. It shows that most of the buildings are very close to a zero carbon emission balance. Here, however, no general statement is possible, because peculiarities of the projects and the influence of their individual infrastructure lead to this result. For example, in case of the Kleehäuser project the generation of electricity (equivalent carbon emission conversion factor of 0,633 $kgCO_2$/kWh) by a gas fired CHP unit (conversion factor of 0,244 $kgCO_2$/kWh) ends in an annual emission balance much closer to zero than the “Net ZEB primary” balance even though both calculations have the same accounting system. The same is noticeable for the primary school in Hohen Neuendorf. Here an advantageous biomass fired CHP is used (conversion factor of 0,041 $kgCO_2$/kWh for biomass to cover heat and DHW demands and to generate electricity). At the Spanish research centre of Circe space heating and DHW loads are mainly covered by a condensing gas boiler whereas electricity is generated to equalize the demands by fed-in credits. The proportion of the weighting between gas and electricity is better for carbon emissions (around 3,2) than for primary energy (2,3). Therefore the emission balance is easier to achieve.

The difference between the “Net ZEB limited” and “Net ZEB primary” is that in the first one does not include plug loads and lighting (in residential buildings). Therefore the buildings are much closer to the zero balance or occur even beyond this (e.g. Glasbrucket or EnergyFlexHouse; see Figure 23. The influence of these (in the view of the EPBD) additional demand sectors can be seen at the primary school in Hohen Neuendorf. The "Net ZEB limited" balance in which only the building related demands are considered ends very close to zero whereas the result for the "Net ZEB primary" balance is negative (-5,30 kWh/m²y). In a case of a school the plug loads and appliances are not the main demand sector. That this difference can be much higher is shown by the values of the two apartment buildings "Kleehäuser" in Freiburg: The "Net ZEB primary" calculation ends in a negative balance (-64 kWh/m²y) whereas the "Net ZEB limited" one is close to zero (see Figure 22 and Figure 23). In this residential case the energy demand for lighting is not included in the "Net ZEB limited" calculation.

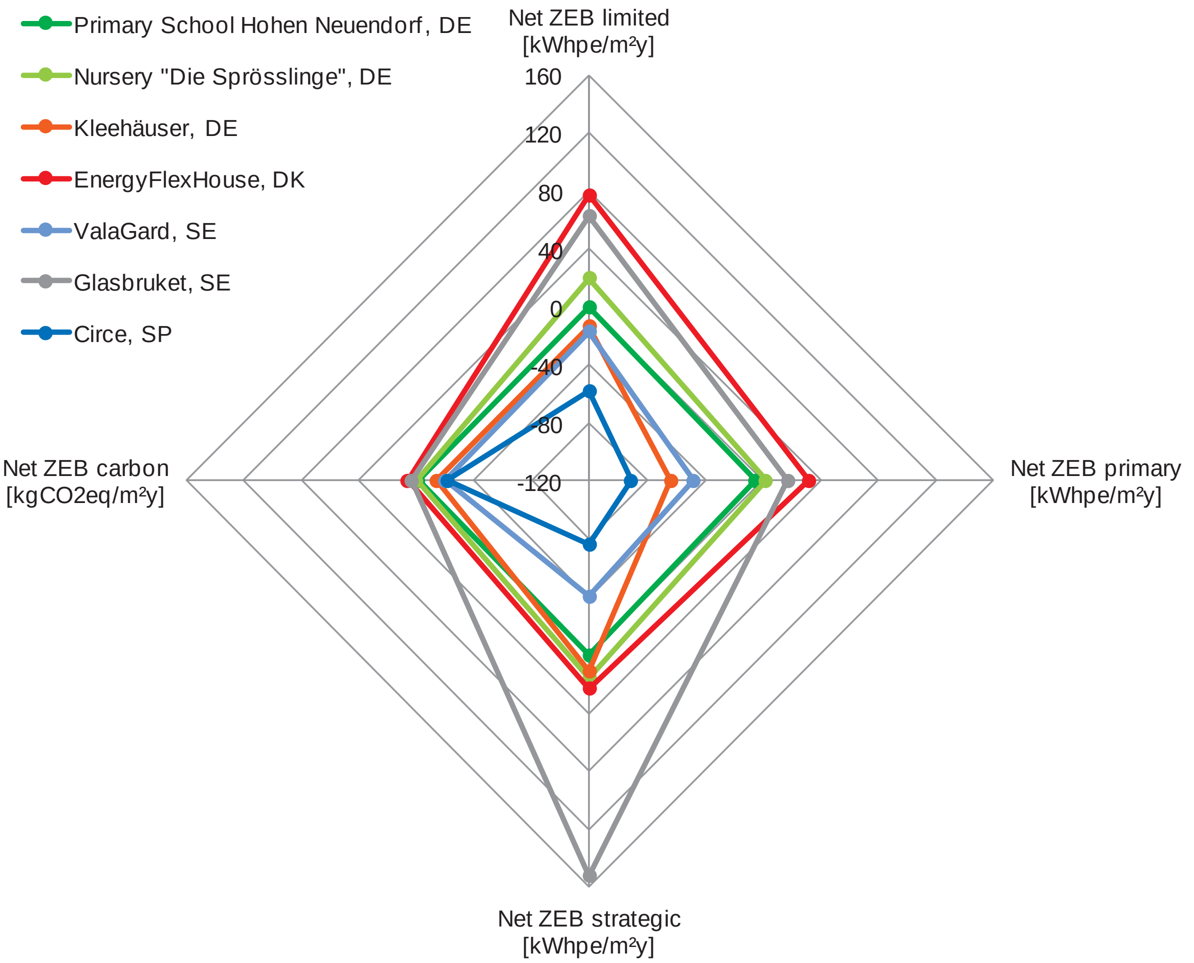

Figure 22.Overview on the four different balance results of all seven tested buildings. Negative values indicate nearly zero-energy buildings which energy balance is not equalized. Positive values indicate Energy-Plus Buildings. Source University of Wuppertal

Figure 22 shows also the influence of changed weighting factors. Whereas in case of the Glasbruket house the result of the "normal" primary energy balance is +18 kWh/m²y, the result of the "Net ZEB strategic" balance is +152 kWh/m²y. Here asymmetric strategic weighting factors for generated energy are used (2,00 for electricity generation and supply instead of 1,5 and 3,00 for heat generation instead of 0,90 for heat from a district heating grid). The strategic weighting factors were chosen because of the local circumstances at the buildings site in Malmo and the assumption the local energy is displaced by fed-in energy (as the calculation bases on design data there is no opportunity to assign the higher factors only to really exported energy because it can´t be assumed which parts of generated energy are really fed into the grid and which are self-consumed).

In the case of the all-electric example EnergyFlexHouse it is the other way round. The strategic weighting factor for electricity is changed from 2,5 to 1,8 which lowers the annual energy surplus from 32 kWh/m^2y to 23 kWh/m^2y. The lowered factor is based on the assumption that in future more renewable energy sources will be used.

The German definition for the demonstration program “EffizienzhausPlus” (formerly “Plus-Energie-Haus-Standard”) stipulates all-electric buildings with PV and heat pump by asking for an annual zero site and primary energy balance. Modified, asymmetric primary energy conversion factors are applied: Instead of 2,6 for electricity demand and generation, which are the factors for calculation according to the official directive DIN 18599 in 2012, 2,8 should be used for exported electricity while the demand should be calculated with 2,4. The changed factors again base on the acceptation of more renewable energy in the power grid. These numbers are coupled with the energy data of the Nursery in Monheim. The “Net ZEB strategic” balance is then +16 kWh/m^2y compared to a “Net ZEB primary” balance of +2 kWh/m^2y. Instead of achieving a positive balance these factors could also end in less PV or other energy generating systems.

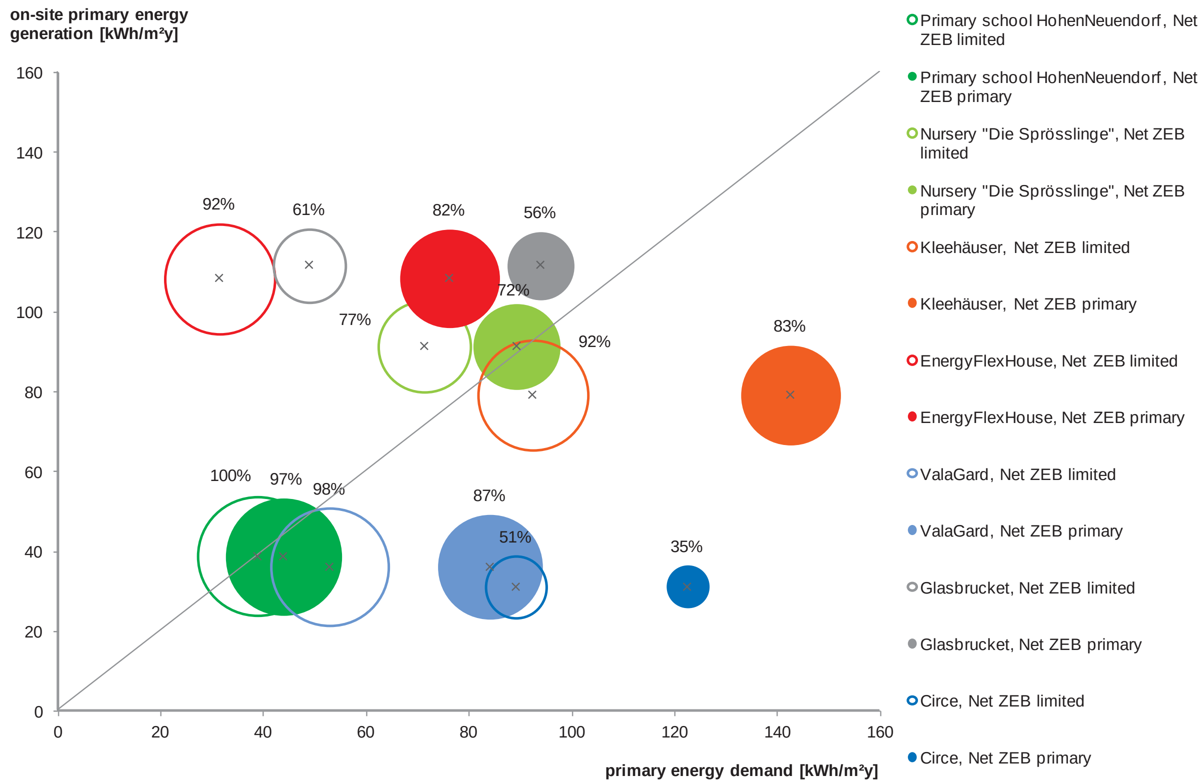

Figure 23.Overview of the differences of the balance results and virtual monthly electricity load machtes for “Net ZEB limited” and “Net ZEB primary”. Source University of Wuppertal

Explanation Figure 23: The two balance results for each of the seven buildings are shown by the X in the graphic (the grey line indicates an equalized annual energy balance). The size of the bladder and the number above show the according electricity load match calculated according to the accounting system of the used balance methodology. As in the "Net ZEB limited" balance no user specific demands are included not only the overall yearly balance results is better but also the load match is higher (same generation capacities but less embraced energy demand). This figure shows also how different the energy performance of buildings can be: Wile the Glasbruket dwelling has an overall primary energy demand of 94 kWh/m²y the Kleehäuser apartments need nearly 143 kWh/m²y.

Beside the accounting system and different weighting the system boundary for energy generation has a huge influence on the success towards an equalized energy balance. In case of Kleehäuser (which in addition expands the physical boundary from a single building to the buildings site because two apartment buildings are considered together) only a share of an external wind turbines (beside PV, CHP) enables a positive energy balance (see Figure 22).

The chosen technical solution set of the buildings have another effect. (Nearly) Net Zero Energy Buildings which only use PV for energy generation have mostly a very high virtual load match during summer times (mostly the generation excesses the demand which end in a load match of 100 %) and very low matches during winter times (e.g. Glasbrucket 100 % from April to August but less than 10 % from November to February, average yearly match of 56 %). Buildings with CHP units and PV (e.g. Kleehäuser or primary school in Hohen Neundorf) have a more constant generation and therefore higher load matches even in winter times (Primary school in Hohen Neundorf average load match of 97%). On-site wind turbines lead to higher load matches in winter times (Circe) but their potential to cover all buildings loads is very small (see Figure 24).

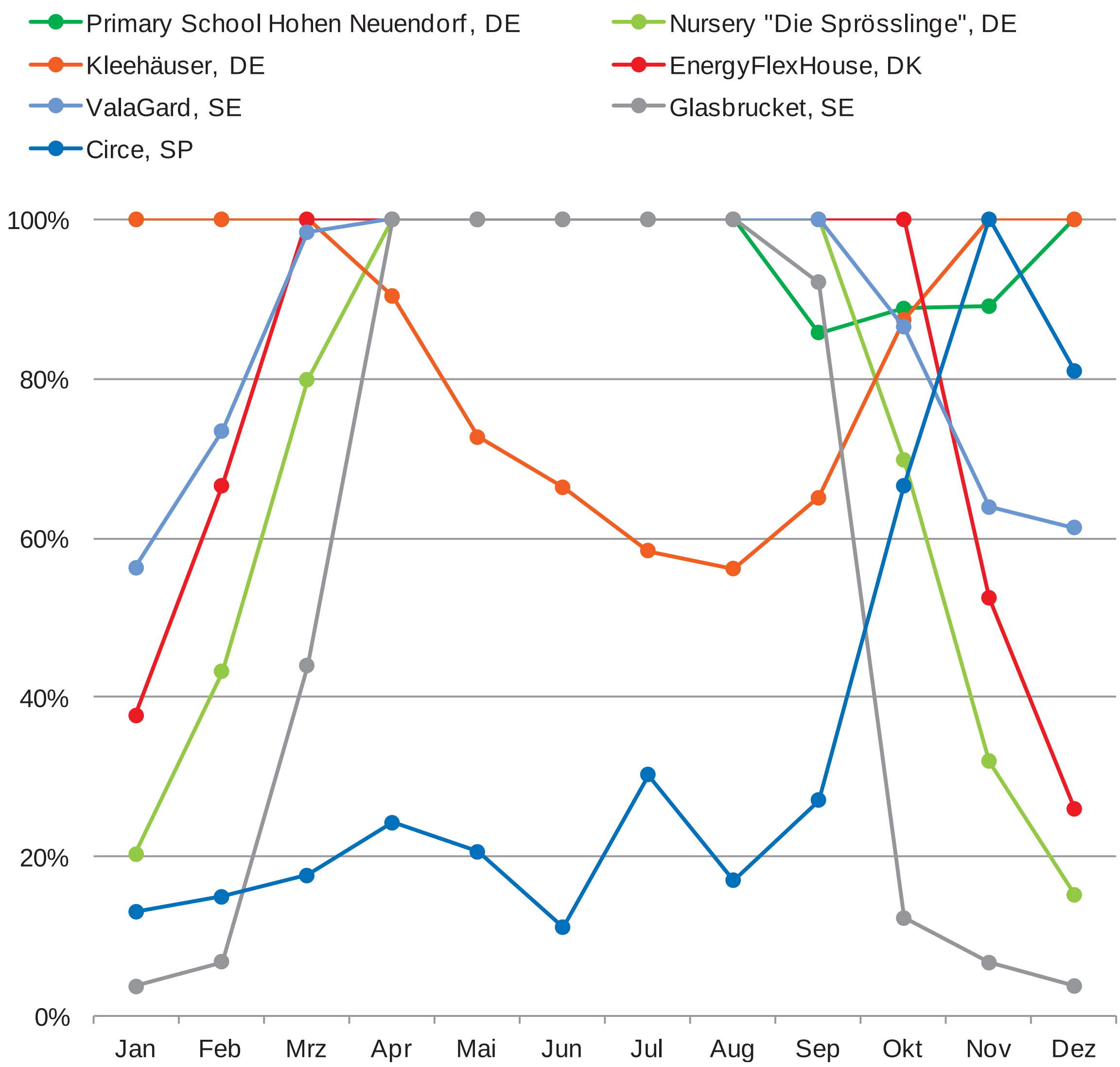

Figure 24.Monthly electricity load match for the "Net ZEB primary" calculations (all consumers included) of the seven buildings. Source University of Wuppertal

All investigations above were made for energy demand and generation which fits to formulations in the EPBD. Focus was the planning phase of a building. During the operation mostly the energy import from and export to the energy grid infrastructure is considered by the use of energy meters or bills for e.g. pellet supply. The balance results differ from the demand/generation balance as shown in Figure 25 for the all-electric building Nursery in Monheim. In both cases the metered yearly energy balance is -1,1 kWh/m²y.

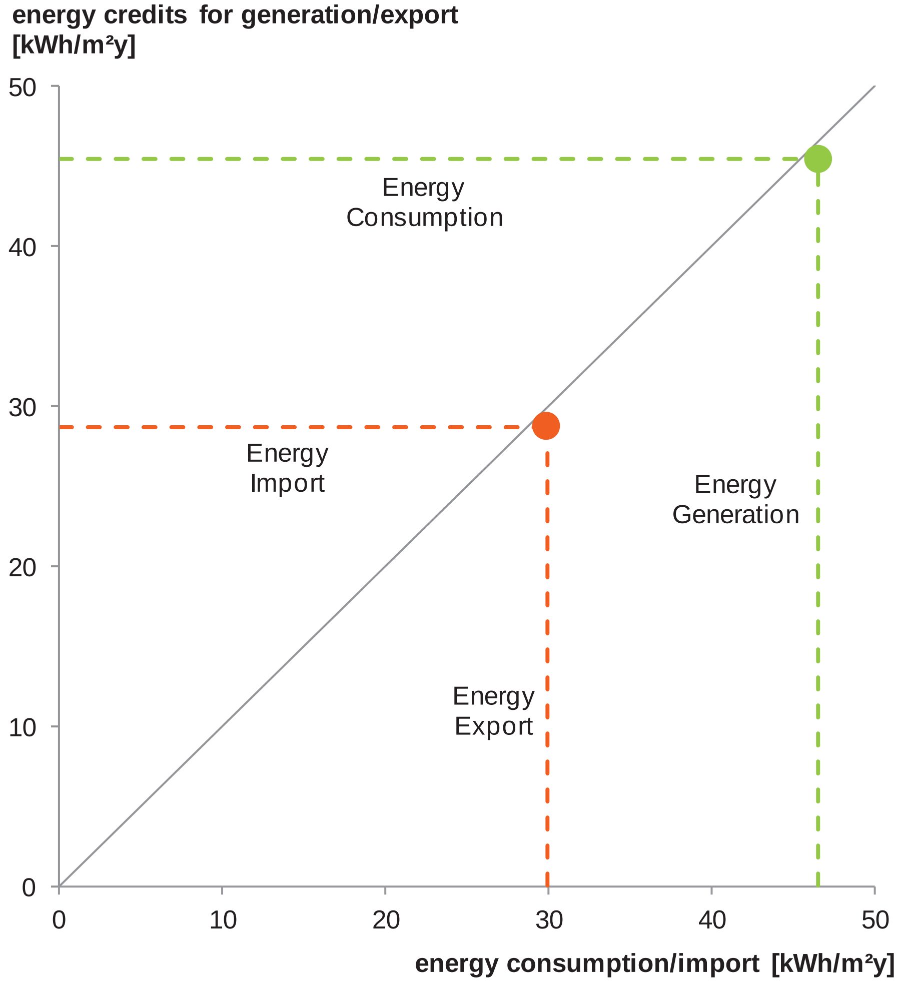

Figure 25.Metered yearly values for energy consumption and generation (electricity) respectively electricity import and export of the nursery in Monheim (data for 2011). Source University of Wuppertal, measurements by CANconnect GmbH

Conclusions

All four presented balance procedures are conceivable in the frame of the EPBD but it is difficult or even not possible to compare different balance methodologies results. The dissimilarity between diverse balances is shown by the investigated buildings balance results. The performances vary a lot even if a similar aim of being energy neutral is followed. Therefore, different EU-wide nationally implemented accounting methods may not be compared on the basis of balance results or measurements from the monitoring of comparable buildings. For this purpose, only the matrix shown in chapter 4.2.2 and its comparison of different assessment categories should be used and gives the ability to check national implementations.

It is also important to compare same contents: energy import compared with energy export respectively energy demand compared to energy generation. If from the performance of buildings also conclusions on the interaction with the grid should be conducted, the export of generated electricity and its seasonal profile is crucial. If an energy performance certificate (as required in the

EPBD) should be created to enable a review on the buildings qualities and to exclude influences of users, a consideration of energy demand and generation is sufficient.
The testing results of the building examples underline the effect of different technology choices and coupled weighting systems (figure 22). If a technological openness is given and therefore the selection of related energy carriers (weighting systems and metric) is left open, customized energy concepts can be developed according to different typologies or local conditions (qualities/conversion factors of energy infrastructure). The load match index indicates that in addition to achieving any kind of energy balance a second order criterion can be defined that reflects the performance of a building in view of the interaction with the grid on a seasonal level. The introduction of such a factor is in favour with a full energy balance approach including the user related power consumption.

A recommendation for the Commission's ability to check national implemented nearly zero-energy building definitions is to use the balance methodology similar to the “Net ZEB limited” approach as this methodology follows the minimum requirements in compliance with EU´s EPBD. The balance boundary includes only (weighted) energy demand for heating, DHW, cooling, ventilation, buildings related auxiliary energy and built-in lighting (for non-residential buildings only) whereas the (weighted) energy supply is limited to on-site generating systems driven by on- or off-site sources (e.g. biomass powered CHP is possible). Static and symmetric primary energy factors are possible but not necessary or an essential part. Household appliances or other user related consumers like built-in lighting (for residential buildings) or central services are excluded which especially addresses the design phase due to missing temporal consumption patterns.

5 Task 2: National plans for increasing the number of nearly zero-energy (or beyond) buildings

5.1 Task 2a: Identification of existing plans

While in Task 1 the focus is on concepts and definitions for nearly zero-energy building, task 2 is on national plans on how to increase the number of buildings which have to be built in line with those concepts and definitions. In this first sub-task, we identified and collected relevant EPBD national plans – or information elements which are deemed to be part of a complete EPBD national plan respectively.

For the purpose of this chapter, Ecofys has set up a spread sheet format similar to the one used for Task 1a) and which has been used for collecting all relevant information on existing plans. The same countries as in Task 1 have been addressed. For filling this spread sheet, the following sources have been analysed:

- *National Energy Efficiency Plans (NEEAPs)* according to Article 14 of Directive 2006/32/EC on energy end-use efficiency and energy services (ESD). Ecofys participates in the 2nd phase of the IEE project "Energy Efficiency Watch (EEWatch)", which is about analyzing and evaluating the NEEAPs covering the 2nd reporting cycle (30 June 2011). Most of those Phase 2 NEEAPs are based on the comprehensive "Guide and template for the preparation of the second national energy efficiency action plans", developed by EC JRC Ispra; this template for NEEAPs already explicity incorporates the new reporting requirements of the recast EPBD (for more information see chapter 5.3.2).
- *National Renewable Energy Action Plans (NREAPs)*, according to Article 4 of Directive 2009/28/EC on the promotion of the use of energy from renewable sources having been submitted by 30 June 2010. The section in the reporting template referring to Article 13(3) does also ask for many relevant nearly zero-energy building issues (for more information see chapter 5.3.2)
- The Concerted Action report "Implementing the Energy Performance of Buildings Directive (EPBD), Featuring Country Reports 2010 (www.epbd-ca.eu)
- Expert knowledge of the involved partners for information that has not been presented in any of the above mentioned documents. The national experts will contact their national authority to get the latest information in a personal talk.

In the following chapters 5.1.1 to 5.1.15, short versions of the national reports can be found. These reports already give a good overview of the existing frameworks but without going into any details. For a complete overview of all national elements, please see the detailed country factsheets in chapter 10.3.1 in the Appendix.

5.1.1 Austria

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Of final energy savings effective in 2016, approximately 80% would result from energy efficiency measures regarding building shells (63.8%) and heat provision (16.2%)
- nearly zero-energy building: no explicit policy targets/goals concerning increase in numbers; the Energy Strategy mentions nearly zero-energy building as focus area in R & D (but not as explicit goal in building related policy instruments)
- some regional energy and climate strategies mention nearly zero-energy building as point of orientation in new construction with support by policy instruments, but no target on shares of nearly zero-energy building in new construction
- RES-energy and shares 2020
  - Estimated share of RES in building sector:

	2005	2010	2015	2020
Residential	24%	25%	26%	26%
Commercial	8%	9%	10%	10%
Public/Industrial	1%	1%	2%	2%

  - Heating and Cooling: 48 593 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 1.0%
    - Solar: 6.4%
    - Biomass: 86.3%
    - Heat pumps: 6.3%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: under development
  - building code for new construction refers to something like a nearly zero-energy building-standard (Niedrigenergiestandard), but only quality of envelope, does not fulfil EPBD definition
- nearly zero-energy building roadmap till 2019/2021: under development
- Other regulations/requirements:
  - mandatory use of “innovative climate-relevant systems” (residential, public)
  - Building code: new buildings with floor area > 1 000 m^2 alternative systems must be used if technically, environmentally and economically beneficial; goal: promotion of RES
  - Planned: Measures for increased use of solar heat, heat pumps and biomass heating
  - Legislation framework sets minimum thermal heating demand, depends on surface/volume factor, use (residential, non-residential), type (new, majorly renovated)

b) Economic incentives and financing instruments

- Residential building subsidy (new and renovated) (since 1982)
- National recovery plan/Renovation voucher: investment subsidy to improve thermal insulation (shell, windows, doors) for renovated buildings (residential, commercial)

- Renovation programmes for public buildings (since 1999)
- Residential construction subsidies ("Wohnbauförderung"): foster nearly zero-energy building (new, renovated)
- "Haus der Zukunft plus": Funding for R & D and top nearly zero-energy building („Plusenergiegebäude")
- Subsidies for refurbishment of non-residential buildings ("Umweltförderung")
- "Environmental Assistance in Austria" (since 1993)
- Climate and Energy Fund Law
- "Buildings as Power Plants" Framework programme of KLI:EN Fonds
- Regional housing support programmes
- Planned: Further development of eligibility criteria and tools (2013)
  - o Stronger focus of housing support on thermal remediation and use of RES for heating
  - o Subsidy scheme wood heating (2011)
  - o Subsidy for extensive remediation (commercial, public): heat insulation, RES and EE
  - o Subsidy for solar PV plants up to 5 kW
  - o Subsidy for Solar thermal: Large-scale solar plants (surface 100-2000 m^2)
  - o Several subsidies based on 2009 Directives for district heating and heat pumps

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard
- "Energieausweis-Vorlage Gesetz": implemented 2008 EPC rates buildings by heat energy demand in kWh/m^2a, issued by qualified experts when building is renovated, sold or rented
- Calculation Methodology: incl. CEN-standards, describes envelope, heating, cooling, ventilation and air conditioning

d) Supervision (energy advice and audits)
- Energy Advice for private households
- Advice platforms and services on EE for local authorities, service and office buildings
- Inspections obligation exists for boilers and air conditioning systems
- Federal Programme klima:aktiv bauen: incl. energy advice and audits with focus on nearly zero-energy building

e) Information
- Federal states and energy utilities offer individual advice services or internet services
- Information events (Municipal construction works; Quality of spaces in school buildings), media campaigns and workshops
- Energy accounting in local authorities: service online and a benchmarking database

f) Demonstration
- R & D demonstration as part of "Haus der Zukunft plus" programme
- „Klima:aktiv haus": all buildings according to criteria (which can be seen as a specific definition of NEARLY ZERO-ENERGY BUILDING) publicly available on the web
- "Mustersanierung": smaller demonstration programme (non-residential) related to high energy performance refurbishment, results monitored and available via web-portal

g) Education and training
- Trainings for energy and renovation advisers on federal level under "klima:aktiv"
- Broad programme on advanced training with a focus on RES, facility management and EE
- Climate and Energy Fund (KLI.EN Fonds): R & D of sustainable energy technologies

* Training on regional level: nearly zero-energy building (passive houses), training of companies (Ökobaucluster)

5.1.2 Czech Republic

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- no target for nearly zero-energy building for 2013, 2016, 2020 set
- 2020 target: all new buildings nearly zero-energy buildings
- Amendment of the Energy Management Act 406/2000 Coll: all new buildings > 1500 m^2 have to meet energy demand of nearly zero-energy building starting 2018 (public by 2016), new buildings > 350 m^2 have to be nearly zero-energy building by 2019 (public by 2017), all other new buildings to be nearly zero-energy building by 2020 (public by 2018)
- Shares RES-Heat by technology 2020
  - Geothermal: 0.6%
  - Solar: 0.8%
  - Biomass: 94.2%
  - Heat pumps: 4.4%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: under approval process; very low energy demand covered to a very significant extent by RES (fixed percentage varies by building type)
- nearly zero-energy building roadmap till 2019/2021 available: yes, defined in amendment of Energy Management Act 406/2000 Coll.; requirements for nearly zero-energy building will be introduced gradually according to the size
- Other regulations/requirements:
  - Planned: benchmarks on energy performance indicators set, when new legislation enters into effect (2013); requirements will be gradually tightened up to 2020
  - Planned: establish primary energy factors at level of individual technologies and respective values used to calculate total annual primary energy
  - Planned: establishment of use of RES currently proposed using primary energy with relevant primary energy factors
  - Each new building and any building over 1,000 m^2 undergoing a major refurbishment has to undergo a renewable energy use assessment
  - Amendment of Act No. 406/2000 Coll: envisages if RES are technically, economically and environmentally feasible, they will have to be incorporated in all new or refurbished buildings; from 2012 all public building; from 2015 all other
  - EPBD is implemented and implementation of the recast in the legislation is planned
  - EPC implementing regulation (2007) sets the same minimum requirements for energy performance of new buildings and existing buildings under major renovation
  - New requirements under EPBD implementation: Global minimum requirements on consumption for all types of buildings expressed in kWh/m^2 per year of delivered energy, RES and D-H feasibility studies for new buildings over 1,000 m^2; EPC
  - Regulation No. 1481/2007 Colt.: specifies details of energy performance of buildings

- o Standard level of heat energy demand: levels of insulation: required and recommended
- o No impact of the EPBD regarding strengthening of the thermal characteristics of envelope
- o 2011 new legislation: amendment of Energy Management Act submitted for approval
- o Planned: 2012 new legislation will become mandatory

b) Economic incentives and financing instruments

- Green Savings programme (2009-2012): supported quality insulation of residential buildings, replacement of heating system for low-emission biomass boilers and efficient heat pumps, installations of these sources in new low-energy buildings, as well as construction of new houses in the passive energy standard; currently negotiations on whether new programme to support construction and reconstruction of buildings will be launched- revenue from the sale of carbon credits is revenue of the State Environmental Fund (SEF)
    - o used to promote selected measures to increase energy efficiency, implemented in residential buildings: Energy savings for heating, New construction to nearly zero energy standard, Use of renewable energy sources for heating and hot water,
    - o Bonus grant for selected combinations of measures
- EFEKT and TIP: grant R & D of energy efficient buildings and nearly zero-energy building (incl. demo projects)
- Currently: no tax reduction considered for nearly zero-energy building
- Support for the modernization of housing stock by means of building society savings schemes (since 1995)
- NEW PANEL: repair of static defects, improvements in the technical thermal properties (high-rise pre-fabricated buildings), since 2010 repair of apartment buildings
- Loans to municipalities to upgrade housing (since 2001)
- Operational Programme Enterprise and Innovation (OPEI) (2008-2015): improvements in thermal and technical properties
- Promotion of voluntary energy saving commitments: target final energy consumers
- MIT and ČSOB rotating fund: for financing of energy saving projects (since 1997)
- Planned: systematic support (time limited) from public resources

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- EPCs obligatory for new buildings (> 50 m^2) and renovated buildings (> 1 000 m^2), sets minimum requirements for total annual delivered energy consumption ($kWh/m^2 a$), primary energy and CO_2 emission not assessed
- Concrete measures leading to savings described, for each measure volume of energy savings is stipulated in technical units, along with financial assessment, amount of investment, simple payback period, and the impact on the energy rating if all measures are implemented.
- EPC should be present to the buyer or renter together with contract, but in practice only happens if newly constructed or renovated
- Ministry of Industry and Trade authorises energy experts for certification schemes, keeps the list of authorised experts and annually collects experts' record (number of issued EPCs, energy saving potential and other monitoring indicators)
- EPC: prove energy performance of nearly zero-energy building
- IEE Project Ideal-EPBD: EPC more trusted when they provide information and recommendations about improvement of the building

d) Supervision (energy advice and audits)

- Inspections of boilers and air-conditioning systems in accordance to EPBD; in place through Act No. 406/2000 Coll on energy management; obligation does not apply to boilers and internal heat distribution systems in residential buildings
- energy audit (EA) mandatory for all buildings with total energy consumption > 1 500 GJ/a
- residential owners are provided with consultations and advice, free of charge, by network of Energy Consultancy and Information Centres (EKIS); advice on nearly zero-energy building available

e) Information

- State support for activities leading to the reduction of thermal energy consumption in households (since 2001)
- Proposed: from 2013 Information and educational activities in the field of low energy building construction
- Proposed: Promotion of international exchanges of information and know-how in cross-border projects
- Programme for the Promotion of Energy-Saving Measures and the Use of RES: website containing information on energy audits and on obtaining subsidies for RES installations
- No official state campaign supporting the EPBD implementation
- IMPLEMENT projects: Local campaign to raise interest regarding EPBD, energy savings and urban RES
- Media campaign focused on energy performance of buildings for the general public
- Organization of conferences; non-profit associations encouraging the market with nearly zero-energy building and promoting sustainable and profitable high performance construction

f) Demonstration

- Planned: promotion of pilot projects for model buildings incl. detailed monitoring and publicity
- Czech Technical University of Prague: demonstration projects of EE buildings and systems
- Training centre of the civic association: building is used for long-term data collection, as a training centre and illustrative educational tool
- Training centre INTOZA: first passive administrative building; used as headquarters of Intoza, for seminars, training and promotion of existing and new technologies in energy savings
- Experimental house by HELUZ : used as test of thermal properties of their products
- 12 passive houses and training centre: first mass-implemented experimental construction

g) Education and training

- Specific training course with high passing grades in the exam is required for experts to issue EPC and for inspection of boilers and A/C systems
- Topic of very efficient buildings included in curricula and training programmes of universities
- CKAIT organizes training courses for civil engineers
- Czech Passive house centre organizes training courses for passive house design

5.1.3 France

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Targets by Environment Round Table (Implemented in national law Grenelle1, 2009)
  - New build: widespread development of low consumption buildings (bâtiments basse consommation, BBC) by 2012 and positive energy buildings by 2020
  - Existing building stock: 38% reduction in primary energy consumption (by 2020)
  - Primary energy consumption of 150 kWhep/m2 year (currently 240 kWhep/m2 year)
  - Major renewal of buildings at a rate of 400 000 renovations/a (2013 to 2020).
  - Intermediate renewal of 9 million dwellings
  - Begin renovation of public buildings by 2012 (reduction of min 40% in energy consumption and 50% in GHG emissions by State building stock within 8 years)
- 2012 Thermal Regulation: Achievement of BBC standard for new constructions
- Reduction of annual final energy consumption (resid.) by 0.41 Mtoe (2016), 1.15 Mtoe (2020)
- Estimated share of renewable energy in the building sector in 2020 (%): Residential: 36%, Tertiary sector (including public, commercial): 23% (no data for industrial), total: 32%
- RES-energy and shares by 2020
  - Heating and Cooling: 229 442 GWh
  - Share RES-Heat by technology
    - Geothermal: 2.5%
    - Solar: 4.7%
    - Biomass: 83.4%
    - Heat pumps: 9.4%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No
- nearly zero-energy building roadmap till 2019/2021 available: No
- Other regulations/requirements:
  - 2005 Thermal Regulation (RT2005): overall primary energy consumption for heating, domestic hot water, cooling, auxiliary and lighting equipment
  - 2006: minimum levels for new buildings, depending on type (dwellings, office, schools)
  - 2007: minimum requirements for installation of new building components
  - Global RT (since 01/2008) for buildings with a surface area of more than 1000 m2
  - Element-by-element RT (minimum performance level for replaced or installed elements)
  - 2012 Thermal Regulation: reduction of primary energy (public, service, private)
  - Planned/Considered: Mandatory use of renewable energies in new buildings
- first EPBD implemented; transposition prepared (Grenelle II) to accommodate EBPD recast

b) Economic incentives and financing instruments

- Financial support: If maximum consumption 10% lower than TR or Achieving BBC level
- Exemption from property tax on existing buildings (TFPB) of 50% or 100% for new dwellings

- Zero-rated loan (PTZ) (residential depending on size)
- Tax credit for loan interest (so-called TEPA tax credit)
- 2011: PTZ and TEPA tax credit provisions are replaced by new provision known as PTZ+
- 2011: investment in rental property ('Scellier' provision), depends on energy performance
- Sustainable Development Tax Credit (CIDD) (since 2007)
- Zero-rated eco-loan (éco-PTZ) (since 04/2009)
- Exemption and relief from property tax on existing buildings (Finance Law for 2006; TFPB)
- Sustainable Development Account (LDD)
- 'Live Better' Future Investments programme
- Re-launch Plan (2009)
- Individuals/Residential:
    - Sustainable Income tax credit
    - Reduced rate VAT
    - Zero rate eco-loan
- Renovation of social housing and public buildings
    - targeted: council housing managers, State, local and regional
    - Thermal renovation of all of these homes by 2020
    - Social housing eco-loan

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- Maintenance/Performance certificate for heating systems since 2006
- Energy Performance Diagnoses (DPEs) (Diagnostic de Performance Energétigue)
- "Haute performance énergétique" ("high energy performance") label
- BBC 2005: low energy consumption building
- Two energy performance - renovation labels

d) Supervision (energy advice and audits)

- Audit of Pubic building stock - 40 % in 2009; 100% in 2010
- Requirement for annual maintenance of boilers (between 4 and 400 kW)
- Regular checking of boilers (> 400 kW)
- Advice in National Law

e) Information

- Maintenance certificate (for boiler inspection)
- Publicity regarding annual boiler maintenance
- ADEME and Ministry publicity campaigns
- Energy Info Sites

f) Demonstration

- ADEME Demonstrator Fund: €1 350 million programme, under ADEME management

g) Education and training

- Examples of Programs supported by ADEME
- Housing Improvement Club
- PRAXIBAT programme
- BEEP (built environment - professional space) network
- PREBAT2 (Research and Testing Programme on Energy in Buildings)
- Qualification/certification programs (Progress Report 2011, regulatory, non-binding)

5.1.4 Germany

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Reduction in the heat requirement of the building stock by 20% by 2020 and in the primary energy requirement by 80% by 2050
- Almost climate-neutral building stock by 2050
- Doubling of renovation rate for buildings from 1% to 2% of the entire building stock annually
- Overall savings for buildings and installation area amount to 775 PJ in the period 1995– 2016
- Expected savings in construction sector for 2008–2016 commitment period amount to 610 PJ
- RES-energy and shares 2020
    - Heating and Cooling: 167801 GWh
    - Share RES-Heat by technology 2020
        - Geothermal: 4.8%
        - Solar: 8.6%
        - Biomass: 78.7%
        - Heat pumps: 7.9%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: in preparation
- nearly zero-energy building roadmap till 2019/2021 available: requirements for nearly zero-energy building will be introduced gradually according to the size (floor area) of buildings since 2016 for building owned by public authorities (2018 other buildings)
- Other regulations/requirements:
    - Energy Saving Order (EnEV) and its amendments (EnEV 2002, EnEV 2009), update in 2012 or 2013, further updates possible before 2020
    - Act on the Promotion of Renewable Thermal Energy (EEWärmeG) (since 2009)
    - Heating Costs Order (1981, revised version in force since 2009)
    - Renewable Energies European Law Adaptation Act (EAG EE): Approved by Bundesrat (German upper house) on 18.03.2011
    - Renewable Energies Heat Act (EEWärmeG) (Jan 2009), amendments through EAG EE of 18.3.2011, particularly introduction of role model function for public buildings, specification of rules on RES cooling

b) Economic incentives and financing instruments

Incentives:

- Market incentive programmes (MAP)
    - BAFA part (since 1999)
    - KfW part (since 2007)
- Several activities in the buildings sector (since 1995) by states (*“Länder”* Programme)
- R & D: to increase the funding for research in the sectors of Energy efficiency (+ 60 %) and RES (+ 100 %) (not only building sector) from 2010 to 2014
- Funding concepts

  - „Solarthermie2000plus“ (BMU)
  - „Solares Bauen – energieeffiziente Stadt“
  - Funding concept "EnEff:Wärme - Forschung für energieeffiziente Wärme- und Kältenetze"
  - Funding Program for Plus Energy Houses ("Häuser nach dem Plus-Energie-Standard"), renamed to "EffizienzhausPlus"
- Competitions
  - "EffizienzhausPlus im Altbau"
  - "Wettbewerb energieeffiziente Stadt“ (BMBF)

Financing instruments (note: Only current and recently finished programs mentioned)

- Private
  - KfW CO2 building renovation programme (2001- 2009)
  - KfW Modernisation of Living Space. Eco Plus (2005- 2009)
  - KfW Ecological building (2005- 2009)
  - KfW Energy-efficient rebuilding (since 2009)
- KfW Energy efficient building (since 2009)Planned: For 2012 to 2014 funds of the CO2 building renovation programme will be increased to 1.5 billion €/yearPublic
  - KfW Energy-efficient rebuilding – Municipalities (since 2009)
- SME
  - Environmental and Energy Efficiency Programme (part B) - implemented by KfW

c) Energy performance certificates’ use and layout in relation to nearly zero-energy building standard

- energy performance certificates for all buildings available

d) Supervision (energy advice and audits)

- BAFA On-site advice (since 1998)
- Advice on Contracting for Federal Government properties
- regular inspection of boilers and air conditioning units (with thermal output greater 12 kW)

e) Information *(Only main ones mentioned)*

- Energy hotline and Internet platform
- Energy saving guidelines
- Energy efficiency initiative
- "House of the Future" campaign
- Municipal and national heating survey
- Heat from renewable energies
- "Climate Seeks Protection" campaign
- Information campaigns and specialist handbooks
- Software and tools provided

f) Demonstration *(lots of demo buildings available)*

- Forschungsinitiative „EnOB – Forschung für Energieoptimiertes Bauen“: Energy-optimised new buildings; Energy-optimised construction in refurbishment; Zero energy buildings; world wide zero energy buildings
- EffizienzhausPlus (BMVBS)

g) Education and training

- n. a.

5.1.5 Greece

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- new buildings should cover entire primary energy consumption with RES
- "building the future" program: refurbishing of 54k buildings until end of 2014
- 2015: no specific targets
- 2020: reduction of primary energy consumption by 20% (compared to 2008 level)
  - 4200 GWH to be conserved in building sector, RES cover 20% of energy needs, CO_2 reduced by 20%
- 2050: reduction of primary energy consumption by 50% (compared to 2008 level)
  - Several scenarios, incl. 100% RES scenario
- RES-energy and shares 2020
  - Estimated share of RES in building sector:

	2010	2015	2020
Residential	17%	22%	27%
Commercial	14%	27%	39%

  - Heating and Cooling: 22 186 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 2.7%
    - Solar: 18.6%
    - Biomass: 64.1%
    - Heat pumps: 14.6%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No
- nearly zero-energy building roadmap till 2019/2021 available: new regulation based on EPBD recast under preparation will define roadmap for nearly zero-energy building
- Other regulations/requirements:
  - Law 3661/2008 on EE of buildings:
  - Law 3851/2010 on acceleration of the development of RES & climate change
  - Law 3855/2010 on improvement of the energy end-use efficiency
  - Energy Performance of Buildings Regulation KENAK (OG 407/B/2010)
  - 60% of domestic hot water provided by solar thermal or alternative systems; from 2020 all new buildings cover primary energy consumption using RES, CHP, District Heating or high efficiency heat pumps; for public buildings start is 2015
  - New Buildings: energy study to prove all are classified at least B; with requirements for U value, heat recovery in central air conditioning units and hot water from solar panels
  - Existing buildings: major renovation upgraded to be classified at least as B
  - EPBD recast implemented under National Law: "All public buildings have to be nearly zero-energy building after 2015" is under revision, nearly zero-energy building will be mandatory after 2019

- o New Building construction law: credits for nearly zero-energy building, particular 20% more space for building

b) Economic incentives and financing instruments

- Tax exemptions for energy saving interventions
- Residential: "Energy saving at home" programme (OIK1 measure) (start 2/2011); compulsory installation of central solar thermal systems in new residential buildings (2012)
- Installation of high-efficiency CHP units together with natural gas cooling systems in hospitals
- Programme "Exoikonomo": energy efficiency in municipal buildings, lighting and transport
- Tax incentives are for owners who install solar collectors and implement RES/EE measures
- Major Energy Saving Programmes for buildings: require issue of EPC and/or audit procedures; schools, private, municipal and public buildings
- Since 2000 Public aid: for private investment in RES and for promoting cooperation between undertakings, research bodies and education establishments on technological development and demonstration research projects
- 2012: Energy upgrading of existing buildings (residential, tertiary) through energy services companies through energy performance contracts, third-party financing (TPF) and public and private joint ventures (PPJV)

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- Energy Performance Certificate (EPC): issued by energy auditors
- 2011: Requirement for EPC as legal document in case of purchase, sale or lease of buildings
- Energy Inspectors Record of YPEKA: private energy inspector place buildings in energy category based on ration building's consumption/reference building's consumption

d) Supervision (energy advice and audits)

- Regular inspection of fossil fuel boilers, heating systems and air conditioning installations,
- Guidelines issued by CRES based on the nearly zero-energy building demonstration project

e) Information

- 2012: Implementation of Energy Management System (public sector; surface area >1000m^2)
- Since 2009: Electronic/intelligent metering of electricity and natural gas consumers (residential; tertiary)
- CRES: database development on energy auditors and maintenance, together with the development and operation of Energy Certificates database
- Main campaign for the issue of EPCs is combined with campaign of the 'Energy Saving at Home' programme: radio and TV commercials, targeting the general public

f) Demonstration

- "Building the future" Project: partnership public sector, construction industry and citizens
- green procurement – energy-efficient and RES technologies (public buildings)
- Implementation of Green Roofs to public buildings
- Interventions for improving energy efficiency in school buildings
- Green Neighbourhood: demonstration project on nearly zero-energy building residential buildings under construction; retrofitting 4 blocks of social residential buildings into nearly zero-energy building

g) Education and training

- Guidance provided through technical seminars and workshops organised by CRES and the Technical Chamber of Greece
- Training of Experts for Energy audits and the issue of EPCs is outlined in the new regulation
- Educational and training projects by the private sector

5.1.6 Hungary

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Reduce energy consumption of newly constructed buildings to 120 kWh/m2 within five years
- Planned: RES ratios and/or maximum CO2 emission values for certain building types and construction sites
- Promote complex renovations that enable energy savings of at least 60 percent (p 72)
- Targets of programs under New Széchenyi Plan:
  - Renovation of an average of at least 50 thousand traditional/30 thousand panel buildings, construction of 22 thousand new, energy-efficient homes per year;
  - The renovation of an average of 3.2 thousand public institutions per year
  - Energy modernisation of all national educational institutions, hospitals, official and other buildings of justice and administration that require renovation (during the 10-year duration of programme)
  - The average energy savings achieved by the investments must be at least 60 percent
  - Promote new constructions that are more energy efficient than required by the regulative specifications; the target in this case is 25 kWh/m2 per year
- RES-energy and shares 2020
  - Heating and Cooling: 21663 GWh
  - 2020 target and estimated trajectory of energy from renewable sources in heating and cooling (heating & cooling only):

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
9.0%	8.8%	8.6%	8.5%	9.1%	9.8%	11.8%	13.7%	15.7%	17.4%	18.9%

  - Share RES-Heat by technology 2020
    - Geothermal: 19.2%
    - Solar: 4.4%
    - Biomass: 68.7%
    - Heat pumps: 7.7%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No
- nearly zero-energy building roadmap till 2019/2021 available: No
- Other regulations/requirements:
  - In effect for public buildings (subsequently extended to all buildings): Construction of new buildings and the increased application of RES during the renovation of existing ones in accordance with technical/technological and economic conditions (e.g. stipulation of a mandatory ratio for four-dwelling or larger condominiums, or in the case of the construction of offices larger than 250 m^2)-->targeted at developers
  - Planned: Increased incorporation of RES during the modernisation of public buildings, in accordance with Article 13(6) of the RED-->government bodies, operators of public institutions

b) Economic incentives and financing instruments

- Building new green homes sub-programme
- Liveable panel dwellings renovation sub-programme
- District heating efficiency sub-programme
- Our home renovation sub-programme
- Renewable public institutions sub-programme
- tender schemes give special priority to public buildings and new constructions or renovations meeting the parameters of "low energy requirement building" or "passive house" can receive special support through a "bonus system
- Preferential electricity tariff for the electricity to operate renewable energy heating systems. The subsidized tariff is only available in the heating season
- For most programs: tender mechanisms or state ESCO; Promotion of ESCO-type investments by regulatory means
- EEOP – Environment and Energy Operational Programme
- CHOP
- Energy Efficiency Credit Fund (EECF)
- National Energy Saving Programme (NESP)
- Green Investment Scheme (GIS)

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- New energy certificates must be issued in the case of new buildings constructed on the basis of a final and enforceable construction authority permit
- Revision of existing regulations has pointed out that more detailed and stricter regulation is necessary what Hungary will introduce in its legislation until June 2012

d) Supervision (energy advice and audits)

- Operation of an energy efficiency consultancy network planned

e) Information

- integrated information and awareness-raising programme
- National Reform Programme: establish data supply and data processing system for measuring the energy consumption and state (state or municipalities owned)

f) Demonstration

- Drafting of a modernisation programme: energy reconstruction of public buildings
- Tender schemes: aid for energy performance modernisation and development (public)

g) Education and training

- Exam for engineers and technicians to be able to perform regular inspections of boilers
- Information campaign: workshops, booklets, ECOHOUSE road show, display of certificates on the ministry's homepage, schools, social events, to raise awareness
- 12 passive houses and training centre (Koberovy): first mass experimental construction
- New Széchenyi Plan: vocational training and retraining of exceptional importance; especially increasing EE of buildings and energy efficient facility management
- Qualification schemes in EE, RES and related areas (by individual initiatives of institutions)
- Concerted Action EPBD: new Regulation

5.1.7 Italy

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Until 2050 development of RES at a fraction of 60% for gross final end energy consumption (2020: 18%) and 80% of gross electricity consumption (2020: at least 35%)
- Burden sharing: energy efficiency target for 2020 17% reduction of energy consumption
- 50% increase of generation from RES, like PV or biogas and anticipation of reaching the nearly zero-energy building target given by directive 31/10/UE in 2015
- RES-energy and shares 2020
  - Estimated share of RES in building sector:

	2010	2015	2020
Residential	84%	283%	81%
Commercial	9%	10%	10%
Public	7%	8%	8%
Industrial	1%	1%	1%

  - Heating and Cooling: 121 581 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 2.9%
    - Solar: 15.2%
    - Biomass: 54.2%
    - Heat pumps: 27.7%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No (but is in progress)
- nearly zero-energy building roadmap till 2019/2021 available: No
- Other regulations/requirements:
  - Regulation 59/2011: methodologies for calculating minimum energy performance requirements for buildings and heating systems; incl. regulation of installation, operation, maintenance and inspection of heating plants
  - Legislative Decree No 192/2005: new criteria set for primary energy needs, limits on annual consumption, higher limits on thermal insulation, minimum for use of RES etc.
  - Energy requirements from RES (new and major renovations): 50% of expected consumption of domestic hot water, heating and cooling, gradual increase up to 2017
  - Planned: minimum quota for electrical capacity installed using RES (new residential)
  - Minimum energy performance (EP) requirements (since 2010): class varies with the climatic zone and shape factor, for new and major renovations minimum EP is C rating

b) Economic incentives and financing instruments

- Tax deductions (55%) for improving EE of existing buildings (individuals and companies)

- White Certificates: creation of EPC market; reduction in primary energy consumption resulting from EE measures; applicable to energy saving measures (e.g. solar heating panels for hot water, efficient air conditioning and central heating systems)
- Regional support: for audits, investments, co-financing, grants (residential, non-residential)
- volume bonus, if new buildings and major renovations of existing buildings ensure coverage of heat, electricity and cooling consumption higher than compulsory minimum values
- Low energy buildings: Energy Performance < 30% / 50% of requirement (new residential)
- “ContoEnergia” (National Incentives Scheme): for PV plants
- “Renewable energy and energy savings”: interregional (e.g. public, hospitals, schools etc.)
- Energy efficiency improvement programmes for public buildings
- Revolving Fund: 3 annual programme cycles aimed at RES, EE and forestry
- “Sun in Public Buildings”: promotes solar thermal systems for low temperature heating
- Kyoto Rotating Fund: supports e.g. heat production from RES
- Planned: ECO PRESTITO (National fund for EE)

c) Energy performance certificates’ use and layout in relation to nearly zero-energy building standard
- Mandatory EPC for public (> 1 000 m^2), new, major renovated and all buildings when sold
- Planned: mandatory EPC of buildings (of all?), by implementing the related framework of sanctions; regional and national IT system for gathering data on EPC and monitoring of EE
- To implement EPBD (2002/91/EC) many regions have own certification scheme, but EPBD not fully implemented at national level: Italy has been referred to the European court of justice
- In this context it is unlikely that there will be significant advances in the short term about the implementation of the nearly zero-energy building target.

d) Supervision (energy advice and audits)
- energy audits of public buildings mandatory (refurbishment of heating systems, replacement of generators or refurbishment of at least 15% of external surface of building envelope)
- Climate-Friendly Buildings Development Agency Network: consultancy services, electronic tender management system, monitoring and registration system for completed projects
- Boiler inspection finalised; for air conditioning systems inspections still under discussion

e) Information
- technical and financial ‘round tables’ with sector’s stakeholders, for preparing proposals and outlines of provisions and measures, to accelerate realisation of high-efficiency and nearly zero-energy building
- Planned: information framework relating to the financial incentives

f) Demonstration
- National Action Plan on Green Public Procurement: in process of definition and adoption
- Demo projects promoted and disseminated by research bodies, private companies and local governments (e.g. “Velux lab”, "Leaf house", the school of Laion (BZ))

g) Education and training
- Interregional operational plan: information programmes accompanied by trainings for designers, manufacturers, maintenance technicians, installers, administrators and technicians working for the public administrative bodies
- Regions responsibility for management of qualified aspects of Energy Certificates
- Training/examination organised by provinces, no universal regional coverage

- Certificates can only be issued by Qualified Experts, architects, engineers and technicians
- Qualified Experts trained by public and private organisations, incl. examination
- Training materials mainly provided by private subjects and specialised magazines/portals

5.1.8 Netherlands

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- "Energy Leap" Programme: achieve 45-80% energy saving in the built environment and zero-energy new buildings from 2020
- Until 2050 reduction of heat consumption in buildings by 80% [source?]
- New buildings: aim to build 50% more energy-efficient (new) buildings in 2015 compared to 2007; also aim to build (new) nearly zero-energy building by 1 Jan. 2021 and (new) nearly zero-energy building occupied and owned by public authorities by 1 Jan. 2019
- Major renovation: renovated part must meet same energy performance requirements as new buildings
- RES-energy and shares 2020
  - Estimated share of RES in building sector:

	2015	2020
Residential	2.8%	3.8%
Commercial/services	2.7%	3.7%
Industrial	0.8%	0.7%

  - Heating and Cooling: 25 337 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 16.2%
    - Solar: 1.4%
    - Biomass: 58.7%
    - Heat pumps: 23.6%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: Not formally decided, but definitions exist
- nearly zero-energy building roadmap till 2019/2021 available:
- Other regulations/requirements:
  - Energy performance (EPC) requirement for new building tightened up in 2015. Tightening will be gradually incorporated into Building Decree over next decade
  - Energy Performance Standard (EPN): sets requirements for EE of new and major renovations of existing buildings; legislation sets minimum requirements for building components, which are regularly evaluated and adjusted
  - "Excellent areas": homes and offices built with at least 25% tighter energy performance coefficient than currently required
  - Tenders for nearly zero-energy building (residential and non-residential)

b) Economic incentives and financing instruments

- Energy Investment Allowance (since 1997): incentives for house building
- "Reduced VAT rate for insulation work" and "Reduced VAT rate for labour costs for the maintenance and renovation of houses" (ended 10/2011)

- Sustainable heat subsidy scheme for solar boilers, heat pumps and micro-CHP systems in existing homes
- grants for innovation of techniques and for supporting process to building nearly zero-energy building (pilots)
- Energy Savings Credit Guarantee / Green Projects Scheme /National Mortgage Guarantee
- Energy efficiency funds under programme "Energy Leap" (2011-2014)
- “More With Less”: energy saving programme for existing buildings, goal: create a substantial market for energy savings; educational training of building workforce
- “Energy subsidy guide”: for energy performance advice, improving energy performance, lower VAT rate for insulation of roof, wall, floor

c) Energy performance certificates’ use and layout in relation to nearly zero-energy building standard
- 2013 all government buildings > 500m^2 provided with visible energy label; from 2015 govt buildings > 250m^2
- EPCs in force for new buildings since 1995, existing since 2008; EPCs can only be issued by qualified assessors, in 2010 25% of residential buildings were issued EPC
- Under development: EPC for New Buildings which follows requirements under EPBD recast

d) Supervision (energy advice and audits)
- Inspection of central heating boilers (20-100kW) based on voluntary inspection scheme and legislation and depending on size; simulation tools are available
- Inspection of air conditioning systems (> 12 kW)

e) Information
- “Energy Leap” and “more with Less” provide information on knowledge, distribution of knowledge and “how to’s” (save energy, apply for grants)
- MilieuCentraal information campaign
- ‘Smart Energy’: campaign to inform facility managers about energy saving and use of RES in their buildings
- “Energy subsidy guide”: internet tool; overview of financial instruments (subsidies, loans)
- “Energy Scout”: interactive internet tool; insight into energy saving measures in existing houses and the financial consequences

f) Demonstration
- “Areas of Excellence”: 12 innovative building projects which are building with a strict EPC
- “Block by Block approach” (5 pilots starting 2011): use standard packages with management role at local level and using money from the market (e.g. from institutional investors)
- demo projects of several offices and schools, which were renovated and transformed into nearly zero-energy buildings

g) Education and training
- training of assessors is the first (voluntary) stage to guarantee high level quality EPCs; second stage: mandatory national exam for each individual assessor
- Uni HAN developed Bachelor in Engineering, which incl. project on nearly zero-energy building in eastern NL

5.1.9 Poland

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Achieve climate neutral building stock up to 2050 (check)
- RES-energy and shares 2020
  - o Estimated share of RES in building sector:

	2010	2015	2020
Residential	11%	14%	16%
Public	10%	13%	15%
Commercial/Industrial	9%	12%	14%

  - o Heating and Cooling: 68 849 GWh
  - o Shares RES-Heat by technology 2020
    - ▪ Geothermal: 3.0 %
    - ▪ Solar: 8.5 %
    - ▪ Biomass: 85.9 %
    - ▪ Heat pumps: 2.5 %

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No
- nearly zero-energy building roadmap till 2019/2021 available: ? No?
- Other regulations/requirements:
  - o Minimum quality requirements: new regulations expressed in prescriptive (U-value) and performance way (primary energy); way of expression chosen by expert
  - o Insignificant differences between requirements before and after the EPBD; building market not seriously affected by implantation of EPBD (2002)
- More than 50 % of new buildings do not fulfil EP requirements, EPBD implemented only in 1. January 2009; delay due to late implementation of methodology on EU level, lobbying and organizational/political issues

b) Economic incentives and financing instruments

- White certificate Scheme (certificates of energy efficiency to support energy-efficient investments); planned: savings from white certificates from eeRE tech can be traded/sold
- Thermo-modernisation premium
  - o Overhaul and thermo-Modernisation Fund
  - o Thermo-modernisation of public buildings
- Renovation premium
- Green certificates (promotion of RES)
- Options for co-financing investments in RES:
  - o National Fund for Environmental Protection and Water Management
  - o Voivodship Funds for Environmental Protection and Water Management
  - o EU funds

- European Economic Area
    - 16 Regional Operational Programmes
- Financial support for investment in solar collectors for hot water preparation
- However, no introduction of incentives/subsidies

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- Energy Performance Certificate displayed in prominent place in all governmental buildings with >500m^2
    - Problem: calculation method contains mistakes-> provide results with huge errors, legal questions arise concerning validity of certificate
- The Building Act: no explicit set of ratios for share of RES; facilitates instalment of RES in Buildings; obligatory notification on installed RES

d) Supervision (energy advice and audits)

- Regulation of Minister of Infrastructure: energy audit, repairs audit sheets, algorithm for evaluating cost-effectiveness of Thermo-modernisation investments
- Regular inspections of boilers and AC systems under building Act, but only safety aspects taken into account, no legislation for energy efficiency and other parameters other parameters under EPBD
- Ministry of Transport: Thermo-modernization fund provides support for renovation audit

e) Information

- National information and educational campaign: increase awareness regarding EE, funding (ESCO, White Certificates); promotion of nearly zero-energy building and passive construction
- Planned: target local governments to raise awareness on RES
- Planned: *Time to save energy* media campaign
- Different campaigns suspended in 2008, since September 2010 information about EPBD brochures or buyer/tenants, additional information Ministry webpage

f) Demonstration

- Exemplary role of public administration: awarding EU funding for public utility facilities primarily (after 2015 exclusively) to buildings with increased energy efficiency, incl. nearly zero-energy building
- Planned: support for promotion of demonstration and pilot projects in the construction of nearly zero-energy building public utility facilities
- Planned (?!): Energy conservation programme to ensure the exemplary role of a public building at national, regional and local level y use of RES or becoming nearly zero-energy building
- Bill on energy efficiency
- Planned: Pilot projects in passive construction in public buildings; monitoring of energy performance until 2017, shall deliver information on profitability of passive housing/nearly zero-energy building

g) Education and training

- Trainings on building energy performance assessment (e.g. energy certification computer programmes, energy performance certificates, energy audit)

- EPC: training for experts to issue EPCs for buildings, no specific requirements for entities offering training course, but scope/method, form of certificate, training fees subject to regulation
- General: recently discussions and energy assessment research picked up in scientific area

5.1.10 Spain

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- From 2021:all new buildings should have primary energy consumption < 85% than building stock in 2006
- 13% of existing homes should be renewed by 2020
- Assumes national targets defined within the EU Directive of 2010; hasn't finished adaptation of EPBD 2002:
  - Planned October 2012: Energy certification scheme for existing buildings (new Royal Decree)
- RES-energy and shares 2020
  - Heating and Cooling: 65744 GWh
  - Electricity: 158053 GWh
  - 2020 target for overall RES-shares 20 %, initial value (2005): 8.7%, expected amount: 225674 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 0.2%
    - Solar: 11.4%
    - Biomass: 87.5%
    - Heat pumps: 0.9%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No
- nearly zero-energy building roadmap till 2019/2021 available: Yes (currently being defined)
- Other regulations/requirements:
  - EE Action Plan for state General Administration's buildings (minimum saving objective 20% by 2016)
  - RITE (Technical Building Code), minimum solar contribution to sanitary hot water (no figures)
    - Regulation on Thermal Installations in Buildings (use of RES required)
    - Recast procedure of existing CTE (Código Técnico de la Edificación) affecting new buildings and integral retrofitting projects start 2011 and fin 2012 (no nearly zero-energy building introduced, but some concepts aiming at becoming starting steps)
  - Planned: 2015: CTE revised/possibly introduced
    - Coupling of energy certification with the CTE
    - Cost-optimality of the energy efficient measures to be applied
    - 2018: third revision of CTE (nearly zero-energy building concepts included)

b) Economic incentives and financing instruments

- Deduction on the Spanish Income Tax Revenue for improvement works on residential housing
- Reduction on the Spanish Value Added tax for renewal and repair works of the main residence

- Energy renewal of the thermal envelope of existing buildings
- Improvement in the EE of interior lighting-plants in existing buildings
- Construction of new buildings and renovation of existing buildings with high energy ratings
- Construction or renewal of buildings with almost zero energy consumption
- State Housing and RENOVE plan
- Programme of RENEWAL aids for the renovation of housing and existing residential buildings
- Programme of aids for the promotion of EE homes
- Measures within the incentive scheme:
  - Thermal rehabilitation of the envelope of existing buildings
  - Improvement if the EE in thermal installations in existing buildings
  - Improvement of the energy EE in lighting installations in existing buildings
- Optional measures (not applied by all communities):
  - Construction of new buildings with high energy rating (A&B)
  - Within the framework of the State's Housing and rehabilitation Plan
  - Fund directly managed by IDAE (Institute for Energy Diversification and Saving)

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard
- Energy certification of new buildings and buildings undergoing major renovation (2007)
- Application of energy certification in public buildings (2007)
- Autonomous Communities in charge of registration, inspection and control of EE certificate
  - project energy efficiency certificate
  - finished building certificate
- Planned: EE certification of existing buildings (2012)
  - Based on simulation, simplified procedures include module of identification and evaluation of energy saving measures
  - Energy certification does not define maximum requirements for energy consumption

d) Supervision (energy advice and audits)
- Periodic EE inspection obligatory for heat and cold generators and complete thermal installations > 15 years old
- Advisory Committee for Thermal Installations, RITE Advisory Committee

e) Information
- National informational campaign by IDEA: training, communication, conferences/fairs, dissemination and information in terms of saving, EE and measures contained in NEEP (for citizens and professionals of sector)

f) Demonstration
- n. a.

g) Education and training
- Training courses on the new energy policy for buildings
- Planned: guidance, in-depth courses aimed at designers, facultative management and agents, appropriate to the functions performed by each of them; management of software programmes relative to the energy certification of existing buildings
- 140 courses in relation to building certification (2007); 2008-2012 in the various Autonomous Communities

5.1.11 Sweden

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- 2020: Reduce final energy consumption by 20% (compared to 1995 level in kWh/m²)
- 2050: Reduce final energy consumption by 50% (compared to 1995 level in kWh/m²)
- RES-energy and shares 2020
  - Estimated share of RES in building sector:

	2005	2010	2015	2020
Residential	55.9%	60.3%	64.7%	69.1%
Public	50.5%	55.1%	59.7%	64.3%
Commercial	50.7%	55.0%	59.3%	63.6%

  - Heating and Cooling: 122 593 GWh
  - Shares RES-Heat by technology 2020
    - Geothermal: 0%
    - Solar: 0.1%
    - Biomass: 90%
    - Heat pumps: 10%

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No (but new building regulations)
- nearly zero-energy building roadmap till 2019/2021 available: No
- Other regulations/requirements:
  - Adopted 2011: New Buildings Act: sets minimum requirements for buildings (incl. energy management, energy requirements tightened by 20%; differentiate: office vs. residential and region/climates)
  - Efficiency requirements set up for heating and cooling installations, air-conditioning systems, control systems and efficient use of electricity
  - RES: no national, regional or local legislation that regulates an increased share of RES, but exists indirectly in form of target for phasing-out fossil-fuelled heating (by 2020) and in funding for certain RES heating and electricity
    - Focus on using instruments other than setting minimum levels for RES to promote RES
  - EPBD (2002) in full action, implantation of recast of EPBD has started
  - Revised building code (2006): first statement on maximum energy allowed in new buildings; demands on all buildings going through renovation (irrespective of size); maximum used energy and maximum U value set as requirements
  - Planned: within some years start of renovation of “one million dwellings program”

b) Economic incentives and financing instruments

- Tax deduction for 50% of the cost of building work on residences and holiday homes, does not apply to new-builds or to conversion and extension work on new-builds

- 2004-2009: assistance for installation of EE windows and bio fuel installations (residential)
- 2006-2007: assistance for switch from oil-fired heating to district heating, heat pumps, bio fuel-fired systems or solar systems
- 2006-2010: grant for conversion from direct electric heating into district heating or individual heating using bio fuels
- Since 2009: grant for installation of solar cells, applies to all (business, public, private), also for investments in solar heating/solar collectors
- Delegation for Sustainable cities: show potential in development of sustainable cities, act as showcases and facilitate the spread and export of sustainable urban planning. Environmental technology and know-how
- Low Energy Buildings Program: energy consumption must be 50% below requirements

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard
- Energy Declaration: ECP to be produced when building is sold, rented or built or if a large building of public authorities or institutions
- Only voluntary classification as passive houses or low energy buildings

d) Supervision (energy advice and audits)
- "Become energy smart" campaign: municipal energy and climate consultants
- Inspection of air conditioning systems every 10 years or combined with every third compulsory ventilation check
- Energy saving advice given by advisers (Energirådgivare) available in communities

e) Information *(many information tools available)*
- The Energy calculation (Energikalkylen): online tool for calculation of energy use (residential)
- Dissemination on energy services via websites, training sessions, presentations and networks: "energy smart" houses, "renovate energy smart campaign", online advice portal
- UFOS Energi's "Energy library": 19 publications/reports on methods of improving EE of the property stock
- "Vision for 2025": collaboration between businesses, municipalities and government; aims at progress towards sustainable construction and property sector via suitable strategies
- Energy IT and Design program: combines expertise in IT with design know-how and knowledge about human attitudes towards electricity, everyday goods and technology use
- Ministry website provides detailed information about Declaration of Buildings to supervising authorities, professionals of sector, property owners, developers and general public

f) Demonstration
- District Heating program with demonstration section
- Cities as showcase for sustainable development
- Major renovation of multifamily houses: reduce energy use by 50%, incl. final report

g) Education and training
- CERBOF: research and innovation program run in collaboration with actors in construction sector; stimulate relevant research and innovation projects;
- Swedish Heat Pump Association (SVEP) provides installer training
- Green Building and LEED: trainings for passive houses and environmental classification
- Swedish Energy Agency supports development of technologies and introduction of existing technologies in renovation process

5.1.12 United Kingdom

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

The United Kingdom constitutes a special case within the European Union, as the four countries England, Wales, Scotland and Northern Ireland form the sovereign state of the United Kingdom of Great Britain and Northern Ireland, which is often simply referred to as the United Kingdom. In case of formulating national targets the different countries of the UK often have their own targets and regulations. For this reason the first part of the country report discusses the targets and regulation separately. The other parts are grouped together as much as possible.

- As required by the Directive the UK is required to meet an indicative national energy savings target of 9% or 136.5 TWh in 2016
- RES-energy shares 2020
  - Heating and Cooling: 72 081 GWh
  - Estimated share of RES in building sector:

	2010	2015	2020
Residential	0.26%	0.59%	0.88%
Commercial	0.09%	0.35%	1.05%
Public	0.03%	0.09%	0.16%
Industrial	1.45%	1.51%	2.09%

  - Share RES-Heat 2020
    - Geothermal: 0%
    - Solar: 0.5%
    - Biomass: 63.1%
    - Heat pumps: 36.3%

England/Wales

- Government's Building a Greener Future - Towards Zero Carbon Development (2007): from 2016 all new homes
- Budget Report 2008: net zero carbon standards from 2018 for new public buildings and from 2019 for other new buildings other than dwellings

Northern Ireland

- Government committed to achieving a carbon neutral building standard for dwellings by 2013
- Move towards low or zero carbon buildings from 2016 for dwellings and from 2019 for buildings

Scotland

- Carbon neutral building standard for dwellings by 2012:
- Building (Scotland) Act (May 2011): Sustainability labelling introduced to Scottish Building Standards (incl. energy and carbon emissions targets, water efficiency, flexibility in design)
- Long-term goals: net zero carbon and total-life zero carbon buildings

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

a) Regulations

- Definition of nearly zero-energy building performance standard available: No. Only reports of Zero Carbon Hub
- nearly zero-energy building roadmap till 2019/2021 available: No. But phased introduction of zero carbon standards has already begun (England); standards on the basis of cost-effectiveness, currently cost benefit analysis and standards are executed
- Other regulations/requirements:

England/Wales

  - Requirements for new buildings (Oct. 2010): ADL1A for dwellings and ADL2A for other buildings. Key criteria: Target Emission Rate as maximum rate of CO2 emission, limited performance values
  - Zero Carbon Buildings and Building Regulations for new homes (from 2016) and new non-domestic buildings (from 2019), including set of Carbon Compliance limits
  - Consultation on changes to the Standard Assessment Procedure, by DECCS (01-03/2012): government's tool for assessing energy and environmental performance of dwellings
  - Consultation on changes to the Building Regulations, by CLG (2012)
  - Planned: publications of proposals for options for 2013 and consultation for steps towards zero carbon
  - Zero carbon homes Wales (from 2013): greater uptake of on-site RES (new residential)

Northern Ireland

  - Regulation 2008: reasonable proportion of energy consumption (hot water heating, space heating, cooling) provided by RES (only dwellings)
  - 2011 Building Regulations for Dwellings (2011-2013): minimum efficiency standards for new dwellings
  - Building Regulations - Nearly Zero Energy Dwellings (start 2016): 70% improvement compared with 2002
  - 2012 Building Regulations - Buildings other than dwellings (start 2012): improves minimum standards improved by 30% compared to 2008
  - Energy Efficient Boiler Regulation (start 2008): minimum seasonal efficiency of 86% for boilers (existing, new dwellings) from 2008 and 90% from 2011
  - Zero Carbon Homes (planned, under review): all new homes low or zero carbon from 2017
  - Zero carbon Non-domestic buildings (planned, under review): all new non-domestic buildings from 2020 (2018 for public sector buildings)
  - Building Regulations Part F: amended to enhance thermal standards towards carbon neutral dwellings from 2016 & carbon neutral non-dwellings from 2019
  - Since 2006: technical, environmental and economic feasibility of installing alternative energy systems to be considered before starting work

Scotland

  - Extensions and alternations not required to comply with new emission standard, but new components must meet all other energy standards
  - The Building (Scotland) Regulations 2004: minimum energy performance requirements for buildings and elements (subject to review in 2013)

- o Revised energy standards in building regulations (10/2010): technical handbooks for achieving the standards (domestic, non-domestic)
- o Planned: emission reductions of 23-28% (domestic) and 18-25% (non-domestic) compared to previous standards

b) Economic incentives and financing instruments

UK, England and Wales:

- Several funding schemes, esp. supporting low income people and smaller companies; range of funding programs for heating
- Warm front scheme (until 2012): efficient heating systems, insulation, draught
- Community energy saving program (since 2009): targets low income communities in England; designed to deliver whole home retrofits on street basis by energy suppliers and generators
- Boiler scrappage scheme (2010): cash back on replacement of 'G' rated boiler by 'A' rated one (households, administrations)
- Renewable Heat Incentive: increase generation of heat from RES
- Support improvement of EE in thermal installations in existing buildings
- Planned: 'allowable solutions' will allow developers to support offsite carbon reduction measures (e.g. district heating schemes) where not technically feasible or commercially viable to abate all carbon emissions through on-site means (CLG)
- "Green Deal": government's flagship policy, designed to significantly reduce emissions from existing buildings by promoting increased retrofitting; market mechanism planed for late 2012 that will enable EE retrofit in homes and businesses; financed through energy bill savings; a Green Deal assessment generates a test of cost-effectiveness, it is debatable if it is the right tool for financing Zero Carbon Houses.
- Renewable Heat Premium Payment (2011- 2012): encourage domestic deployment of RES

Northern Ireland:

- NISEP (Northern Ireland Sustainable Energy program): funding for EE and RES energy scheme for domestic and non-domestic properties
- Accelerated Capital Allowances for Energy Efficient Equipment: companies can claim full cost against corporation tax when purchase EE equipment (incl. RES technology)
- "Greener Homes" and "Houses of Tomorrow": Grant assistance for EE and RES heating appliances (residential)
- Social Housing Investment Programme
- "Better Energy Workplaces" (since 2011):support sustainable energy upgrades (public, business)
- "Better Energy Homes" (since 2011): residential retrofits; dependant on annual government budget allocations; before "Home Energy Saving" scheme
- CHP Deployment programme: - grants for selected renewable and alternative heat sources
- ReHeat programme (ended 2011): grants for selected renewable and alternative heat sources; goal: prime market, establish a supply chain
- Public Sector Building Demonstration Programme

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- Building Energy Rating established in Northern Ireland and linked to funding; EPC issued for new, sold or rented buildings; EPC is publicly accepted and visible, a national database for validated certificates exists; quality control is in place; in rest of UK: EPC exists, but voluntary
- EPCs give information on energy efficiency and reduction of CO2 emissions, all homes bought, sold or rented require EPC (valid for 10 years)
- EPC incl. energy rating baseline (existing building's energy efficiency)
- Individual and combined assessment of Energy Conservation Measures (Scotland)

d) Supervision (energy advice and audits)

- “Better Energy Homes”: advice, subsidies and obligation scheme (residential retrofit)
- Inspection of air-conditioning equipment only; for boilers efficiency advice, but no inspections

e) Information

- Energy saving trust (EST): advices to consumers via phone, online, face-to-face alongside green deal when it starts
- Major publicity campaigns have taken place in all parts of the UK through a range of media
- Technical Handbooks give guidance on achieving the standards (residential, non-residential)

f) Demonstration

- Demonstration Projects by local Authorities and voluntary/co-operative housing associations s to deliver sustainable energy-efficient housing with minimum A2 energy rating; goal: advance knowledge and experience base in design, construction and use of high performing EE housing and promote awareness of relevant technologies
- Voluntary demonstration projects incl. use of RES in many regions and local areas
- The Department of the Environment, Heritage and Local Government: funding for flagship low-carbon housing schemes in eight local authorities and annual prize for development of sustainable public buildings

g) Education and training

- Report on Low Carbon Construction: recommendation for achieving required improvement: development and maintenance of education and training by Sector Skills Councils, Universities and colleges, professional bodies and education funding agencies to support production of low and zero carbon buildings
- Independent experts: Energy assessors must be member of a specialist Accreditation Scheme approved government; each organisations responsible for members

5.1.13 Norway

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- Major renovation of existing buildings
  - Low energy standards by 2015 (public buildings from 2014)
  - Passive House standard by 2020 (public buildings from 2018)
- New constructions
  - Passive House standard by 2015
  - Nearly Zero Energy standard by 2020 (public buildings from 2014)

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

h) Regulations

- Energy requirements in building regulation revised in 2007 for implementation of first EPBD
- Current building regulation contains technical requirements (TEK 10)
  - specific energy limits for different building types in kWh/m² final energy demand per year (13 different building categories)
  - requirements for different building components from envelop, technical installations and heat recovery systems.
- Norwegian standard NS 3700 for "low energy" and "Passive House" residential buildings contains stricter requirements than the current technical requirements (TEK 10)
- Analogous Norwegian standard for non-residential buildings (NS 3701) is in work

i) Economic incentives and financing instruments

- Support programs offered by ENOVA (State Energy Agency) since June 2010
  - for passive house and low energy buildings
  - financial support is related to the reduction of energy consumption
  - maximum support is 40 % of the expected additional costs in relation to the building under the current regulations or renovation in relation to historical energy use
- Husbanken (State Housing Bank)
  - allowances for state analysis of existing residential buildings (50 % of cost)
  - favourable loan with lower rates (approximately 1 % point lower) of interest than ordinary bank if renovation includes measures for energy efficiency or universal design
  - for new buildings prerequisite for loan is energy performance (or other environmental measures) and universal design on higher level than required in regulations TEK10 (low-energy or passive house standards)
  - projects with particular challenges can get additional “competence grants”.

j) Energy performance certificates’ use and layout in relation to nearly zero-energy building standard

- EPCs obligatory in case of new construction, major renovation, sale and rent of both residential and non-residential buildings since July 2010
  - For existing residential buildings the certificate can be assessed by home owners via internet on the Energy Certificate System in a simple version (free of charge)

- For new or major renovated buildings and existing non-residential buildings an expert is required for the assessment
  - Non-residential buildings over 1000m² required to have valid energy certificate displayed to the public
- EPC contains:
  - Energy label (calculated delivered energy needed and to what extend heating of space and water can be done with RES)
  - Recommendations for energy efficiency
  - Documentation of the information that was used in certification
- For non-residential buildings gives consumed energy in the last three years

k) Supervision (energy advice and audits)

- Support for counselling (when applying for funding for Passive House)
  - Advice is provided by Enova's adviser team or by another consultant
  - Maximum number of hours of counselling:
    - 20 hours for projects with heated area <500 m2
    - 40 hours with heated area more than 500 m2
    - Projects including several construction categories up to 60 hours
- Regular inspection of boilers, air conditioning and ventilation systems established in 2010
  - Based on the size of the area served by system
  - Boilers using fossil fuels serving heated floor area over 400 m2 must be inspected every 4years and every 2 years if over 2,000 m2
  - Heating systems using fossil fuels, serving a heated area over 400 m2 and older than 15 years require one-off inspection
  - AirCon systems serving an area over 500 m2 shall be inspected every 4 years
- Report from the inspection should be uploaded onto the Energy Certification System at NVE (Norwegian Water Resources and Energy Directorate.)

l) Information

Information on passive house and ZEB buildings is availabble via ZEB research centre, Enova (State Energy Agency), Husbanken (State Housing Bank), Lavenergiprogrammet (the low energy programme; an industry association) and a number of local events, such as conferences, seminars, breakfast meetings organised by these institutes.

m) Demonstration

- Planned: 6-8 ZEB pilot projects will be realized with the support of the ZEB (Zero Emission Buildings) research centre in the period 2012-2015 including residential and commercial buildings, both new and renovation projects

n) Education and training

- Two types of courses on Passive house concept/standard
- organised by university NTNU and targets architects and engineers (includes part on ZEB)
- organised by the Lavenergiprogrammet ("The low energy programme, and industry associaiton) and research institute SINTEF: designers, architects, engineers, developers, contractors, craftsmen

5.1.14 Switzerland

a) Regulations

- Standards for heat and electricity demand under development
- 2014 and 2020: recast of basic agreement of the Cantons for building efficiency, recasts of the different energy laws of the Cantons
    - The coordinated Building code of the Swiss Cantons shall be strengthened by 2014: The energy demand for hating and domestic hot water in new residential buildings shall be limited to 30 kWh/(m2a)
    - Prohibition of electric heating also for existing buildings by 2015, with execution deadline 2025
    - EPBD-requirement of NEARLY ZERO-ENERGY BUILDINGs for new buildings shall be integrated into the building codes of the Swiss cantons by 2014 with the deadline for the NEARLY ZERO-ENERGY BUILDING's (new buildings) to become mandatory by 2018.
    - Recently launched MINERGIE-A-standard, considered as a way to define NEARLY ZERO-ENERGY BUILDING's

Targets for 2050:

- increase of retrofit rate from 0.9 to 2% per year

b) Economic incentives and financing instruments

- Retrofitting
    - Tax reduction
    - Federal and cantonal government grant ongoing
- Renewable sources (esp. photovoltaics and solar thermal)
    - Financial support (federal and cantonal government)
    - Cost-covering refund for electricity delivered by photovoltaic plants

Change until 2050

- financial support for photovoltaic systems < 10 kWp (one contribution max 30% of investment cost) (federal government)
- financial support for photovoltaic systems > 10 kWp (money for each generated kWh)(federal government)

- CO2-tax on national level to feed subsidy-Programs for efficiency measures and renewables

c) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

- Building energy certificate is basis for a retrofit-grant
- Some Cantons gives grants for building energy certificates with joint report on energetic optimisation option for the building

- Energy certificate of existing buildings will be based on simulation, simplified procedures include module of identification and evaluation of energy saving measures

Target 2050:
Obligation: building energy certificate must be made when the building is sold

d) Supervision (energy advice and audits)
e) Information
- Online Tool for calculate energy use in residential buildings, offices and schools at retrofitting: "Gebäudeausweis der Kantone GEAK" [Energy Calculation with efficiency rating].
    - Started in 2009
    - In autumn 2012 a second tool "GEAK Plus" starts supplementary to the GEAK, regarding proposals for improving buildings incl. costs for 3 different retrofit-options. This tool could be used for new buildings, either.
- Different Cantons have there own tools to make proposals for improving buildings
f) Demonstration
g) Education and training

5.1.15 United States of America

National targets (Intermediate and 2020) for improved energy performance of new and existing buildings undergoing major renovation

- No specific federal target for achievement of Zero Energy Buildings
- Federal commercial buildings:
  - by 2015, 15% of existing Federal buildings conform to new energy efficiency standards and 100% of all new Federal buildings be Zero Net Energy by 2030
- Residential building
  - target to reduce energy consumption across the sector by at least 50% by 2030
  - Reduction compared to benchmark and by climatic zones (Mixed/Hot-Dry and Marine, Mixed-Humid and Hot-Humid, Cold)
- New residential buildings

  Target years for savings according to climatic zones (see above)
  - "best in class" (20% or above): 2010, 2011 ,2011
  - 30%: 2011, 2012, 2013
  - 50%: 2014, 2015, 2016
  - Existing residential buildings
    - "best in class" (15% or above): 2011, 2011, 2011
    - 30% 2012, 2013, 2014
    - 50% 2015, 2016, 2017

California: rigorous plan to reach zero energy buildings for all new construction by 2020

Massachusetts: all new buildings (residential and commercial) have to reach net zero energy by 2030

Elements of policy packages for the promotion of nearly zero-energy building (new and existing buildings undergoing major renovation)

o) Regulations

California

- adjusted building codes to require net-zero-energy performance in residential buildings by 2020 and in commercial buildings by 2030
- focused on net-zero-energy performance instead of fossil fuel use
- since 2009 studying the requirement that existing buildings be substantially improved at the time of sale and repurchase

Massachusetts

- state-level “stretch” building energy code will help lead to continual improvements in building practices such that by 2030, net-zero energy buildings should comprise all new construction in the state

p) Economic incentives and financing instruments: no official information available

q) Energy performance certificates: no official information available

r) Supervision (energy advice and audits): no official information available

s) Information: no official information available

Demonstration: no official information available

t) Education and training

- Building America Program focuses on conducting the systems research required to improve the efficiency

5.2 Task 2b: Analysis of existing plans

5.2.1 EPBD reporting requirements on national plans for increasing the number of nearly zero-energy buildings

According to the EPBD Article 9 paragraph 1, Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. These national plans may include targets differentiated according to the category of building. And according to paragraph 3, the national plans shall include, inter alia, the following elements:

- The Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m2 per year. Primary energy factors used for the determination for the primary energy use may be based on national or regional yearly average values and may take into account relevant European standards
- Intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1.
  Information on the policies and financial or other measures adopted in paragraphs 1 and 2 for the promotion of nearly zero-energy buildings, including details of national requirements and measures concerning the use of energy from renewable sources in new buildings and existing buildings undergoing major renovation in the context of Article 13(4) of Directive 2009/28/EC and Articles 6 and 7 of this Directive.

Related articles and paragraphs as mentioned in the three paragraphs above are specified in more detail below:

EPBD Article 9 paragraph 1

Member States shall ensure that:

(a) by 31 December 2020, all new buildings are nearly zero-energy buildings and
(b) that after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings

EPBD Article 9 paragraph 2

Member States shall furthermore, following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, and inform the Commission thereof in their national plans referred to in paragraph 1.

Article 13(4) of Directive 2009/28/EC

Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building sector

- In establishing such measures or in their regional support schemes, Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings.
- By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy

from renewable sources in new buildings and in existing buildings that are subject to major renovation. Member States shall permit those minimum levels to be fulfilled, inter alia, through district heating and cooling produced using a significant proportion of renewable energy sources

EPBD Article 6

New buildings

1. Member States shall take the necessary measures to ensure that new buildings meet the minimum energy performance requirements set in accordance with Article 4.
   For new buildings, Member States shall ensure that, before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems such as those listed below, if available, is considered and taken into account:
   (a) decentralised energy supply systems based on energy from renewable sources;
   (b) cogeneration;
   (c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources;
   (d) heat pumps.
1. Member States shall ensure that the analysis of alternative systems referred to in paragraph 1 is documented and available for verification purposes.
2. That analysis of alternative systems may be carried out for individual buildings or for groups of similar buildings or for common typologies of buildings in the same area. As far as collective heating and cooling systems are concerned, the analysis may be carried out for all buildings connected to the system in the same area.

EPBD Article 7

Existing buildings

Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements set in accordance with Article 4 in so far as this is technically, functionally and economically feasible.
Those requirements shall be applied to the renovated building or building unit as a whole. Additionally or alternatively, requirements may be applied to the renovated building elements.
Member States shall in addition take the necessary measures to ensure that when a building element that forms part of the building envelope and has a significant impact on the energy performance of the building envelope, is retrofitted or replaced, the energy performance of the building element meets minimum energy performance requirements in so far as this is technically, functionally and economically feasible.
Member States shall determine these minimum energy performance requirements in accordance with Article 4.
Member States shall encourage, in relation to buildings undergoing major renovation, the consideration and taking into account of high-efficiency alternative systems, as referred to in Article 6(1), in so far as this is technically, functionally and economically feasible.

EPBD Article 4

Setting of minimum energy performance requirements

1. Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The energy performance shall be calculated in accordance with the methodology referred to in Article 3. Cost-optimal levels shall be calculated in accordance with the comparative methodology framework referred to in Article 5 once the framework is in place.
   Member States shall take the necessary measures 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.
   When setting requirements, Member States may differentiate between new and existing buildings and between different categories of buildings.
   These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building.
   A Member State shall not be required to set minimum energy performance requirements which are not cost-effective over the estimated economic lifecycle.
   Minimum energy performance requirements shall be reviewed at regular intervals which shall not be longer than five years and, if necessary, shall be updated in order to reflect technical progress in the building sector.
2. Member States may decide not to set or apply the requirements referred to in paragraph 1 to the following categories of buildings:
   - (e) Buildings officially protected as part of a designated environment or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance;
   - (f) Buildings used as places of worship and for religious activities;
   - (g) Temporary buildings with a time of use of two years or less, industrial sites, workshops and non-residential agricultural buildings with low energy demand and non-residential agricultural buildings which are in use by a sector covered by a national sectoral agreement on energy performance;
   - (h) Residential buildings which are used or intended to be used for either less than four months of the year or, alternatively, for a limited annual time of use and with an expected energy consumption of less than 25 % of what would be the result of all-year use;
   - (i) Stand-alone buildings with a total useful floor area of less than 50 m^2.

Summary of EPBD requirements on national plans

1. National definition of nearly zero-energy building available (reflecting their national, regional or local conditions and including a numerical indicator of primary energy use)?
   - ➔ EPBD Article 9 Paragraph 3(a)
2. By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings
   - ➔ EPBD Article 9 Paragraph 3(b) in combination with EPBD Article 9 Paragraph 1(a)
3. By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings
   - ➔ EPBD Article 9 Paragraph 3(b) in combination with EPBD Article 9 Paragraph 1(b)
4. Policies and financial or other measures to promote that by 31 December 2020, all new buildings are nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   - ➔ EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 1(a), EPBD Article 6, EPBD Article 4 and Directive 2009/28/EC Article 13(4)
5. Policies and financial or other measures to promote that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   - ➔ EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 1(b), EPBD Article 6, EPBD Article 4 and Directive 2009/28/EC Article 13(4)
6. Policies and financial or other measures , following the leading example of the public sector, to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   - ➔ EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 2, EPBD Article 7, EPBD Article 4 and Directive 2009/28/EC Article 13(4)

5.2.2 Qualitative and quantitative rating of achievements relative to EPBD reporting requirements on plans for increasing the number of nearly zero-energy building

The comprehensive overview of the national plans as elaborated in Task 2a allows us to evaluate the compatibility of that information with the requirements of the EPBD (Chapter 5.2.1). For this purpose, we did a qualitative and a quantitative rating:

- Qualitative rating of achievement / completeness relative to the EPBD minimum requirements for national plans. To what extent have the respective elements been addressed
- Related rough Quantitative rating (red, yellow, green)

Table 8 gives an overview of the used rating system. In general if the area has been awarded a 0 nothing has been done that is line with the requirements of the EPBD.

Table 8 Explanation of rating scheme

Category	Grade 0	Grade 1	Grade 2	Grade 3
(0-2)	None	Planned/ introduced / under preparation	implemented	n. a.
(0-3)	None	Planned/discussed incl. first steps and measures	Introduced/first levels set	Fully implemented following EPBD

The overall rating is additionally presented in the form of traffic light colours while green is the best, yellow stands for a medium result and red is the worst category. The colours result from the overall number of achieved points in the specific sub-categories:

- 0-8 = red,
- 9-13 = yellow,
- 14-16 = green.

Additionally, a 'knock out criteria' has been determined: Accordingly, it is impossible for a country to fall into the green category in the quantitative rating scheme, if just one of the six categories has been assessed with 0 points.

It should be noted that the rating is done only with respect to the reporting requirements of the EPBD. It is possible for countries to score rather poorly, even though a lot is being done in the area of low-energy buildings and energy efficiency. In this case the instruments are not yet in line with the EPBD (which is not necessary at the moment).

Following these guidelines Table 9 gives an overview of country scores according to country activities supplied in NEEAP, NREAP, the Concerted Action reports and country expert evaluations.

Table 9 EPBD requirements on the national plans for increasing the number of nZEB and a quantitative assessment of associated MS's frameworks already in place

Country	1) Definition (Rating: 0-2)	2) 2015 targets all new buildings (Rating: 0-3)	3) 2015 targets new public buildings (Rating: 0-3)	4) Measures all new buildings 2021 (Rating: 0-3)	5) Measures new public buildings 2019 (Rating: 0-3)	6) Measures for refurbishment into nZEB (Rating: 0-3)	Overall rating
Country 1	0	1	1	0	0	2	4
Country 2	1	2	2	3	3	2	13
Country 3	0	3	3	3	3	2	14
Country 4	1	3	2	2	2	2	12
Country 5	0	2	2	2	2	2	12
Country 6	0	2	2	1	1	2	8
Country 7	1	1	0	1	0	1	4
Country 8	1	2	2	2	2	2	11
Country 9	0	0	0	0	0	1	1
Country 10	0	2	2	1	1	2	8
Country 11	0	2	2	1	1	1	7
Country 12	0	2	2	1	1	1	7

Explanation of categories:

1) National definition of nearly zero-energy building available (reflecting their national, regional or local conditions and including a numerical indicator of primary energy used)
2) By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2020, all new buildings are nZEBs
3) By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings
4) Policies and financial or other measures to promote that by 31 December 2020, all new buildings are nearly zero-energy buildings, *including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels*
5) Policies and financial or other measures to promote that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings, *including...*
6) Policies and financial or other measures , following the leading example of the public sector, to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, *including...*

5.3 Task 2c: Identification of common elements and recommendations for a harmonized reporting format

This chapter shows which information is available, how scattered / consistent this information is in different sources and what can be realistically required from the MS as a common denominator for reporting the progress relative to implementing nearly zero-energy building.

Based on the output of 2b, 3a and 3b, the target of this task is to give recommendations for a harmonized reporting format that is also compatible with the reporting requirements under the recast EPBD and serves the Commission as input to monitor deviations and progress in the Member States.

As pointed out, the new NEEAP template already includes distributed elements to fulfil the EPBD's reporting requirements. Nevertheless, a comprehensive template for a "stand-alone" report does not yet exist.

Such template is a vital pre-condition for the European Commission's efficient subsequent evaluation of the adequacy of national plans and targets within an analytical framework (Task 3b) aimed at significantly increasing the number of nearly zero-energy building.

The proposed way to go serves two aspects:

- Least possible additional reporting burden to MS
- Best possible format for the Commission to evaluate compatibility and/or distance to target between national plans and minimum EPBD requirements.

The approach for finally developing a proposal for a nearly zero-energy building reporting template contains the following steps:

1. EPBD reporting requirements on national plans (including sub-categories of measures)
2. Point out EPBD nearly zero-energy building relevant items in NEEAP and NREAP templates (including sub-categories of measures)
3. EPBD reporting requirements not yet considered in NEEAP and NREAP
4. Evaluation of real reporting in NEEAP and NREAP templates
5. Comparison and assessment of categories considered and not considered in NEEAP / NREAP in order to detect "conflict categories"
6. Proposal for how to improve reporting in conflict categories
7. Proposal for a nearly zero-energy building reporting template

There are also some interactions between the different steps. An overview of these interactions and influences is presented in Figure 26.

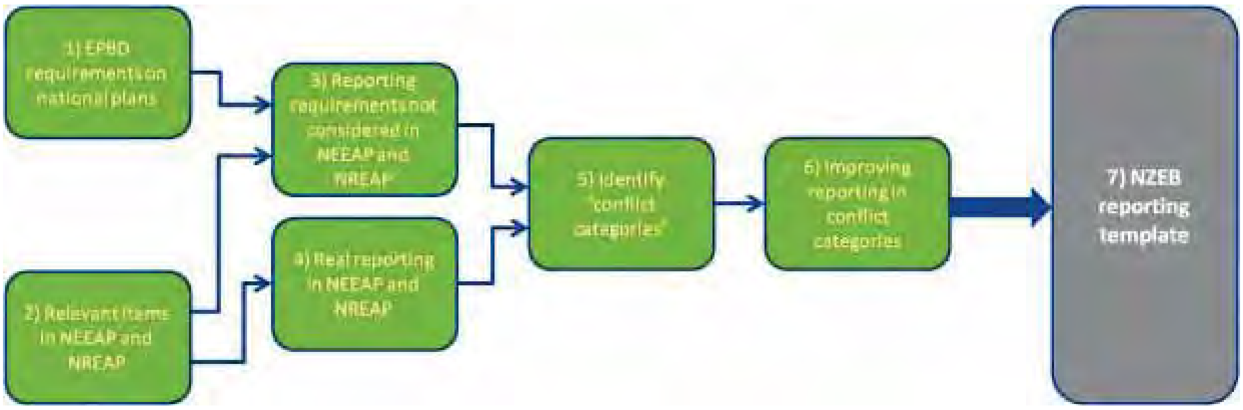

Figure 26. Methodology for the development of a nearly zero-energy building reporting template

A detailed description and the results of each of these steps are given in the following chapters 5.3.1 to 5.3.7.

5.3.1 EPBD requirements on national plans

As already analysed in chapter 5.2.1, the EPBD requirements on the national plans for increasing the number of nearly zero-energy buildings are the following:

1. National definition of nearly zero-energy building available (reflecting their national, regional or local conditions and including a numerical indicator of primary energy use)?
   → EPBD Article 9 Paragraph 3(a)
2. By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings
   → EPBD Article 9 Paragraph 3(b) in combination with EPBD Article 9 Paragraph 1(a)
3. By 2015 intermediate targets for improving the energy performance of new buildings incl. a view on how to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings
   → EPBD Article 9 Paragraph 3(b) in combination with EPBD Article 9 Paragraph 1(b)
4. Policies and financial or other measures to promote that by 31 December 2020, all new buildings are nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   → EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 1(a), EPBD Article 6, EPBD Article 4 and Directive 2009/28/EC Article 13(4)

5. Policies and financial or other measures to promote that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   - ➔ EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 1(b), EPBD Article 6, EPBD Article 4 and Directive 2009/28/EC Article 13(4)
6. Policies and financial or other measures , following the leading example of the public sector, to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, including details of national requirements and measures in order to increase the share of all kinds of energy from renewable sources (by 31. December 2014 requirement for minimum levels of energy from renewable sources) and to set minimum energy performance requirements with a view to achieving cost-optimal levels
   - ➔ EPBD Article 9 Paragraph 3(c) in combination with EPBD Article 9 Paragraph 2, EPBD Article 7, EPBD Article 4 and Directive 2009/28/EC Article 13(4)

5.3.2 Point out building sector relevant items in NEEAP and NREAP templates

The NEEAP and NREAP templates already ask the Member States for some relevant input regarding the implementation process of nearly zero-energy buildings. Therefore, in this task, we have a look on the kind of asked information.

The "Guide and template for the preparation of the second national energy efficiency action plans", developed by EC JRC Ispra, already explicitly incorporates the new reporting requirements of the recast EPBD, e.g. in:

i. Chapter 3.1.2 "National targets for nearly zero-energy buildings"

ii. Chapter 3.4.2 "Public sector leading role in EPBD"

iii. Chapter 3.8 "Strategy for the increase of nearly zero-energy buildings" (or alternatively 3.3.2.1 "Measures in the buildings sector")

iv. Chapter 3.10 "Measures to support EPBD implementation".

Also the template for the National Renewable Energy Action Plans (NREAPs) to be filled and submitted by the Member States contains several relevant issues for nearly zero-energy buildings. Some of them are more direct and important than others, but all provide useful information to get a comprehensive overview of the framework around nearly zero-energy buildings. The relevant sections in the reporting template are the following:

4.2.2 – Technical specifications

4.2.3 – Buildings

4.2.4 – Information provisions

4.2.5 – Certification of installers

4.4 – Support schemes to promote the use of energy from renewable resources in heating and cooling applied by the Member State or a group of Member States

Especially section 4.2.3 is referring to Article 13(3) of the Renewable Energy Directive (2009/28/EC) and amongst others lists the following requirements, which are relevant:

i. information on references to national and regional legislation,

ii. summary of existing and planned measures,

iii. minimum levels for the use of renewable energy in building regulations and codes,

iv. projected increase of renewable energy use in buildings till 2020, possibly divided into the categories residential, commercial, public, industrial

v. Obligations for minimum levels of renewable energy in new and newly refurbished buildings, development of such option till 2015.

vi. plans for ensuring the exemplary role of public buildings at national, regional and local level by using renewable energy installations or becoming zero energy buildings from 2012 onwards

vii. guidance for architects and planners

5.3.3 EPBD reporting requirements not yet considered in NEEAP and NREAP

Table 10 presents an overview which relevant questions of the NEEAP and NREAP templates provide useful information for the national plans of member states to increase the number of nearly zero-energy buildings according to the reporting requirements of the EPBD. This table is based on Table 9 and thus, contains the same categories.

Table 10. overview which relevant questions of the NEEAP and NREAP templates provide useful information for the national plans to increase the number of nearly zero-energy building

Country	1) Definition	2) 2015 targets all new buildings	3) 2015 targets new public buildings	4) Measures all new buildings 2021	5) Measures new public buildings 2019	6) Measures for refurbishment into nZEB
NEEAP 3.1.2		X	X			
NEEAP 3.3.2.1				(X)	(X)	(X)
NEEAP 3.4.2					(X)	(X)
NEEAP 3.8				(X)	(X)	(X)
NEEAP 3.10				(X)	(X)	(X)
NREAP 4.2.2				(X)	(X)	(X)
NREAP 4.2.3				(X)	(X)	(X)
NREAP 4.2.4				(X)	(X)	(X)
NREAP 4.2.5				(X)	(X)	(X)
NREAP 4.4				(X)	(X)	(X)
Reporting template cost optimality	Not relevant					

It comes out that the NEEAP and NREAP templates, at least in theory, should provide useful information at least for 5 out of 6 EPBD requirements on the national plans. Accordingly, especially the issue of a description of the national definition of nearly zero-energy buildings should additionally be addressed in the new national plans for increasing the number of nearly zero-energy building.

5.3.4 Evaluation of real reporting in NEEAP and NREAP templates

In this task, we have a look on the kind of asked information and check to which magnitude these respective questions have been answered. The aim is to find out whether the questions (and thus, answers) can just be adopted for the nearly zero-energy building national plans, or whether some kind of rethinking and reformulation has to be done.

The following Tables evaluate strict compliance with the NEEAP and NREAP templates. Thereby, **only** reporting format and contentual validity of answers given in the respective sections are assessed. For an evaluation of national measures and strategies towards nearly zero-energy building see section 5.2.2.

Green /Red cells indicate that the section of the template has been adopted/not adopted.

Numbers 0-2 respectively colours green (2 points)/ yellow (1 point) / red (0 points) refer to the relevance of the response with respect to the asked information;0 (low relevance), 1 (medium relevance/ references made to national law or other sections), 2 (high relevance). If a section has not been explicitly adopted, the relevance automatically is 0.

Table 11. Use of relevant sections of the NEEAP template by the considered MS

Country	3.1.2 of NEEAP template		3.3.2.1 of NEEAP template		3.4.2 of NEEAP template		3.8 of NEEAP template		3.10 of NEEAP template	
	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB
Country 1		0		1		0		0		0
Country 2		1		2		0		1		1
Country 3		1		0		0		2		1
Country 4		0		2		2		2		0
Country 5		2		0		2		2		2*
Country 6		2		0		1		0		1*
Country 7		0		0		0		2		0
Country 8		1		2		1		2		1
Country 9		0		0		2		0		2
Country 10		0		2		0		0		2
Country 11		0		2		0		0		0
Country 12	-	0		0		0		0		0

Greece: * 3.10 available in separate document

Hungary: * special listing (3.10) available but in Hungarian

Table 12 shows how the relevant sections of the **NREAP** template have been used by the considered Member States.

Table 12. Use of relevant sections of the NREAP template by the considered MS

Country	4.2.2 of NREAP template		4.2.3 of NREAP template		4.2.4 of NREAP template		4.2.5 of NREAP template		4.4 of NREAP template	
	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template	Relevance of output by MS for a national plan on nZEB	Explicitly adopted from template
Country 1		0		2		2		2		2
Country 2		0		2		1		2		1
Country 3		1		1		1		1		2
Country 4		2		2		2		2		2
Country 5		0		2		2		2		1
Country 6		2		2		2		2		2
Country 7		2		2		2		2		2
Country 8		1		2		2		2		2
Country 9		1		2		2		2		2
Country 10		1		1		1		1		2
Country 11		2		2		2		2		2
Country 12		1		2		2		1		2

France: Sub questions not answered

Spain: information mostly unstructured, sub categories do not correspond to template.

Table 13 summarizes the findings from Table 11 and Table 12. Acceptance of templates is reflected in “Ratio of adoption” that shows how many of the considered member states reported according to the template.

For the relevance of the question, overall achieved points are put in relation to the maximal amount of achievable points of 24. The cells are coloured according to three categories: red (0-4/0-8 achieved points), yellow (5-8/9-16 achieved points), green (9-12/17-24 achieved points).

Table 13. Summary of adoption and relevance of sections by 12 considered member states

Country	3.1.2 of NEEAP template		3.3.2.1 of NEEAP template		3.4.2 of NEEAP template		3.8 of NEEAP template		3.10 of NEEAP template	
	Ratio of adoption	Achieved relevance rating	Ratio of adoption	Achieved relevance rating	Ratio of adoption	Achieved relevance rating	Ratio of adoption	Achieved relevance rating	Ratio of adoption	Achieved relevance rating
All	5/12	7/24	6/12	11/24	5/12	8/24	6/12	11/24	7/12	10/24
Country	**4.2.2 of NREAP template**		**4.2.3 of NREAP template**		**4.2.4 of NREAP template**		**4.2.5 of NREAP template**		**4.4 of NREAP template**	
	Ratio of adoption	**Achieved relevance rating**	**Ratio of adoption**	**Achieved relevance rating**	**Ratio of adoption**	**Achieved relevance rating**	**Ratio of adoption**	**Achieved relevance rating**	**Achieved relevance rating**	**Achieved relevance rating**
All	12/12	13/24	12/12	22/24	12/12	21/24	12/12	22/24	12/12	22/24

5.3.5 Comparison between 3, 4 and 5 to identify “conflict categories”

As analysed in chapter 5.3.2, the NEEAP and NREAP tamplate especially asks for input to the EPBD reporting requirements on the national reports 4-6. Also, but just in one section of the NEEAP, is information asked for requirements 2-3.

Therefore, before having a more detailed look on how the Member States have answered/filled the NEEAP and NREAP templates, it is already clear that requirement 1 is not considered at all. By considering where the NEEAPs and NREAPs provide input and how the Member States answered the templates, it is possible to point out “conflict categories”, which means where additional effort is necessary. The result of this analysis is presented in Table 14.

Table 14. Analysis of conflict categories in EPBD requirements on national reports

	1) Definition	2) 2015 targets all new buildings	3) 2015 targets new public buildings	4) Measures all new buildings 2021	5) Measures new public buildings 2019	6) Measures for refurbishm. into nZEB
NEEAP (based on how the MS filled the template)						
NREAP (based on how the MS filled the template)						
Summary						

Table 14 shows that EPBD reporting categories 1-3 are not well covered/answered in the considered action plans. In contrast, input to categories 4-6 is provided in most of the relevant NEEAP and NREAP sections, therefore we assess these categories as not problematic.

5.3.6 Proposal for how to improve reporting in conflict categories

As discovered in the previous chapters, the reporting manner in national reports can vary significantly. The main challenges for the reporting template for national plans for increasing the number of nearly zero-energy buildings are especially to get comparable results on the content of each Member State's national plan. This contains the national definitions for nearly zero-energy building, the intermediate targets and the promotion framework for nearly zero-energy buildings. For this purpose, a common structure would significantly facilitate the comparison and evaluation of national reports. Additionally a similar level of detail within the reports would facilitate this process.

The different challenges can be solved through different approaches. To make the content comparable, a common reporting format is key. Therefore, it is not just enough that the Commission provides the Member States with a common reporting template but it should also be tried to convince the Member States to use this template although it was already agreed that the Member States will not be committed to do so.

To furthermore facilitate the Member States to gather all necessary input rather than containing contradictions or producing double work, the template should be structured in a way that information from other national reports, e.g. the NREAP, NEEAP or the report on cost-optimality can be used. In this context, the respective parts in the reporting template should contain an indication that synergies with other reports exist and that this may be helpful and facilitate the work.

5.3.7 Recommendations for a harmonized nearly zero-energy building reporting format

Based on the analyses in the previous chapters, several recommendations could be formulated for the purpose of this template:

- A template would guide the Member States in reporting and support the EC in evaluating the reports. Without a template, the national plans will probably have a widely dispersed format (see NEEAP reporting). This will add significant complexity to the evaluation of the reports.
- The Commission should aim to convince MS to use the template and to answer all questions. In the original NEEAPs, some questions have not been answered at all whereas in the NREAP the reporting was excellent.
- The nearly zero-energy building report should in fact be embedded in the National Energy Efficiency Action Plans (NEEAP), as announced in the EPBD recital 21.
- To facilitate reporting for MS, the four reports mentioned in the subsequent paragraph - all containing building sector related information - could be merged. Thus, different and redundant information in the specific reports could be avoided and more transparency would be achieved.
- The four reports with building related information should be required at the same point in time. At the moment, the reporting schedules differ significantly:

- o Nearly zero-energy building: 31.12.2012 and every three years thereafter [Directive 2010/31/EU Article 9(5)];
- o Cost-optimality: March 2013 (moved from 30 June 2012) and thereafter in regular intervals of no longer than 5 years [Directive 2010/31/EU Article 5(2)];
- o NEEAP: a first NEEAP not later than 30 June 2007; a second EEAP no later than 30 June 2011; a third EEAP no later than 30 June 2014 [Directive 2006/32/EC Article 14(2)]. By 30 April 2014, and every three years thereafter, Member State shall submit supplementary reports with information on national energy efficiency policies, action plans, programmes and measures implemented or planned at national, regional and local level to improve energy efficiency [COM(2011) 370 final Article 19(2)];
- o NREAP: 31 December 2011, and every two years thereafter [Directive 2009/28/EC Article 22(1)];

Table 15 summarises the information above.

Table 15: Summary of the different reporting schedules.

	Nearly zero-energy building	Cost optimality	NEEAP	NREAP
Reporting time	31.12.2012 31.12.2015 31.12.2018 31.12.2021	31.03.2013 30.06.2017 30.06.2022	30.06.2014 30.06.2017 30.06.2020	31.12.2013 31.12.2015 31.12.2017 31.12.2019 31.12.2021

Taking into account all relevant requirements and identified obstacles through the analyses in the previous chapters and the detailed analysis regarding the taxonomy of nearly zero-energy buildings, the reporting template as presented in the Appendix in chapter 10.3.2 has been developed for the Member States' national plans for increasing the number of nearly zero-energy buildings. In addition, a separate digital MS Word document containing the template for reporting and evaluating the national plans has been delivered to the Commission.

The reporting template is structured in 8 main input chapters. It starts by asking the Member States to describe the starting point in their country as detailed as possible, then the six identified reporting categories has to be filled and finally an overall self-evaluation for possible improvements is asked.

Below, each of these input chapters is described in more detail.

5.3.7.1 Starting point

As an introduction to the national report, each Member State should give an introduction by describing the starting point for the implementation of nearly zero-energy buildings in the country. For this purpose, Member States should especially address the following two topics:

1. Building stock characteristics
2. Development of national requirements on the energy performance of buildings

Within the description of the building stock characteristics, the size and age structure of the residential as well as the non-residential building stock should be addressed and the most emerging needs should be highlighted.

Additionally, the chronological development of national requirements on the energy performance of buildings should be illustrated. As an example, Figure 27 shows how such an illustration could look like.

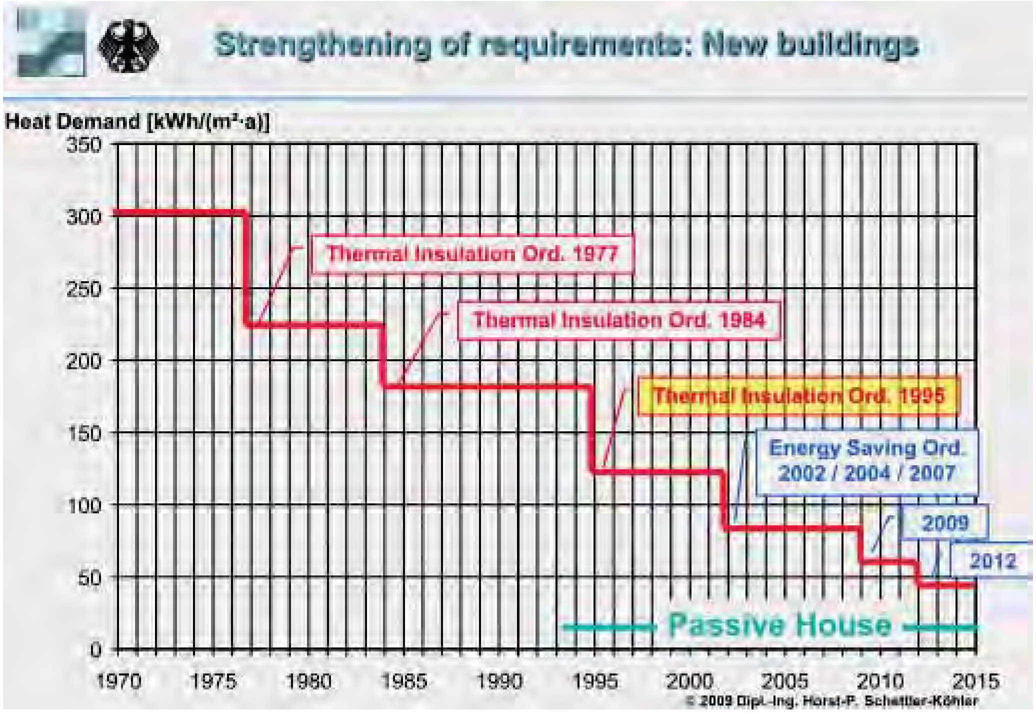

Figure 27: Example of the development of national requirements on the energy performance of buildings (Germany): Source: (Schettler-Köhler, 2009)

5.3.7.2 Application of the definition of nearly zero-energy buildings

According to EPBD Article 9 Paragraph 3(a) the "national plans shall include (…) the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m² per year. Primary energy factors used for the determination of the primary energy use may be based on national or regional yearly average values and may take into account relevant European standards."

In this section, Member States should indicate how a nearly zero-energy building is defined within their national context and explain underlying assumptions and factors that provide the rationale for the chosen definition.

Specifically, the following EPBD requirements have to be addressed:

- The building needs to have a very high energy performance:
  - The amount of energy required should be nearly zero or very low

- The energy required should be covered to a very significant extent by energy from renewable sources
- Inclusion of a numerical indicator of primary energy use expressed in kWh/m² per year
- Primary energy use may be based on national or regional yearly average values and may take into account relevant European standards

For reporting the detailed application in practice of the definition of nearly zero-energy buildings, the table presented in Figure 17 to Figure 19 is to be used. This table has been delivered to the Commission also in a separate MS Excel file. The input provided by the Member States in this taxonomy table will later on used by the Commission to evaluate the definition (see chapter 6.2).

Additionally, the Member States are asked to explain if a national definition of nearly zero-energy buildings does not exist in the specific country, to indicate whether precise plans are already under development and if so, to describe these plans. They are also asked to describe if any current used non-governmental definitions will be considered in these plans and/or a future directive.

5.3.7.3 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings

EPBD Article 9 Paragraph 3(a) stipulates that "national plans shall include (...) intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1 of Article 9 ("(a) by 31 December 2020, all new buildings are nearly zero- energy buildings").

Member States should set targets for 2015 aiming to improve the energy performance of new buildings and enabling a smooth transition towards the full practical implementation of the EPBD for new buildings in 2020. The qualitative and quantitative 2015 targets should be explicitly reported in this section.

The qualitative 2015 targets should be focus on energy related requirements for new residential and non-residential buildings and in this context specifically determine

- Requirements on the fraction of renewable energies:
- Requirements on the useful energy demand:
- Requirements on the primary energy demand:

The quantitative 2015 target should contain the aimed share of nearly zero-energy building according to official nearly zero-energy building definition or a comparable standard on all newly constructed buildings. Here, the reference parameter as for example the number of buildings, floor area, volume etc. has to be defined.

If available, also miscellaneous targets of all kind for residential and commercial nearly zero-energy building should be stated in this chapter.

A distinction should be made between residential and non-residential buildings. A rationale should be given for the definition of the targets and the way in which the set targets relate to and help to achieve that by 31 December 2020, all new buildings are nearly zero-energy buildings (EPBD Article 9 Paragraph 1(a)).

Note: Chapter 3.1.2 of the National energy efficiency action plan "National targets for nearly zero-energy buildings" does also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and, if useful, consider this as an input here.

5.3.7.4 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings

EPBD Article 9 Paragraph 3(a) stipulates that "national plans shall include (...) intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1 of Article 9 ("(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.")

Member States should set targets for 2015 aiming to improve the energy performance of new public buildings and enabling a smooth transition towards the full practical implementation of the EPBD for new public buildings in 2018. The qualitative and quantitative 2015 targets should be explicitly reported in this section.

The qualitative 2015 targets should be focus on energy related requirements for new public buildings and in this context specifically determine

- Requirements on the fraction of renewable energies:
- Requirements on the useful energy demand:
- Requirements on the primary energy demand:

The quantitative 2015 target should contain the aimed share of public nearly zero-energy building according to official nearly zero-energy building definition or a comparable standard on all newly constructed public buildings. Here, the reference parameter as for example the number of buildings, floor area, volume etc. has to be defined.

If available, also miscellaneous targets of all kind for public nearly zero-energy building should be stated in this chapter.

A rationale should be given for the definition of the targets and the way in which the set targets relate to and help to achieve that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings (EPBD Article 9 Paragraph 1(b))

Note: Chapter 3.1.2 of the National energy efficiency action plan "National targets for nearly zero-energy buildings" does also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and, if useful, consider this as an input here.

5.3.7.5 Policies and measures for the promotion of all new buildings being nearly zero-energy buildings after 31 December 2020

EPBD Article 9 Paragraph 3(c) stipulates that "national plans shall include (...) Information on the policies and financial or other measures (...) for the promotion of nearly zero-energy buildings." with view to achieving the goal that "by 31 December 2020, all new buildings are nearly zero- energy buildings" (Article 9, Paragraph 1 (a))

In this section, Member States should report on the measures targeted at all new buildings both private and public. For new buildings, Article 6 of the recast EPBD regulates that "measures should be taken (...) to ensure that new buildings meet the minimum energy performance requirements. "

Guidelines for setting energy performance requirements are set out in Article 4 (1) of the EPBD and include, inter alia, that "minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels."

The reporting in this section should include "details of national requirements and measures concerning the use of energy from renewable sources in new buildings (...)" (Article 9, Paragraph 3(c) of EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that "By 31 December 2014, Member States shall, in their building regulations (...) require the use of minimum levels of energy from renewable sources."

Summarising the above paragraph, the measures should clearly show how they

- promote that by 31 December 2020, all new buildings are nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources (including foreseen minimum requirements in national building codes) in all new buildings;
- increase the energy performance with a view to achieving cost-optimal levels in all new buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). When describing the measures, a differentiation between residential and non-residential buildings should be made. The measures that should be described in the context of this chapter are listed below:

- Relevant regulations
- Relevant economic incentives and financing instruments
- Energy performance certificates' use and layout in relation to nearly zero-energy building standard
- Supervision (energy advice and audits)
- Information (tools)
- Demonstration
- Education and training

For every measure it is recommended to provide all or some of the following information

- Title of the energy saving measure/programme
- Timeframe
- Status and implementation
- What is the approximate total and/or annual budget for the measure?
- Implementing body
- Monitoring authority
- Overlaps
- Energy savings and underlying assumptions

Note: Chapters 3.3.2.1, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP do also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

5.3.7.6 Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero-energy buildings after 31 December 2018

EPBD Article 9 Paragraph 3(c) stipulates that “national plans shall include (…) Information on the policies and financial or other measures (…) for the promotion of nearly zero-energy buildings.” In view of the goal that “after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings” (Article 9, Paragraph 1 (b), recast EPBD)

In this section, Member States should report on the measures targeted at all new buildings owned or occupied by public authorities. For new buildings, Article 6 of the recast EPBD regulates that “measures should be taken (…) to ensure that new buildings meet the minimum energy performance requirements. “

Guidelines for setting energy performance requirements are set out in Article 4 (1) of the EPBD and include, inter alia, that “minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels.”

The reporting should include “details of national requirements and measures concerning the use of energy from renewable sources in new buildings (...)” (Article 9, Paragraph 3(c), recast EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that “By 31 December 2014, Member States shall, in their building regulations (…) require the use of minimum levels of energy from renewable sources.”

Summarising the above paragraph, the measures should clearly show how they

- promote that after 31 December 2018, all new public buildings are nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources in public buildings;
- increase the energy performance with a view to achieving cost-optimal levels in public buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). The measures that should be described in the context of this chapter are listed below:

- Relevant regulations
- Relevant economic incentives and financing instruments
- Energy performance certificates’ use and layout in relation to nearly zero-energy building standard
- Supervision (energy advice and audits)
- Information (tools)
- Demonstration
- Education and training

For each measure it is recommended to provide all or some of the following information

- Title of the energy saving measure/programme
- Timeframe
- Status and implementation
- What is the approximate total and/or annual budget for the measure?
- Implementing body
- Monitoring authority
- Overlaps
- Energy savings and underlying assumptions

Note: Chapters 3.3.2.1, 3.4.2, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP do also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

5.3.7.7 Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero-energy buildings

In this section, measures taken to promote the transformation of both private and public existing buildings into nearly zero-energy buildings should be reported pursuant to Article 9, Paragraph 2 of the recast EPBD: "Member States shall furthermore, following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings (...)".

With regard to existing buildings, EPBD Article 7 provides that "Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements (...)".

These requirements should be "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." while "Member States may differentiate between new and existing buildings" (Article 4 (1) of the EPBD.

The reported measures should ensure "the promotion of nearly zero-energy buildings (...) concerning the use of energy from renewable sources in (...) existing buildings undergoing major renovation" (Article 9, Paragraph 3(c), recast EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that "by 31 December 2014, Member States shall, in their building regulations (...) require the use of minimum levels of energy from renewable sources."

Summarising the above paragraph, the measures should additionally show how they

- stimulate the transformation of buildings (both public and private) that are refurbished into nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources in the existing building stock;
- increase the energy performance of existing buildings with a view to achieving cost-optimal levels;

- assure that the public sector takes up a leading example in transforming existing buildings into nearly zero-energy buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). When describing the measures, also a differentiation between residential and non-residential buildings should be made. The measures that should be described in the context of this chapter are listed below:

- Relevant regulations
- Relevant economic incentives and financing instruments
- Energy performance certificates' use and layout in relation to nearly zero-energy building standard
- Supervision (energy advice and audits)
- Information (tools)
- Demonstration
- Education and training

For every measure it is recommended to provide all or some of the following information

- Title of the energy saving measure/programme
- Timeframe
- Status and implementation
- What is the approximate total and/or annual budget for the measure?
- Implementing body
- Monitoring authority
- Overlaps
- Energy savings and underlying assumptions

Notice: Chapters 3.3.2.1, 3.4.2, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP do also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

6 Task 3: Benchmarks for nearly zero-energy buildings for different European climate zones and analytical framework for assessing national plans and definitions

6.1 Task 3a: Development of representative benchmarks for nearly zero-energy buildings

6.1.1 Overview

In order to (i) show an example of transparent methodology that might be a useful model for MS reporting and Commission analysis, (ii) derive benchmarks for nearly zero-energy buildings, (iii) discuss their connection with cost-optimal methodology and results,

we developed and present here a methodology to construct building variants including nearly zero energy. For the selected climate conditions and building prototypes the **energy needs** for heating and cooling, the **delivered energy** for heating, cooling, hot water and lighting, and finally **the net primary energy** is calculated for each variant.

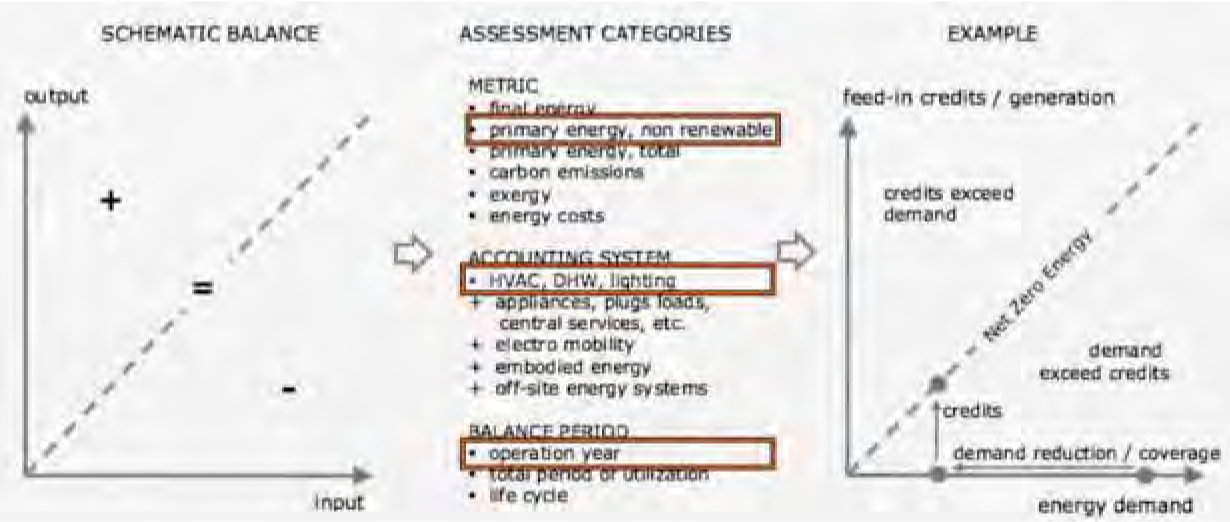

Figure 28 – Balancing approach for benchmark calculations

We apply our calculation example by using the "**Net ZEB limited**" definition, that is we calculate the **net primary energy** (**over a year, and using symmetric weighting**) associated to heating, domestic hot water, ventilation, auxiliaries, built in lighting, but **we exclude the electric consumption of appliances and other plug loads** (although we consider their effects on thermal energy needs). For the sake of comparison, we consider lighting both in non-residential and residential buildings. For better precision and following the recommendation of the Cost-optimal framework methodology, the energy need calculation is performed using fully dynamic methods.

The overall methodology includes the following main steps:

- For the main models of buildings (head-models) where the selected Energy Efficiency **envelope technologies** and combinations thereof are implemented, calculation of the energy needs for heating and cooling are executed by using the dynamic simulation software EnergyPlus (in order to correctly take into account dynamic phenomena connected to energy storage and release connected to thermal mass, as required by EPBD and as physically relevant due to variable weather conditions and internal loads).
- Generation of building families (group of variants related to opaque envelope (symbol “e” in subsequent graphs), glazing and air tightness (“w”), passive cooling techniques (“c”), plus plant variants) by variation of Energy Efficient **system / plant technologies** for each head-model and calculation of delivered energy values for each building family; the assessment has been performed by associating appropriate performance coefficients to each plant type (including generation, distribution and emission efficiency values).
- For the buildings that include RES plants, calculation of the **amount of renewable energy generated** and calculation of net (over a time lapse of one year) primary energy consumption for all building families; the conversion factors of delivered energy to primary energy in the different countries/regions has been taken into account.
- Association of installation costs to each technology, including labour costs.
- Calculation of global costs, including capital costs, substitution costs, salvage costs, operating energy costs, over a period of 30 years, all discounted to year zero (where year zero is either 2010 or 2020).
- Note that embedded energy (also called gray energy) is not included in the calculation, which does not exclude the possibility that a MS might decide to include it in the definition and calculation.

In order to be consistent with the EU process of implementation of EPBD and allow a discussion of the relationship between nearly zero-energy and cost-optimal, our methodology is coherent with the cost-optimal methodology framework.

In accordance with Article 5 and Annex III of Directive 2010/31/EU [European Parliament And Council 2010], EU Guidelines [European Commission 2012a] and Regulation (EU) N° 244/2012 [European Commission 2012b], the Commission established 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 specifies how to compare energy efficiency measures, measures incorporating renewable energy sources and packages of such measures in relation to their energy performance and the cost attributed to their implementation and how to apply these to selected reference buildings with the aim of identifying cost-optimal levels.

The complete process to assess and report on cost optimal levels for energy performance requirements of buildings is described in Figure 29. Such picture includes also a schematic description of a plausible process for setting minimum performance requirements, which is **not** the focus of the present study.

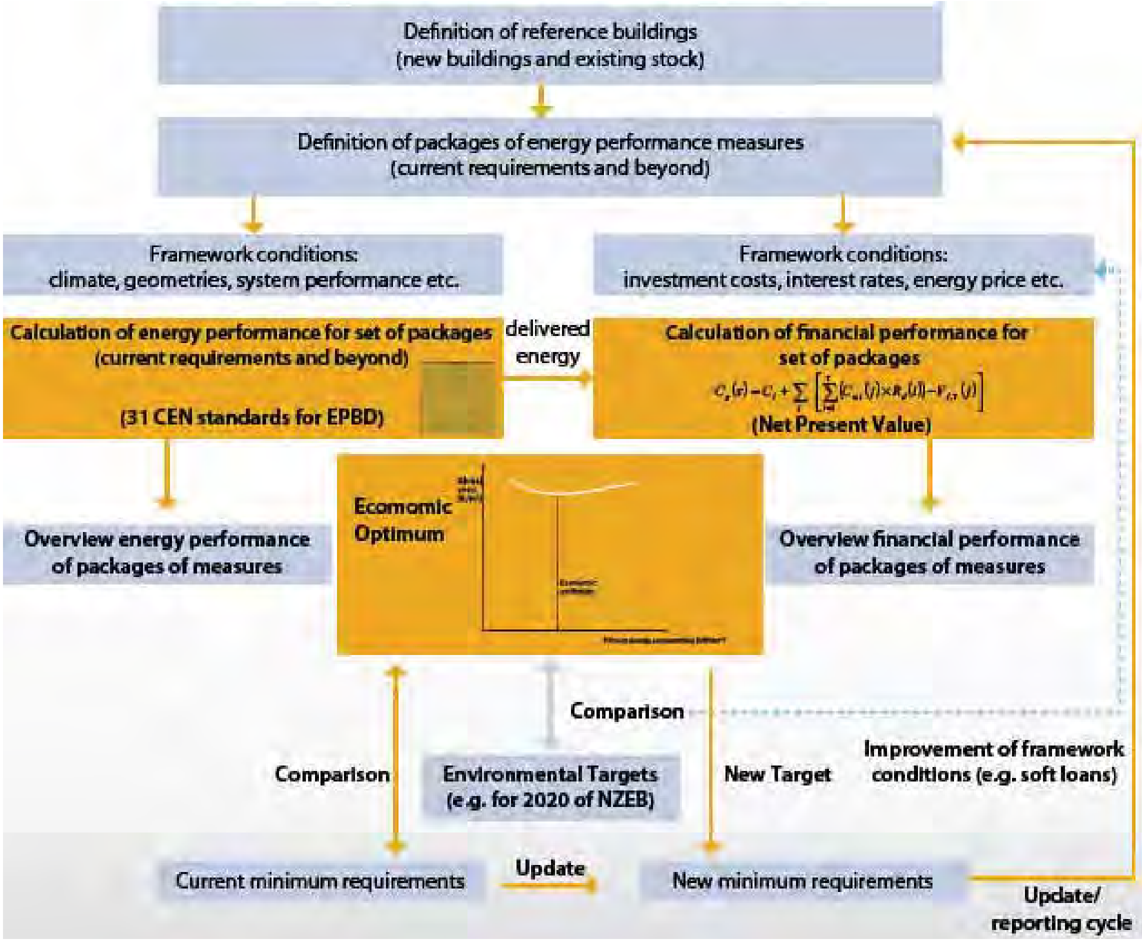

Figure 29. Flowchart comparative methodology. Reproduced from [BPIE 2010]

The detailed calculation methodology for energy performance and global cost proposed by the EU Regulation N° 244/2012 [European Commission 22012b] and the Commission's Guidelines [European Commission 22012a], can be summarized *via* the following Figure 30 and Figure 31. Note that the time interval on which the balance is calculated (e.g. a day, a month, a year) should always be explicitly stated. It is noted that Figure 30 is equivalent to figure 1 of the Guidelines for application of the Cost-Optimal framework methodology with addition of some explanatory note by the authors.

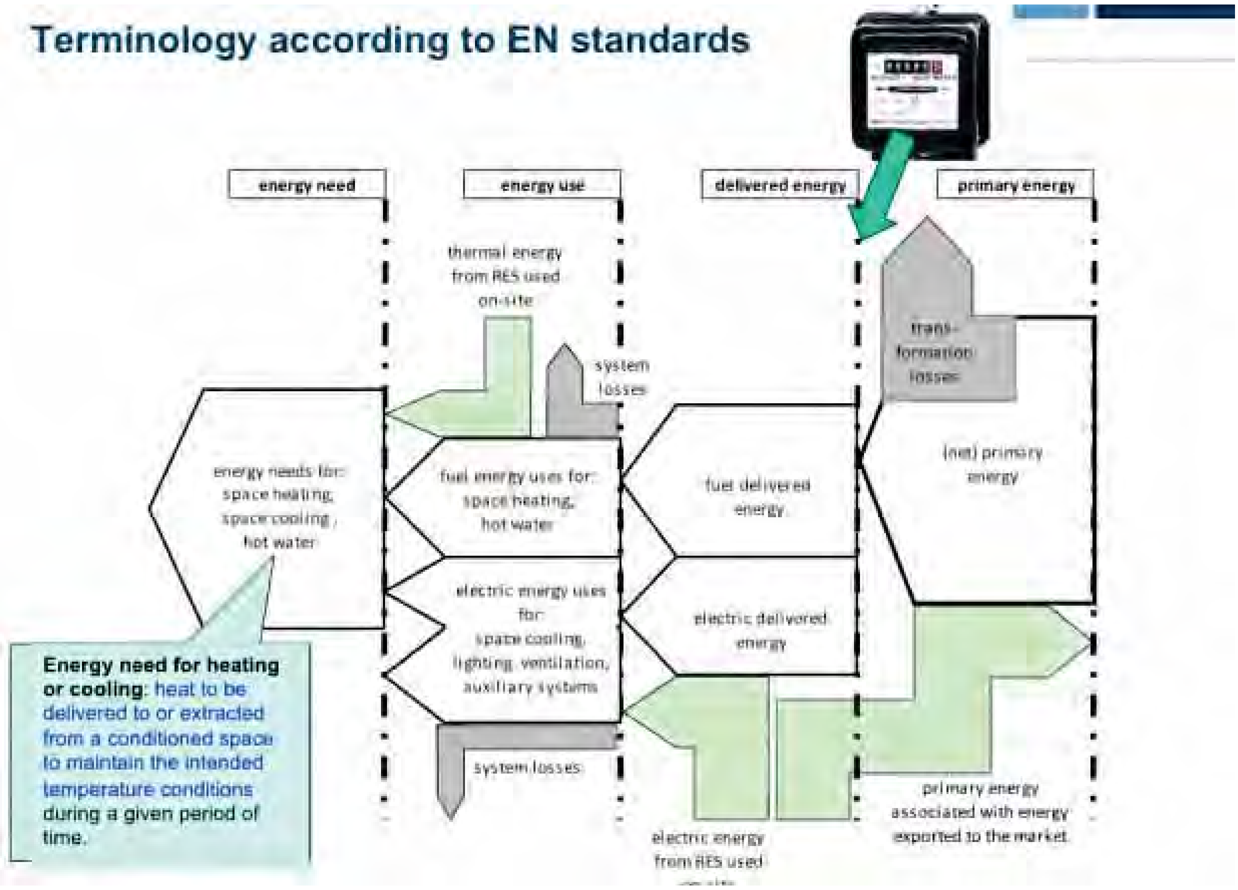

Figure 30. Scheme of calculation of the (net) primary energy demand resulting from the application of measures and packages of measures to a reference building.

In particular, about the energy performance calculation, we are performing the following steps:

1. Selection of efficiency technical solutions and their grouping into typical packages (since very often these technical solutions are not used as stand-alone measures but in combination with other measures), based on the definition of the reference base case (see below).
2. Calculation of energy needs for heating and cooling and energy use for lighting for main models of buildings (head-models) for which simulations are performed where the selected EE-envelope technologies and combinations thereof are implemented; we are carrying out this quantitative assessment by dynamic simulations (by using the EnergyPlus software).
3. Generation of building families by variation of EE-system technologies for each head-model (building families (group of variants related to opaque envelop (e), glazing and air tightness (w), passive cooling techniques (c), plus plant variants verifying that the system architecture is coherent) and calculation of delivered energy values for each building; the energy saving assessment are performed by associating appropriate performance coefficients to each plant type, in accordance with EN standards and other bibliographic references.

4. Addition of energy uses for mechanical ventilation and auxiliary systems calculated by dynamic simulation or estimated through a simplified dimensioning.

5. Inclusion of energy generation from RES systems (such as solar thermal panels, photovoltaic panels,...) by simple estimation methods and calculation of **net** (**over a time laps of one year**) primary energy consumption for the entire building; the delivered-to-primary conversion factors of the different countries/regions are taken into account.

The term **(net)** primary energy means – as recommended in 2012/C 115/01, page 10 [EU 2012] – the result of the following steps (see also Figure 30 above):

- (6) Calculation of the primary energy associated with the delivered energy, using national conversion factors;
- (7) Calculation of primary energy associated with energy exported to the market (e.g. generated by RES or co-generators on-site);
- (8) Calculation of primary energy as the difference between the two previous calculated amounts: (6) - (7).

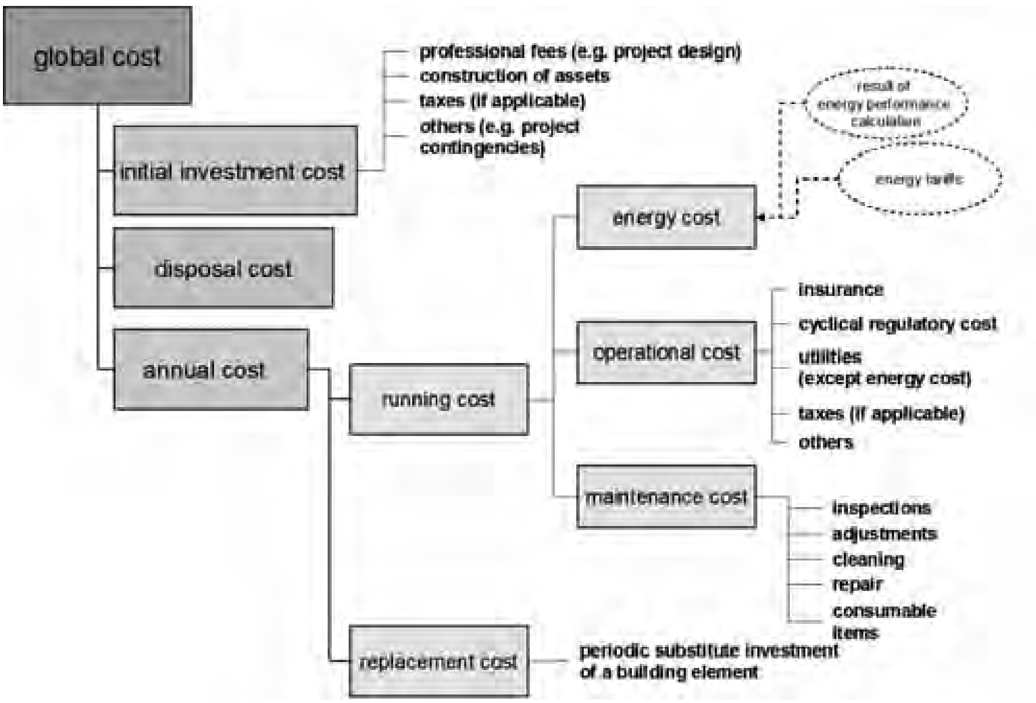

Figure 31. Scheme of calculation of the global cost in terms of net present value for each building variant.

6.1.2 Selection of target climatic condition

Characterization of climate zones can be used for various objectives for example

- To orient the design process of low energy buildings by suggesting the suitability of certain techniques to various certain climatic zones,
- Or to normalise energy consumption to a limited number of variables in order to make possible (to some degree) extrapolation of performances calculated for one climate zone and building to other climate zones.

Within the methods suited to the first objective are methods like Olgyay's chart, Köppen- Geiger climate classification [Peel et al. 2007] and its updates, and other classification schemes developed and/or used as design guidance.

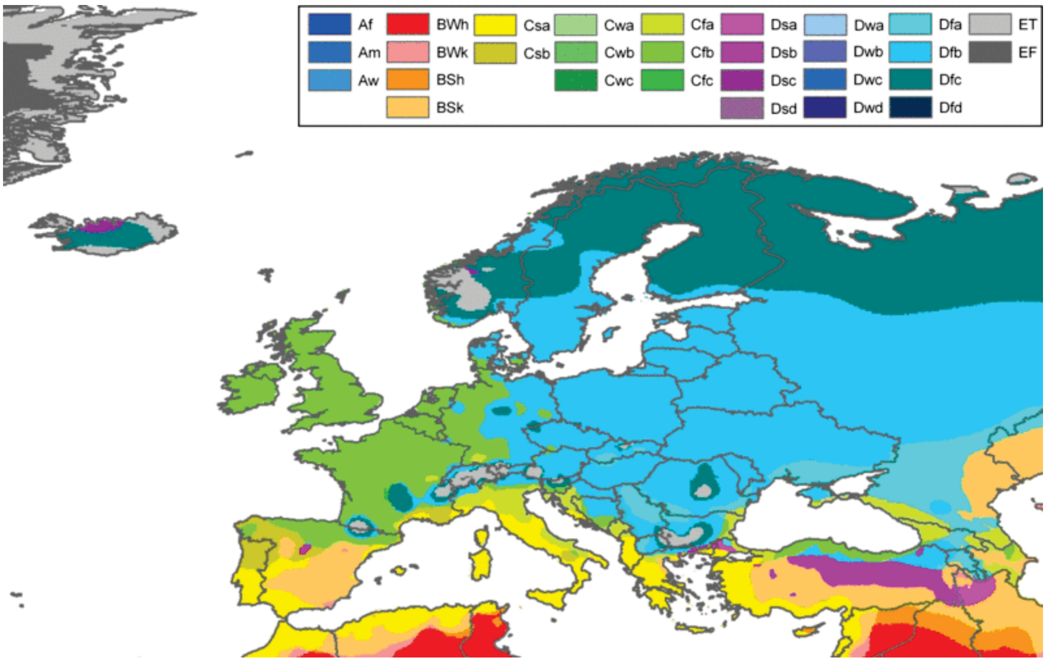

Figure 32. European climate classification of Köppen. Reproduced from [Peel et al. 2007]

Within the methods suited to the second objective one can enumerate e.g. the Degree-Day method, the Climate Severity Index method developed by Markus et al. [Markus et al. 1984], Keller's method [Keller et al. 2004] and others.

The definition for relevant climates by using degree-days has the advantage of being relatively simple and the disadvantage of considering only air temperature as driving force and disregarding all the others (solar radiation, wind, ...). Classification of climate based on heating and cooling degree-days have been proposed e.g. in the EU projects SolarCombi+ and KeepCool 2. Caution should be used since the value of degree-days depends on the assumed indoor reference or base temperature and on whether the time step used for the calculation is 24 hours or finer, so harmonization should be ensured beforehand.

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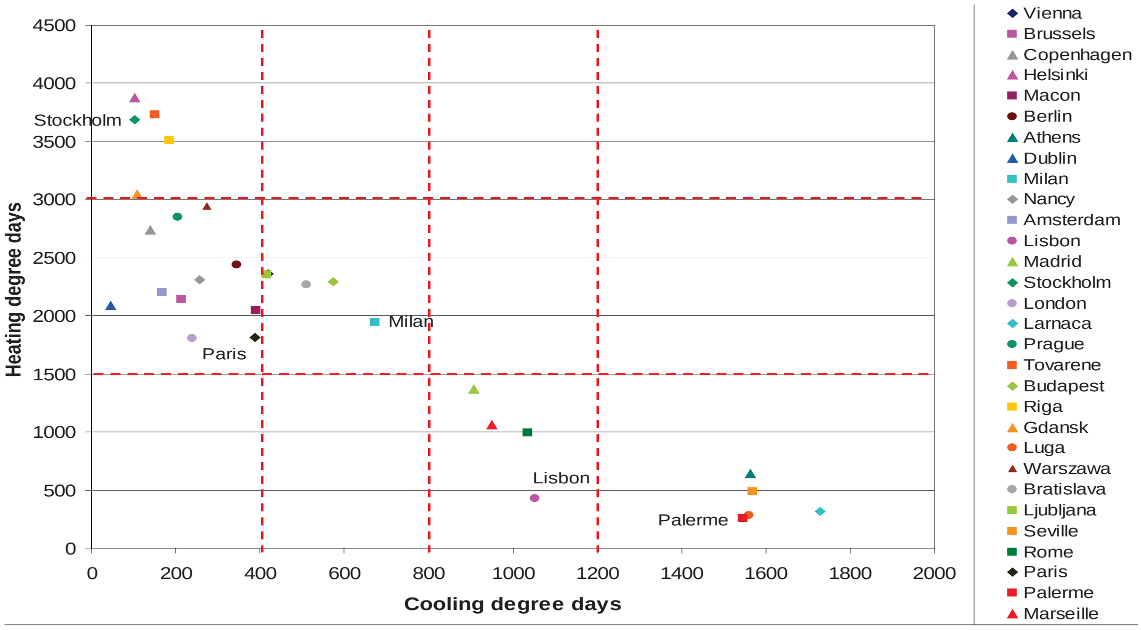


Figure 33. Heating degree-days and cooling degree-days for 30 European cities. Reproduced from [KeepCool2 2010].

The Climate severity Index, developed at the University of Strathclyde in the 80s [Markus 1982, Markus et al. 1984] originally proposes ways to derive, via detailed simulations of a defined building, a correlation between the energy demand of that building, three climatic variables and three physical parameters describing the building itself. It is hence not a description of the climate per se but a description of the behaviour of a certain building within a range of climates. It has been subsequently used to propose correlations between the average consumption of a mix of building prototypes and two or three climatic variables. Caution should be used in the choice of the building prototypes, since buildings with poor or advanced envelope features will result in quite different values of this aggregated index. A better level of correlation might be achieved for smaller regions that the entire EU, e.g. at national level with relatively homogeneous construction traditions. More recently some climate classification methods have been proposed, which are based on estimates of the energy saving potential of certain passive techniques and are independent of the building typology. For example maps of the potential savings by night ventilation cooling have been produced for Europe [Artmann et al. 2007] .

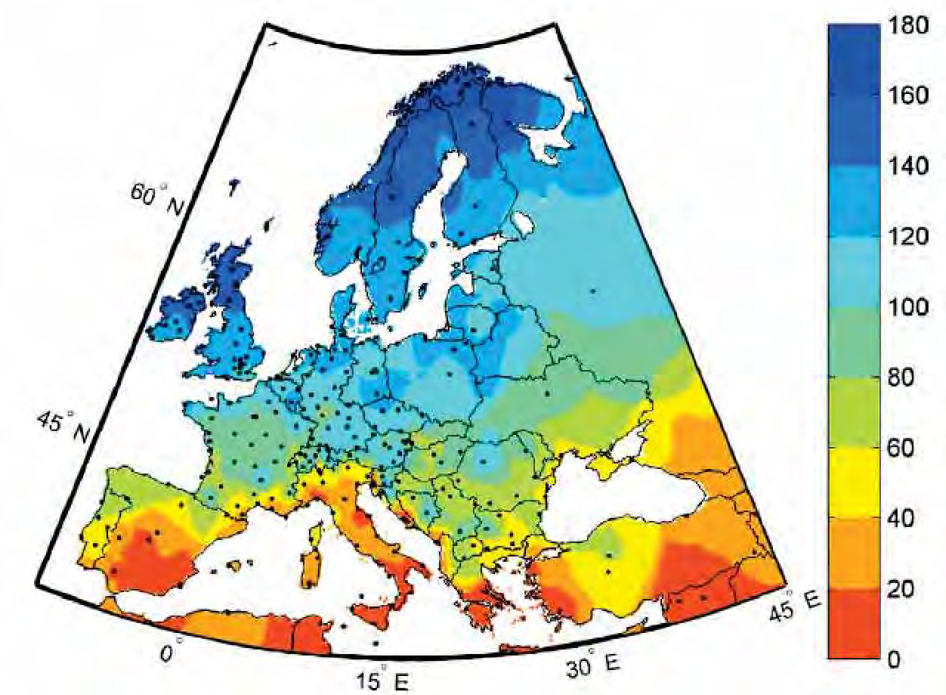


Figure 34. Map of mean cooling potential by night ventilation (Kh/night) in July based on Meteonorm data. Reproduced from [Artmann et al. 2007]

In accordance with the work programme of the project we concentrate on calculating limiting cases and on the construction of the cost/energy curves in order to give practical support for the evaluation activities of Nearly Zero-Energy Building plans of by the Commission and to investigate the relationship between cost-optimality and nearly zero-energy. Based on the review of climate data, four cities/climate conditions have been chosen as boundary conditions for the calculation of benchmarks. Weather data used are coherent with international standards.

Table 16. Repartition of 30 European cities in five European zones based on global radiation, cooling degree-days, heating degree-days and cooling potential by night ventilation.

	Cities	Representative Cities
Zone 1	Athens - Larnaca - Luga - Catania – Seville - Palermo	Catania
Zone 2	Lisbon - Madrid - Marseille - Rome	-
Zone 3	Bratislava - Budapest - Ljubjana - Milan - Vienna	Budapest
Zone 4	Amsterdam - Berlin – Brussels - Copenhagen - Dublin - London - Macon - Nancy - Paris - Prague - Warszawa	Paris
Zone 5	Helsinki - Riga - Stockholm – Gdansk - Tovarene	Stockholm

In order to obtain consistent and reliable results we are carrying out the thermo-energetic simulations of our reference building models using Typical Meteorological Years (TMY), specific weather files based on the latest 15 years and built by integrating hourly weather station observations and the new NOAA reanalysis data sets [NOAA 2013], rather than data sets based on previous decades. In some MS also data sets representing future climate and taking into account the climate modifications foreseen by climatic models are available and are to be taken into account while planning for buildings which will extend their lifes for many decades into the future. Not having those data sets available for all the considered climates, in this report we consider climatic data sets based on the latest 15 years.

6.1.3 Definition of reference building types

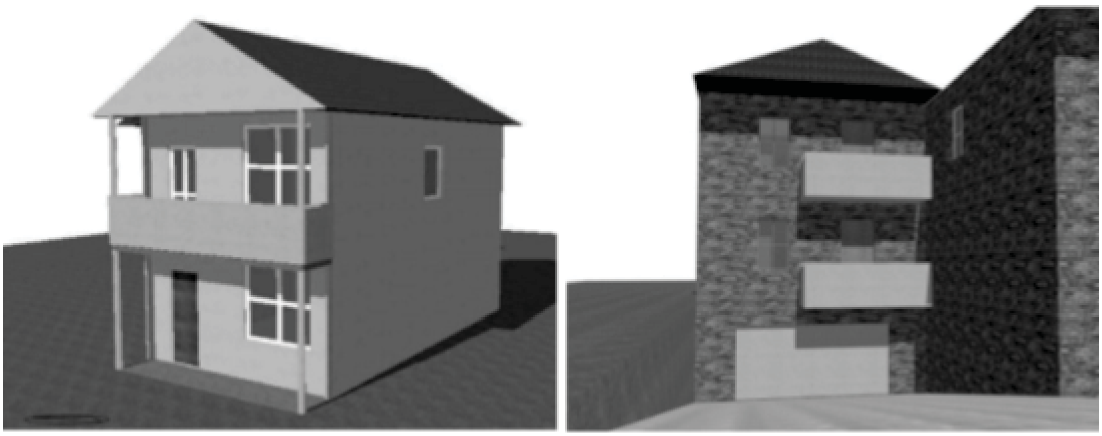
In order to show an example of the proposed calculation and format for the presentation of results two building types are considered within two building sectors: residential (single-family house) and tertiary (office building).

For establishing the reference building we considered already existing studies and databases of reference buildings and the work carried out under the Intelligent Energy Europe programme, especially within the EU projects KeepCool 2 [KeepCool2 2010] and Passive-On [Ford et al. 2007].

We give in the following chapters a short description of the selected prototypes.

6.1.3.1 Single family house

We considered a terraced-two-floor house (located at the end of the row) with a habitable net area of about 100 m², comprising a basement, ground and first floor. A stairwell links the basement, the living area on the ground floor and the sleeping area on the first floor. This typology has a surface-volume ratio relatively large and hence unfavourable to low energy buildings, but it is considered here due to its relatively large share in new housing construction in countryside and suburban areas in the last years.



a) South and East façades **b) North façade**

Figure 35. Perspective views of the reference building.

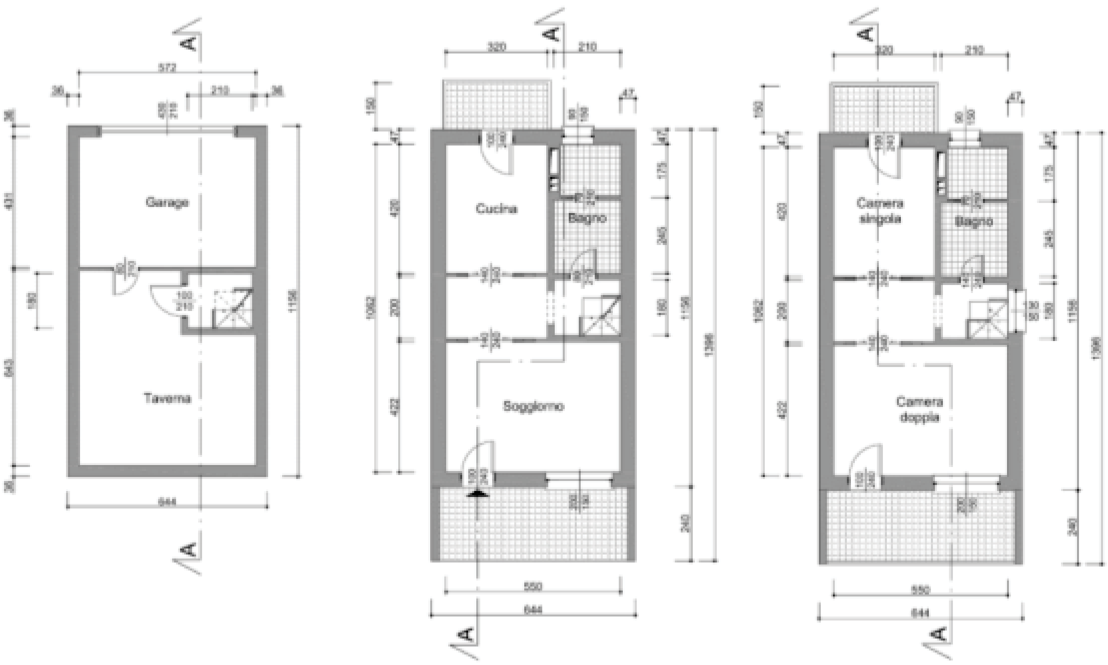
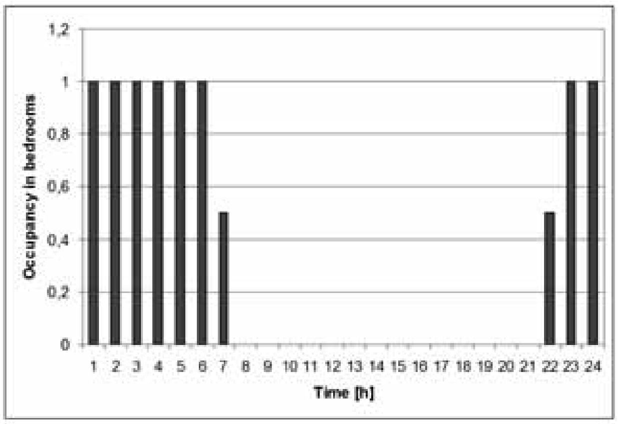
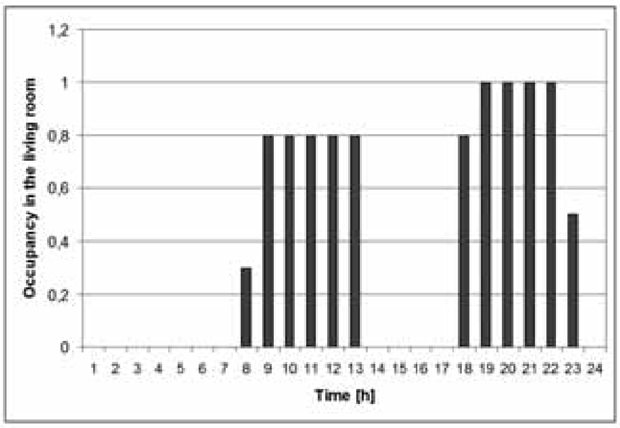


Figure 36. House plans for basement (on the left), ground (center) and first floor (on the right).

The house is supposed to be used by two adults and two children. About internal loads, we considered different occupation densities (normalised to an adult, considered to contribute a heat gain of 120 W at 1,2 met) in the different building rooms: one person per 10 m² in the bedrooms, one person per 6.6 m² in the living room and one person per 5,5 m² in the kitchen. Moreover different occupation profiles have been defined for each room and distinguishing between weekdays and weekends/holidays. Some occupation schedules are (% with respect to occupation at maximum density) given in Figure 37.



Bedrooms - Monday to Friday

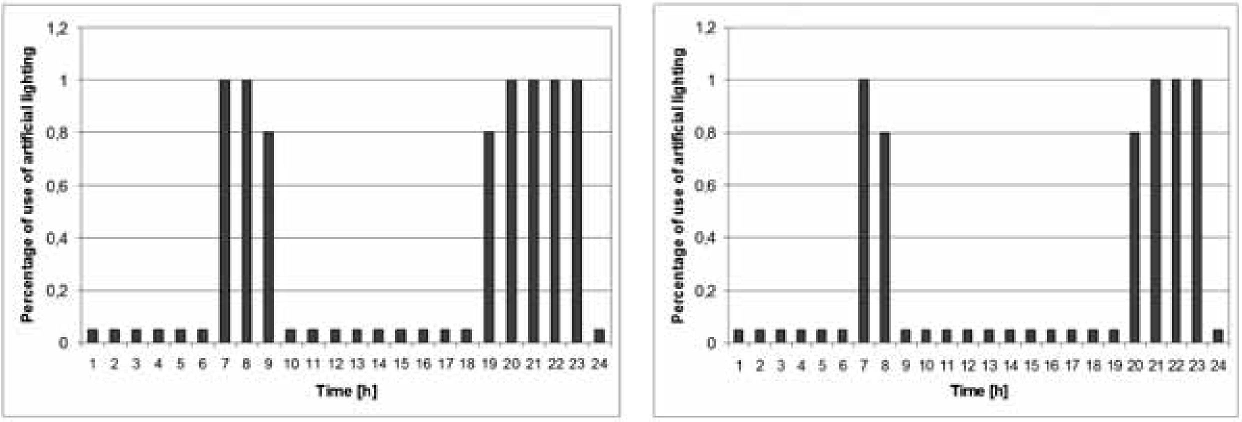


Living room - Week-end

Figure 37. Example of occupancy profiles.

To define loads and use profiles of lighting and appliances, the results of previous projects SAVE Eureco *“Measurements and analysis of energy consumption and power load profiles of refrigeration, space conditioning, heating ancillary equipment and other appliances in 410 households”* [Alari et al. 2000] and IEE Remodece *“Analysis of monitoring campaign in Europe, Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe”* [Grinden and Feilberg 2008] have been considered.

The max lighting power in simultaneous use is assessed to be 5 W/m² and the load profile (expressed as percentage of use of above) for the artificial lighting is given in Figure 38.



from October 1 to March 31 | from April 1 to September 30

Figure 38. Lighting profile in the reference house.

Also the electric power used and released as heat by the appliances (when in use) is differently sized depending on the room: 7 W/m² in the bedroom, 10 W/m² in the living room and 45 W/m² in the kitchen.

For the bedroom, this load occurs during the first and last hour of occupation whereas in both other zones it occurs as soon as there is an occupant. When there is no occupation, appliances are operating in “parasitic” mode (stand by, off mode) for which the power is assumed to be 5% of the installed load.

While the geometry, the schedules of use and the internal loads have not been changed; we varied the characteristics of the envelope and of heating/cooling systems in order to obtain two reference configurations, respectively for new and existing buildings. They are described briefly in the following tables.

Table 17. Reference single house: configuration for new buildings (for Paris and Budapest)[3].

<table>
<tr><th colspan="2">For new buildings</th><th>Single house</th></tr>
<tr><td rowspan="7">Building geometry</td><td>N° of heated floor =</td><td>2</td></tr>
<tr><td>A / V ratio =</td><td>0,88 m^2/m^3</td></tr>
<tr><td>Orientation:</td><td>S/N</td></tr>
<tr><td>Area of S façade =</td><td>33 m^2</td></tr>
<tr><td>Area of E façade =</td><td>64 m^2</td></tr>
<tr><td>Area of N façade =</td><td>33 m^2</td></tr>
<tr><td>Area of W façade =</td><td>64 m^2</td></tr>
<tr><td colspan="2">Ratio of window area to building envelope area =</td><td>8%</td></tr>
<tr><td colspan="2">Floor area m^2 (as used in building code) =</td><td>117 m^2 (net) ; 143 m^2 (including walls)</td></tr>
<tr><td rowspan="4">Description of the building</td><td>Construction materials:</td><td>Hollow brick, concrete, insulation materials, plaster</td></tr>
<tr><td>Typical infiltration rate[4]:</td><td>Ach = 0,5 h^{-1}</td></tr>
<tr><td>Use pattern:</td><td>Typical</td></tr>
<tr><td>Age:</td><td>Typical for year 2011</td></tr>
<tr><td rowspan="7">Description of the average building technology</td><td>U value of wall =</td><td>0,32 W/m^2K</td></tr>
<tr><td>U value of roof =</td><td>0,30 W/m^2K</td></tr>
<tr><td>U value of basement =</td><td>0,32 W/m^2K</td></tr>
<tr><td>U value of windows =</td><td>2,00 W/m^2K</td></tr>
<tr><td>g value of windows =</td><td>0,6</td></tr>
<tr><td>Technical building systems:</td><td>Condensing gas boiler, insulated distribution, radiant floor, medium efficient air conditioner split system, solar plant (hot water)</td></tr>
<tr><td>Passive systems:</td><td>No solar shading device[5]</td></tr>
</table>

[3] For the climates of Stockholm and Catania the reference case configuration is obviously coherent with the climate and national context and hence different from the configuration reported here. The table is meant as an example of which data would be useful to make explicit in the reports.
[4] Infiltration rate (average over one year) calculated with airflownetwork, assuming that windows and external doors have an air tightness of class 2, according to the classification established in EN 12207.
[5] In Catania the reference case configuration includes external solar shading with g-value of 0.3 when fully closed.

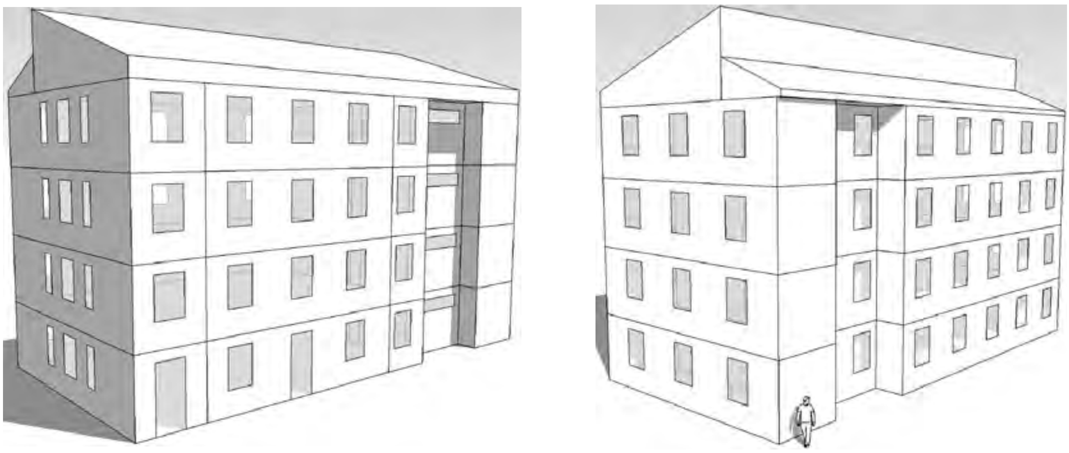
Table 18. Reference single house: configuration for existing buildings (for Paris and Budapest)[6]. (before refurbishment).

For existing buildings		Single house
Building geometry	N° of heated floors =	2
	A / V ratio =	0,88 m^2/m^3
	Orientation:	S/N
	Area of S façade =	33 m^2
	Area of E façade =	64 m^2
	Area of N façade =	33 m^2
	Area of W façade =	64 m^2
Ratio of window area to building envelope area =		8%
Floor area m^2 (as used in building code) =		117 m^2 (net) ; 143 m^2 (including walls)
Description of the building	Construction materials:	Hollow brick, concrete, air gap, plaster
	Typical air infiltration rate[7]:	Ach = 0,8 h^{-1}
	Use pattern:	Typical
	Age:	Typical for years '60-'80
Description of the average building technology	U value of wall =	1,20 W/m^2K
	U value of roof =	1,40 W/m^2K
	U value of basement =	2,10 W/m^2K
	U value of windows =	3,50 W/m^2K
	g value of windows (in absence of solar shading)=	0,8
	Technical building systems:	Standard gas boiler, not insulated distribution, radiators, low efficient air conditioner split system.
	Passive systems:	No solar shading device[8]

[6] For the climates of Stockholm and Catania the reference case configuration is obviously coherent with the climate and national context and hence different from the configuration reported here. The table is meant as an example of which data would be useful to make explicit in the reports.
[7] Infiltration rate (average over one year) calculated with airflownetwork, assuming that windows and external doors have an air tightness of class 1, according to the classification established in EN 12207.
[8] In Catania the reference case configuration includes external solar shading with g-value of 0,3 when fully closed.

6.1.3.2 Office building

As reference of office building, a medium-size office building has been selected, with 4 floors of 3 m height each (Figure 39). The repartition of internal spaces is given in Figure 40.



- a -   - b -

Figure 39. Perspective views of the reference building: a) North and West façades; b) South and East façades.

Figure 40. Floor plan of the reference office building.

We considered an occupation density of 10 m^2/person in offices. Assuming 1,2 met, corresponding to 120W/person for an adult, this results in a thermal gain of 8,75 W/m^2 oin average over all usable surface when occupation is a 100%. We assumed the schedules of occupation shown in Figure 41.

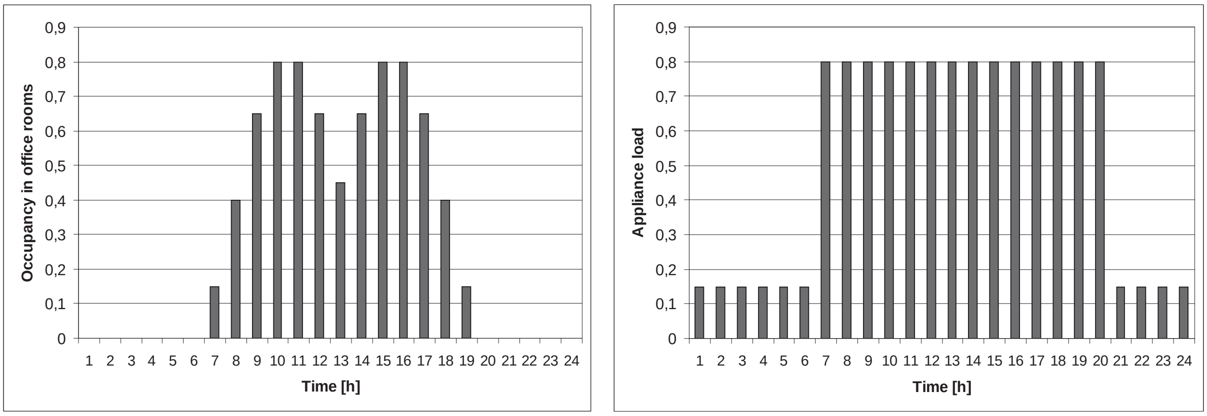
To define loads and use profiles of lighting and appliances, we considered the results of the IEE project EL-TERTIARY *"Monitoring Electricity Consumption in the Tertiary Sector"* [Gruber et al. 2008].

The installed lighting power is assumed to be 10 W/m² in office rooms, 7 W/m² in the circulation areas and toilets. Artificial lighting is supposed to be switched off during non-occupancy hours and when daylighting is able to provide 500 lux on the visual task area (we allow for lower illuminance levels in less crucial areas, according to EN 12464-1 "Light and Lighting – Lighting of workplaces").

For natural illuminances lower than 500 lux, daylighting is integrated by artificial lighting, using dimmers controlled in such a way to obtain a total of 500 lux.

As for the control of solar shading, they are set in such a way to avoid direct beam entering the space, when solar irradiance on the window is higher than 200 W/m^2.

As for office appliances, an installed power of 10 W/m^2 is assumed.



- a - - b -

Figure 41. Occupancy (a) and appliances (b) profile compared to the sizing value[9].

The new and existing reference office buildings are described briefly in the following tables and for further details see appendixes.

[9] e.g. 0,8 means that 80% of installed power is actually switched on during a certain time interval.

Table 19. Reference office building: configuration for new buildings (for Paris and Budapest)[10].

For new buildings		Office building
Building geometry	N° of floor =	4
	A / V ratio =	0,47 m^2/m^3
	Orientation:	S/N
	Area of N façade =	262 m^2
	Area of N façade =	128 m^2
	Area of N façade =	262 m^2
	Area of N façade =	128 m^2
Shares of window area on the building envelope =		16%
Floor area m^2 (as used in building code) =		924 m^2 net floor area
Description of the building	Construction materials:	Hollow brick, concrete, air gap, plaster
	Typical air infiltration rate[11]:	Ach = 1 h^{-1}
	Use pattern:	Typical
	Age:	Typical for year 2010
Description of the average building technology	U value of wall =	0,32 W/m^2K
	U value of roof =	0,30 W/m^2K
	U value of basement =	0,33 W/m^2K
	U value of windows =	2,00 W/m^2K
	g value of windows (in absence of solar shading) =	0,6
	Technical building systems:	Standard gas boiler, not insulated distribution, radiators, low efficient chiller, mechanical ventilation
	Passive systems:	No solar shading device[12]

[10] For the climates of Stockholm and Catania the reference case configuration is obviously coherente with the climate and national context and hence different from the configuration reported here. The table is meant as an example of which data would be useful to make explicit in the reports.
[11] Infitration rate (average over one year) calculated with airflownetwork, assuming that windows and external doors have an air tightness of class 2, according to the classification established in EN 12207.
[12] In Catania the reference case configuration includes external solar shading with g-value of 0,3 when fully closed.

Table 20. Reference office building: configuration for existing buildings (for Paris and Budapest)[13]. (before refurbishment).

For existing buildings		Office building
Building geometry	**N° of floor =**	4
	A/V ratio =	0,47 m^2/m^3
	Orientation:	S/N
	Area of S façade =	262 m^2
	Area of E façade =	128 m^2
	Area of N façade =	262 m^2
	Area of W façade =	128 m^2
Shares of window area on the building envelope =		16%
Floor area m^2 (as used in building code) =		924 m^2
Description of the building	**Construction materials:**	Hollow brick, concrete, air gap, plaster
	Typical air infiltration rate:	Ach[14] = 2,5 h^{-1}
	Use pattern:	Typical
	Age:	Typical for years '60-'80
Description of the average building technology	**U value of wall =**	1,20 W/m^2K
	U value of roof =	1,40 W/m^2K
	U value of basement =	2,10 W/m^2K
	U value of windows =	3,50 W/m^2K
	g value of windows (in absence of solar shading)=	0,8
	Technical building systems:	Standard gas boiler, distribution pipes without insulation, radiators, low efficient chiller, mechanical ventilation
	Passive systems:	No solar shading device[15]

6.1.4 Identification of technical packages

In order to compile packages of measures to increase the energy performance compared to the reference cases, technologies and techniques from the following groups have been taken into account:

[13] For the climates of Stockholm and Catania the reference case configuration is obviously coherent with the climate and national context and hence different from the configuration reported here. The table is meant as an example of which data would be useful to make explicit in the reports.
[14] Infiltration rate (average over one year) calculated with airflownetwork, assuming that windows and external doors have an air tightness of class 1, according to the classification established in EN 12207
[15] In Catania the reference case configuration includes external solar shading with g-value of 0,3 when fully closed

- Building envelope: measures that deal primarily with the reduction of heat transmission and improved air tightness of the building envelope with the intention of reducing transmission losses and losses from (uncontrolled) air-exchange.
- Space heating: an active system is usually necessary to meet the demand for heating. This demand can be met by efficient and/or renewable energy systems (e.g. condensing boilers, heat pumps, thermal solar panels, ...) in conjunction with suitable storage and distribution systems.
- Domestic hot water: DHW is often produced with the same system used for space heating, but it can also be supplied by combined systems (e.g. when integrating solar energy systems with a generator using fuel or electricity) or separate systems. High efficient storage and distribution systems are crucial for reducing heat losses along all the chain.
- Ventilation systems: mechanical ventilation systems allow having control on the air-change rates necessary for IAQ and can also limit losses from air-exchange if heat recovery systems are installed. Ventilation and heat recovery can have both a centralised or decentralised layout, with the latter sometimes easier to use in retrofit work.
- Cooling: passive cooling systems such as shading devices, night ventilation coupled with exposed mass, etc., can help reduce or avoid cooling needs to be met by active systems.
- Lighting: In this report only the base case is analysed (e.g., in offices 10 W/m^2 installed power, efficient occupancy and daylighting controls); **further possible variants with energy efficiency measures for artificial lighting or for increasing daylighting use are NOT included.** So applications to increase the use of daylight (e.g., light shelves, prismatic glazing, light pipes, etc.) and improvements for artificial lighting (e.g., higher efficiency light sources, finer tuned distribution of illuminance values according to visual tasks, etc.) able to reduce installed power and energy use compared to the base case are not considered here.

About the envelope measures, keeping the building geometries/orientations and the use schedules fixed, in this report we present an example where we chose to simulate the effect of five technological packages of increasing performance (low, medium-low, medium, medium-high, high) in the three technology areas:

- Opaque envelope **(e)**
- Windows (frame and glazing) **(w)**
- Solar protection and passive cooling **(c)**

combining them in three steps of variation (Table 21) for each area. Please note that the three steps are different in different cities in order to take into account the climate.

In table 6 we present:

- the symbols with which this packages variants will be indicated in the results,
- the values corresponding to each level of performance,
- which packages have been used in each climate.

Table 21. Envelope families considered in this analysis: South - West

Package	Measure	SOUTH: Catania (IT)						WEST: Paris (FR)					
		Family 1		Family 2		Family 3		Family 1		Family 2		Family 3	
"e"	Roof U-value [W/m^2K]	low: "-"	1.5	medium-low: "o-"	0.38	medium-high: "o+"	0.2	low: "-"	1.5	medium: "o"	0.3	high: "+"	0.1
	Wall U-value [W/m^2K]		1		0.48		0.23		1		0.32		0.14
	Basement U-value [W/m^2K]		2.1		0.49		0.26		2.1		0.32		0.2
"w"	Window U-value [W/m^2K]	low: "-"	5.2	medium-low: "o-"	3	medium-high: "o+"	1.4	low: "-"	3	medium: "o"	2	high: "+"	0.8
	Air infiltration rate: ach [16] [h^{-1}]		0.8		0.5		0.3		0.8		0.5		0.1
"c"	Total solar transmittance (or g-value) (window + shading)	low: "-"	0.8	medium-high: "o+"	0.3	high: "+"	0.1	low: "-"	0.8	medium-low: "o-"	0.6	medium-high: "o+"	0.3
	Night natural ventilation rate[17]: ach [h^{-1}]		0		2		6		0		0		2
	Envelope reflectance		0.3		0.5		0.7		0.3		0.3		0.5

[16] Average yearly air changes due to infiltration calculated via airflow network with the considered climate, with varying air permeability class of windows and doors (EN 12207: windows and doors – air permeability – classification).
[17] Ventilation rate additional to infiltration, calculated with airflow network, assuming that windows are open according to certain control rules (30% of window surface opened when external temperature is 2°C lower than indoor.

0

Table 22. Envelope families considered in this analysis: East - North

Package	Measure	EAST: Budapest (HU)						NORTH: Stockholm (SW)					
		Family 1		Family 2		Family 3		Family 1		Family 2		Family 3	
"e"	Roof U-value [W/m^{2}K]	low: "-"	1.5	medium: "o"	0.3	high: "+"	0.1	low: "-"	1.5	medium-high: "o+"	0.2	high: "+"	0.1
	Wall U-value [W/m^{2}K]		1		0.32		0.14		1		0.23		0.14
	Basement U-value [W/m^{2}K]		2.1		0.32		0.2		2.1		0.26		0.2
"w"	Window U-value [W/m^{2}K]	low: "-"	3	medium: "o"	2	high: "+"	0.8	low: "-"	3	medium-high: "o+"	1.4	high: "+"	0.8
	Air infiltration rate: ach [h^{-1}]		0.8		0.5		0.1		0.8		0.3		0.1
"c"	Total solar transmittance (or g-value) (window + shading)	low: "-"	0.8	medium-high: "o+"	0.3	high: "+"	0.1	low: "-"	0.8	medium-low: "o-"	0.6	medium-high: "o+"	0.3
	Night natural ventilation rate: ach [h-1]		0		2		6		0		0		2
	Envelope reflectance		0.3		0.5		0.7		0.3		0.3		0.5

Table 23. Combinations of envelope families to generate variants analysed in this study.

Package	"e" envelope	"w" windows	"c" cooling passive techniques
Variant 1 (base case)	1	1	1
Variant 2	1	1	2
Variant 3	1	1	3
Variant 4	1	2	1
Variant 5	1	2	2
Variant 6	1	2	3
Variant 7	2	1	1
Variant 8	2	1	2
Variant 9	2	1	3
Variant 10	2	2	1
Variant 11	2	2	2
Variant 12	2	2	3
Variant 13	2	3	1
Variant 14	2	3	2
Variant 15	2	3	3
Variant 16	3	2	1
Variant 17	3	2	2
Variant 18	3	2	3
Variant 19	3	3	1
Variant 20	3	3	2
Variant 21	3	3	3

At the next step we have associated the 21 envelope variants with a large number of coherent heating/cooling system plant architectures starting from the sub-plant variants shown in the following table.

Table 24. Variants of Heating/cooling plant elements considered in this analysis.

Plant	Sub-plant	Variant description	Performance factor			
			$\eta_{HEATING}$			$\eta_{COOLING}$
			η_{h1}	η_{h2}	η_{h3}	η_{c1}
Heating	Generation	Standard gas boiler	80%	80%	80%	
		Condensing boiler	104%	95%	-	
		Air source Heat pump with high SPF (and SEER)	350%	225%	-	300%
		Ground source heat pump	500%	325%	-	450%
	Emission	Standard radiant floor	98%	96%	94%	
		Insulated radiant floor	99%	98%	97%	
		Radiator	95%	94%	92%	
		Fan coil	96%	95%	94%	
		Air diffuser	96%	95%	94%	
	Distribution	Internal - not insulated	98%	96%	95%	
		Internal - a bit insulated	99%	97%	96%	
		Internal - insulated	99%	98%	97%	
	Control	climatic	86%	84%	80%	
		indoor thermostatic	97%	95%	91%	
		climatic+indoor thermostatic	98%	97%	95%	
Cooling	Generation	Chiller with medium SEER				200%
		Chiller with high SEER				300%
		Air source Heat pump with high SEER (and SPF)	350%	225%	-	300%
		Ground source heat pump	500%	325%	-	450%
	Emission	Standard radiant floor				97%
		Insulated radiant floor				97%
		Insulated radiant ceiling				98%
		Fan coil				98%
		Air diffuser				97%
	Distribution	Internal - insulated				99%
	Control	climatic				90%
		indoor thermostatic				98%
		climatic+indoor thermostatic				99%
Heat Recovery		absent	0%			
		high efficiency	80%			

In addition to the RES systems indicated in the previous table (heat pumps), we considered variants of photovoltaic (panels of monocrystalline silicon with peak power factor of 0,15 kW/m^2) and thermal solar (vacuum tubes with high efficiency) systems integrated on the building roof. For each building variant the size of the solar fields (a combination of thermal and PV panels) was obtained by considering a useful available roof area (assumed to be 40% for the office type and to 30% for the single house type).

6.1.5 Simulation of energy needs for heating and cooling

The simulation campaign has been carried out within the EnergyPlus dynamic simulation environment (version 7.0), implementing the module AirFlowNetwork in order to evaluate in detail the air flows due to infiltration (with windows closed) and ventilation, either natural (windows open) or mechanical (via a ventilation system), taking into account temperature and wind conditions at each step of the simulation.

For obtaining building envelope variants fully comparable in terms of comfort performance, the energy needs for all the building variants are calculated assuming the same indoor conditions for each typology (residential or office):

- The same operative[18] temperature (21°C in winter and 25°C in offices and 26°C in homes in summer) and relative humidity (35% in winter and 65% in summer) setpoints.
- The same values of air change (coherent with the assumed occupation levels and the ventilation rates proposed by EN 15251[19] for very low-polluted buildings: 0,55 h^{-1} in the residential buildings and 0,96 h^{-1} in the office building).

We calculated the heating energy need as sum of two contributions: the non recoverable and the (potentially) recoverable one.

The recoverable energy need is the amount of energy associated to air exchange that can be subject to heat recovery. It is hence equal to 0 if the air infiltrations are sufficient to ensure the IAQ levels and hence there is no need for additional ventilation airflow. Otherwise the airflow additional to infiltration might be obtained by windows opening (no heat recovery possible) or through a ventilation system (heat recovery possible by installing a heat recovery exchanger).

Cooling energy needs consist of both sensible and latent component

The thermal comfort levels have been chosen conservatively in this study, e.g. 21°C operative temperature in winter, while in summer 25°C in offices and 26°C in homes, and 35 % minimum relative humidity in winter. Other choices, are also possible [Pagliano and Zangheri 2010] and may be one of the ways to reduce energy needs for heating and cooling below the ones calculated in this study, while offering comfortable living and working conditions to occupants, according to ISO 7730 and EN 15251 [Carlucci et al. 2013a, Carlucci et al. 2013b, Carlucci 2013].

It is important that these boundary conditions, however chosen, are clearly and explicitly reported in every analysis since as stated in EN 15251: *"An energy declaration without a declaration related to*

[18] A combination of air temperature and radiant temperature of surfaces.

[19] EN 15251-2007: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

the indoor environment makes no sense. There is therefore a need for specifying criteria for the indoor environment for design, energy calculations, performance and operation of buildings".

The chosen temperature and ventilation conditions have relevant implications on energy consumption as shown for example in [Sfakianaki et al. 2011].

As for humidity levels, EN 15251 states that: *"If humidification or dehumidification is used the values in Table B.6 is recommended as design values under design conditions. Usually humidification or dehumidification is needed only in special buildings like museums, some health care facilities, process control, paper industry etc. Besides it is recommended to limit the absolute humidity to 12 g/kg."* The same standard, in table *"B6: Example of recommended design criteria for the humidity in occupied spaces if humidification or dehumidification systems are installed"* proposes as design values in category II (new buildings) a design setpoint for dehumidification of 60% and of 25% for dehumidification. We have chosen slightly different values for humidity set-points in this study, but this has little influence on comfort as measured by Fanger's PMV.

6.1.5.1 Catania

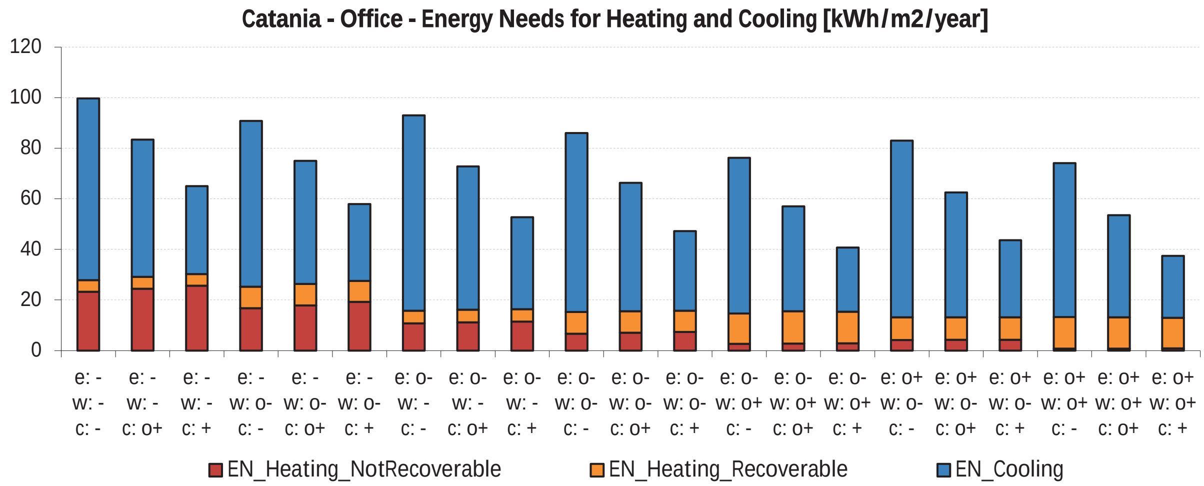


Figure 42. Energy Needs (EN) for heating and cooling of the office building type located in Catania, as a function of the 21 envelope variants.

For example in the three left columns it is clearly visible that improving passive cooling technologies (shading, night ventilation, light façade colours) reduce energy needs significantly. It also can be seen that improving the window quality (air-tightness) decreases the share of non-recoverable heat.

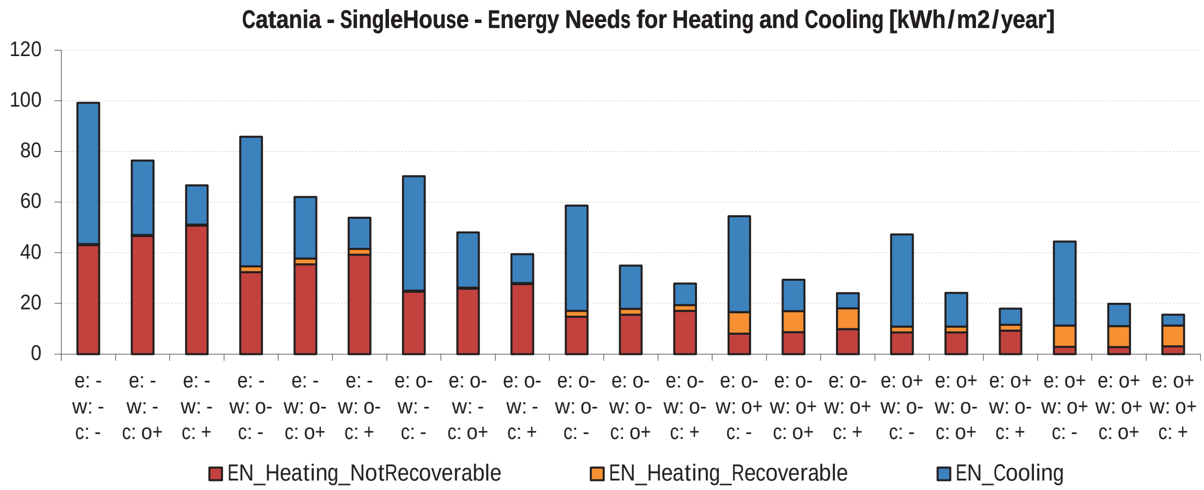


Figure 43. Energy Needs (EN) for heating and cooling of the single house building type located in Catania, as a function of the 21 envelope variants.

6.1.5.2 Paris

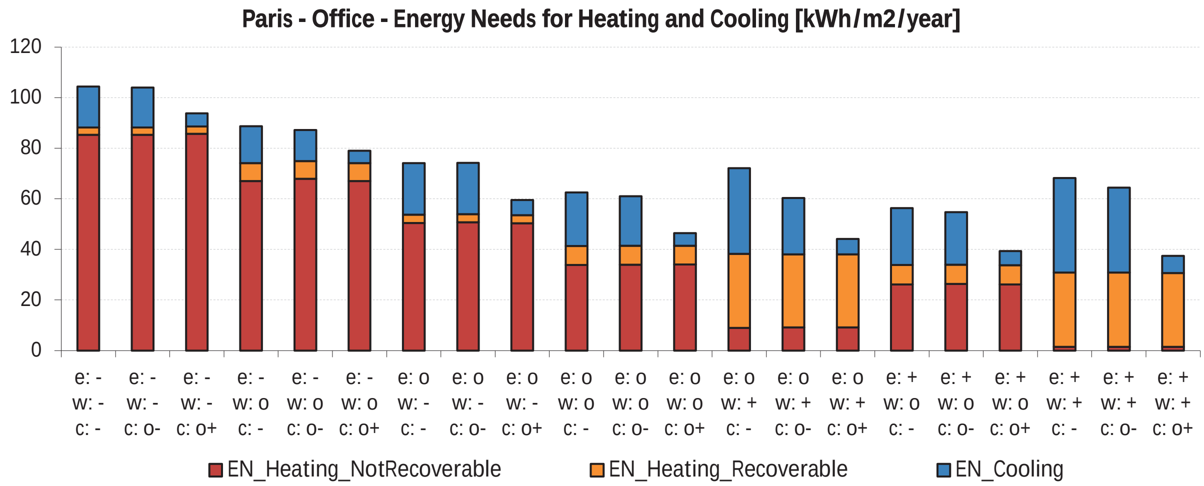


Figure 44. Energy Needs (EN) for heating and cooling of the office building type located in Paris, as a function of the 21 envelope variants.

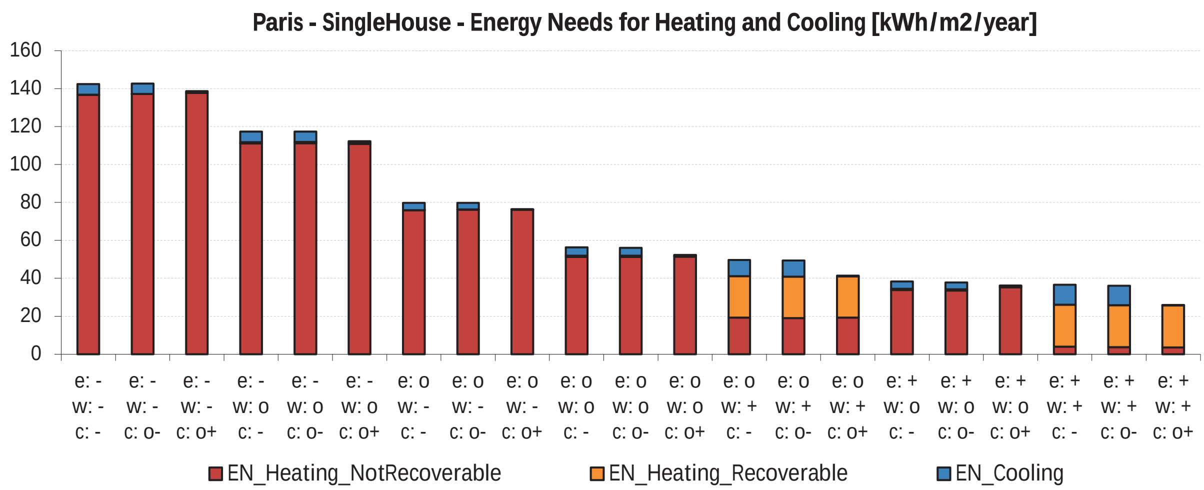


Figure 45. Energy Needs (EN) for heating and cooling of the single house building type located in Paris, as a function of the 21 envelope variants.

6.1.5.3 Budapest

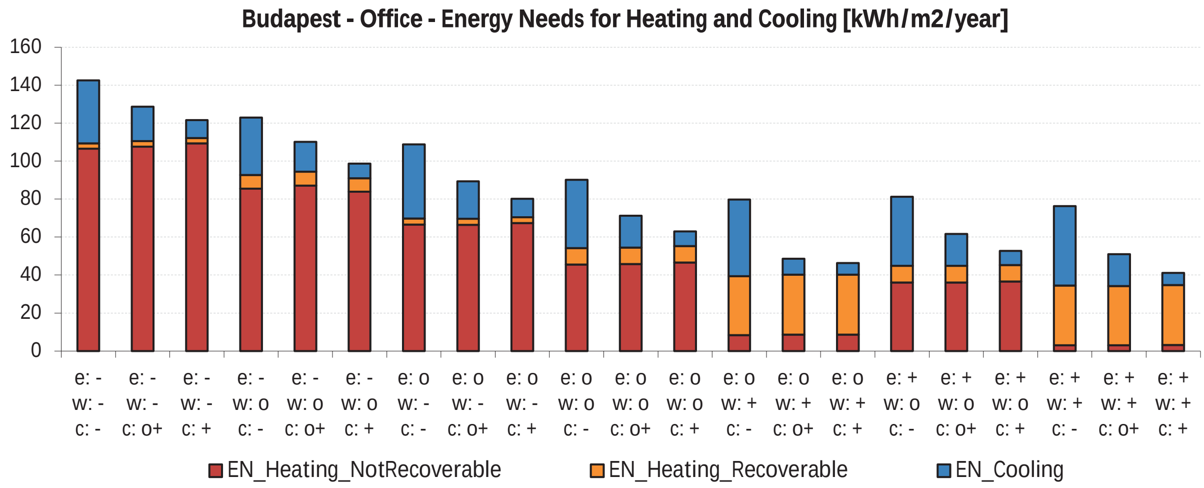


Figure 46. Energy Needs (EN) for heating and cooling of the office building type located in Budapest, as a function of the 21 envelope variants.

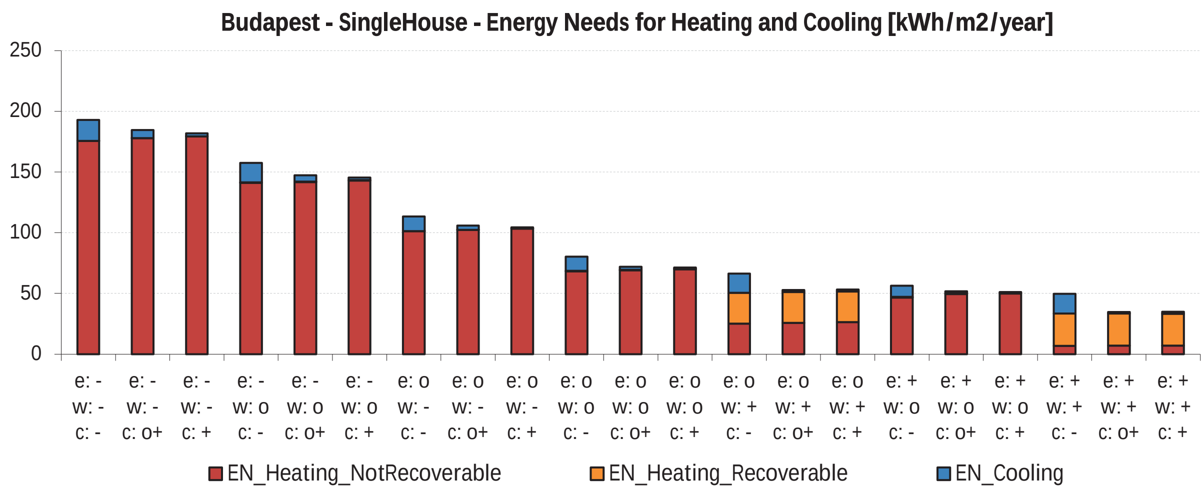


Figure 47. Energy Needs (EN) for heating and cooling of the single house building type located in Budapest, as a function of the 21 envelope variants.

6.1.5.4 Stockholm

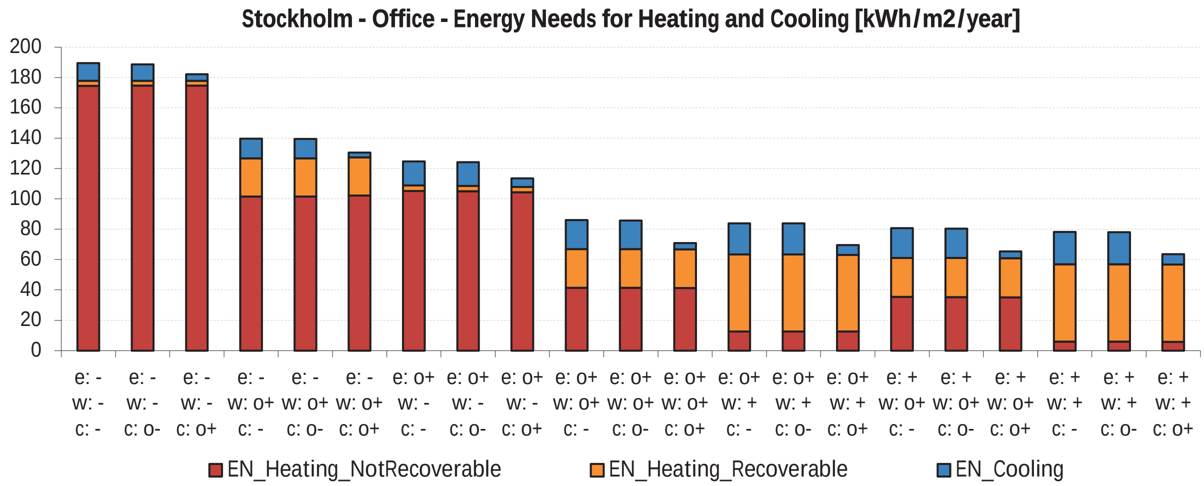


Figure 48. Energy Needs (EN) for heating and cooling of the office building type located in Stockholm, as a function of the 21 envelope variants.

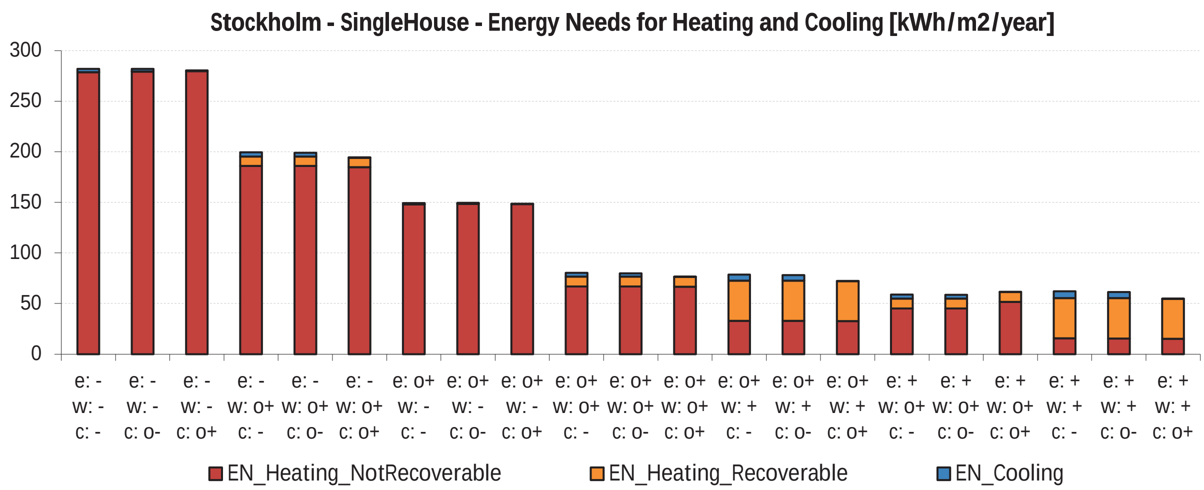


Figure 49. Energy Needs (EN) for heating and cooling of the single house building type located in Stockholm, as a function of the 21 envelope variants.

6.1.6 Benchmark for nearly zero-energy buildings

6.1.6.1 Methodology

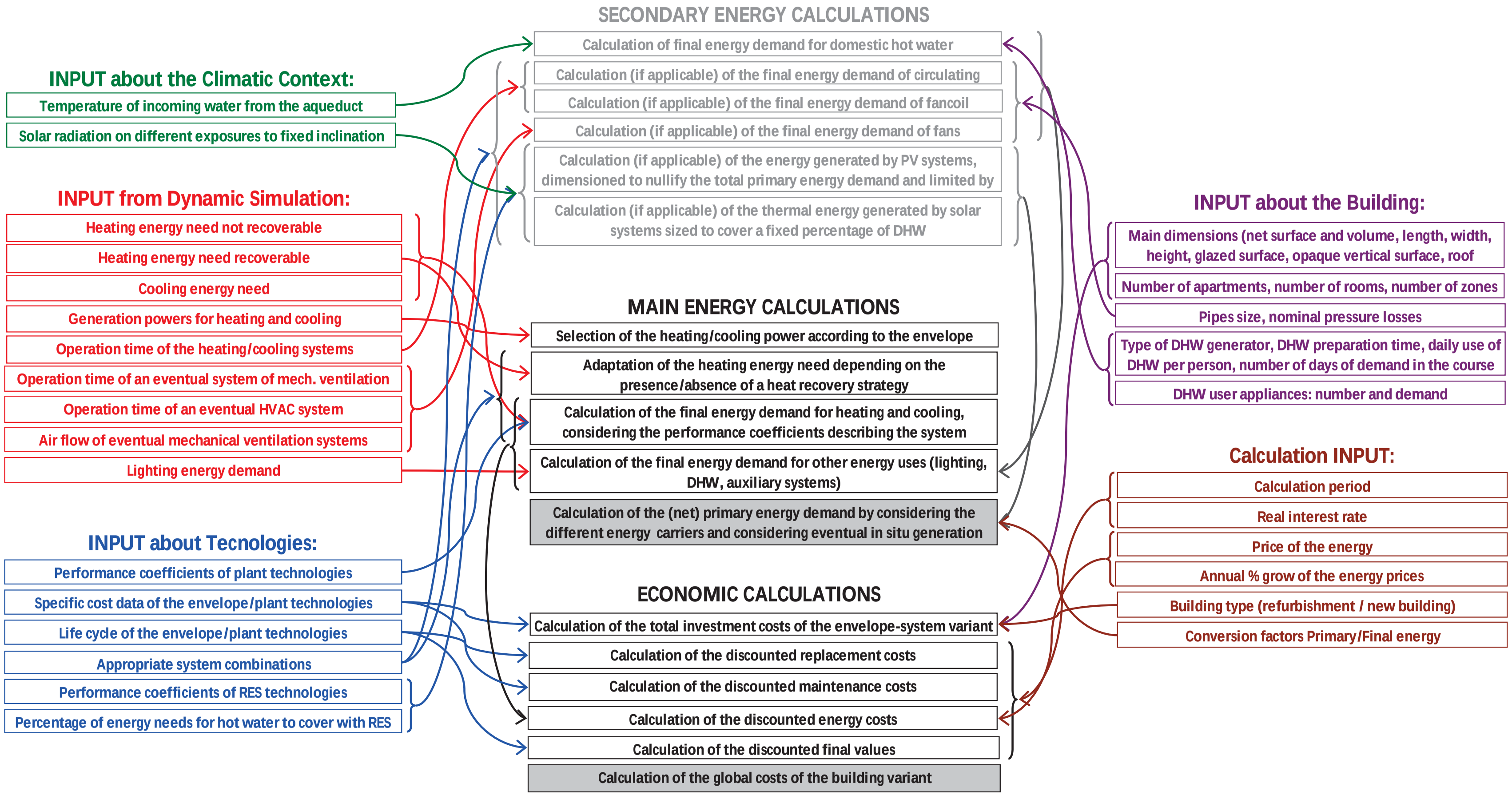


Figure 50. Scheme of the calculation methodology adopted.

Data inputs for the global cost calculation

For this analysis three perspectives have been considered: financial A, financial B and macro-economic. We show below the values considered for the main parameters of calculation.

In all cases the calculation is done in real terms, that is the inflation rate is subtracted from the nominal (market) interest rate, the same logic is applied for escalation rates of energy costs, i.e. they are also calculated as real values. A real price increase means the price for a specific product (i.e. gas price) is higher than the average price increase (= inflation rate) in a country. We only considered one interest rate (2%) for the macro-economic perspective, which is lower than the cost optimal methodology suggests (3%), in order to have an average between this and lower rates. All prices in the subsequent tables are in real terms, base year 2010.

Table 25. Main input data of Catania context.

SOUTH: Catania (IT)	2010			2020		
Perspective	**Financial A**	**Financial B**	**Macro-economic**	**Financial A**	**Financial B**	**Macro-economic**
Real interest rate	4%	10%	2%	4%	10%	2%
Calculation period	30 years					
Primary/Delivered conversion factor for electricity	2.17			1.74		
Primary/Delivered conversion factor for natural gas	1					
Price of electricity (taxes excluded)	0.17 €/kWh_{el}			0,213 €/kWh_{el}		
Price of natural gas (taxes excluded)	0,061 €/kWh_{th}			0,076 €/kWh_{th}		
Price of electricity generated at the building site and sold to the grid	0.07 €/kWh_{el}			0.087 €/kWh_{el}		
Real escalation rate of energy prices	2.5%/y					
Investment cost for new buildings not related to energy use (tax excluded)	1000 € (2010)/m^2			1000 € (2020) /m^2		
VAT	21%					
Taxes on electrical energy	23%					
Taxes on natural gas	23%					
Subsidies and incentives	excluded					
Taxes	included		excluded	included		excluded
Costs of avoided environmental damage (50 €/tCO_2)	excluded		Included	excluded		Included

Table 26. Main input data of Paris context.

WEST: Paris (FR)	2010			2020		
Perspective	**Financial A**	**Financial B**	**Macro-economic**	**Financial A**	**Financial B**	**Macro-economic**
Real interest rate	4%	10%	2%	4%	10%	2%
Calculation period	30 years					
Primary/Delivered conversion factor for electricity	2.58			2.06		
Primary/Delivered conversion factor for natural gas	1					
Price of electricity (taxes excluded)	0.115 €/kWh_{el}			0.144 €/kWh_{el}		
Price of natural gas (taxes excluded)	0.053 €/kWh_{th}			0.066 €/kWh_{th}		
Price of electricity sold to the grid	0.048 €/kWh_{el}			0.059 €/kWh_{el}		
Real escalation rate of energy prices	2.5%					
Investment cost for new buildings not related to energy use (tax excluded)	1000 € (2010)/m^2			1000 € (2020) /m^2		
VAT	15%					
Taxes on electrical energy	24%					
Taxes on natural gas	20%					
Subsidies and incentives	excluded					
Taxes	included		excluded	included		excluded
Costs of avoided environmental damage (50 €/tCO_2)	excluded		Included	excluded		Included

Table 27. Main input data of Budapest context.

EAST: Budapest (HU)	2010			2020		
Perspective	**Financial A**	**Financial B**	**Macro-economic**	**Financial A**	**Financial B**	**Macro-economic**
Real interest rate	4%	10%	2%	4%	10%	2%
Calculation period	30 years					
Primary/Delivered conversion factor for electricity	2.5			2.00		
Primary/Delivered conversion factor for natural gas	1					
Price of electricity (taxes excluded)	0.125 €/kWh_{el}			0.156 €/kWh_{el}		
Price of natural gas (taxes excluded)	0.046 €/kWh_{th}			0.058 €/kWh_{th}		
Price of electricity sold to the grid	0.052 €/kWh_{el}			0.065 €/kWh_{el}		
Real escalation rate of energy prices	2.5%					
investment cost for new buildings not related to energy use (tax excluded)	1000 € (2010) /m^2			1000 € (2020) /m^2		
VAT	21%					
Taxes on electrical energy	24%					
Taxes on natural gas	21%					
Subsidies and incentives	excluded					
Taxes	included		excluded	included		excluded
Costs of avoided environmental damage (50 €/tCO_2)	excluded		Included	excluded		Included

Table 28. Main input data of Stockholm context.

NORTH: Stockholm (SW)	2010			2020		
Perspective	**Financial A**	**Financial B**	**Macro-economic**	**Financial A**	**Financial B**	**Macro-economic**
Real interest rate	4%	10%	2%	4%	10%	2%
Calculation period	30 years					
Primary/Delivered conversion factor for electricity	2.00			1.60		
Primary/Delivered conversion factor for natural gas	1					
Price of electricity (taxes included)	0.147 €/kWh_{el}			0.184 €/kWh_{el}		
Price of natural gas (taxes included)	0.079 €/kWh_{th}			0.099 €/kWh_{th}		
Price of electricity sold to the grid	0.067 €/kWh_{el}			0.084 €/kWh_{el}		
Real escalation rate of energy prices	2.5%					
Investment cost for new buildings not related to energy use (tax excluded)	1000 € (2010) /m^2			1000 € (2020) /m^2		
VAT	20%					
Taxes on electrical energy	37%					
Taxes on natural gas	48%					
Subsidies and incentives	excluded					
Taxes	included		excluded	included		excluded
Costs of avoided environmental damage (50 €/tCO_2)	excluded		Included	excluded		Included

In addition to the parameters shown in the previous tables, assumptions were made on price increases/decreases of certain components. Detailed information about these assumptions can be found in Table 42 and Table 43.

6.1.6.2 Results

In the next paragraphs we show the results obtained for each building type in each climatic-economic context. In particular, the following analyses are shown:

- A**) Global costs versus (net) primary energy** performance calculated for new buildings in financial perspective (Real Interest Rate RIR = 4%), considering the cost data **2010**.
- B**) Global costs versus (net) primary energy** performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data **2020**.

The analysis A and B may prove useful in discussing how low it is likely to get in net primary energy, in each climate and for each building typology, under the specified set of hypotheses, with or without the possibility to make use of solar energy on the rooftop. It may also be used to identify a "cost-optimal zone" and a "**nearly zero-energy zone**", in each climate and for each building typology. Of course it was not the objective of this study to perform a full set of cost-optimal calculations as defined in the cost optimal delegated regulation.

We recall here the definitions:

- Global costs include capital costs, cost of energy, maintenance costs, replacement costs, residual value at end of life, all discounted to year zero [20] with a given discount rate. For all items only market prices are considered and external costs related to environmental or health damages different from CO_2 are not included. Positive benefits other than energy savings are also neglected, even though they might be relevant, e.g in variants with high performance building envelope better distribution of temperatures, avoidance of draft, higher availability of daylighting, in a word higher thermal and visual comfort, might increase the usability of costly m^2 and productivity of workers according to various surveys.
- Net primary energy is the primary energy that would be consumed in one year by the building if renewable generation (in our assumptions on-site) were absent, minus the primary energy equivalent of renewable energy generated (in our assumptions on-site).

In most cases analysed this approach (net primary energy over a time frame of one year) results in a large mismatch between time when solar renewable energy is generated (mostly in summer) and when conventional energy (electricity from the grid and natural gas) is consumed (prevalently in winter, especially for residences). In this approach energy generated in summer in excess gives credit to the building to offset consumption in periods when generation is insufficient to cover demand.

This implies that even if the building reaches a yearly zero net energy performance, conventional energy is still drawn from the grid at certain times which further implies consumption of conventional fuels (gas, oil, coal, nuclear) and corresponding environmental impacts, and/or the need for energy storage in the energy infrastructure to deal with the mismatch of generation and demand. The corresponding external costs of environmental and health damage and of additional energy infrastructure are not considered in this study[21] (and in many other studies) as this is beyond its

[20] In our case year zero is alternatively assumed to be 2010 or 2020
[21] Only CO_2 emission costs are considered in certain scenarios and only for the net primary energy consumption, not for the emission due to the time mismatch; also, other environmental, health and grid costs are disregarded

scope. They are nevertheless true economic costs that should be carefully considered in another study in order to achieve a complete economic and environmental picture. We show a sensitivity analysis about the potential impact of the external costs for one case (Stockholm single house)

Further analyses:

- C) **Sensitivity analysis** on changes of the lower profile (Pareto Frontier) of the energy/cost domain as a function of several key economic perspectives and different cost databases (2010/2020) **for new building**.
- D) **Sensitivity analysis** on changes of the lower profile of the energy/cost domain as a function of several key economic perspectives and different cost database (2010/2020) for **renovation**.

The Analysis C) and D) are aimed at giving a visual, **QUALITATIVE overview of the influence of the various perspectives on the position of the Pareto frontier**, which would not be possible by superposing or comparing side by side the various corresponding complete clouds. In order to produce curves representing the Pareto frontier a polynomial interpolation (to second or third power) of the points on the frontiers has been performed. This allows a quick perception of the trends but necessarily introduces imprecision. Given the approximation introduced this analysis is **NOT aimed at supporting a discussion about the position of the cost-optimal zone.**

Further analysis:

- E) **Disaggregation of building costs** for several building variants **positioned on** the lower profile (**Pareto Frontier**) of the energy/cost domain, considering a financial perspective (RIR = 4%) and the cost data **2010**.

Analysis E gives an impression of the relative weight of capital costs of energy related technologies (labelled “initial investment”), present value (i.e. discounted to year zero) of costs incurred for energy over the 30year time-horizon (labelled “energy- without PV credits”), costs of construction not directly related to energy (structure, finishing materials,…, labelled “base initial investment”) which are not affecting the analysis but are reported here again as an indication of the orders of magnitude, present value (i.e. discounted to year zero) of income incurred selling electric energy from PV to the grid over the 30year time-horizon (labelled “PV credits”). We have assumed no subsidies hence PV energy is supposed to be sold to the grid at a price comparable to that of conventional generation sources on the wholesale market. Costs of land, property taxes etc. are not included

Further analysis:

- F) **Percentages within** the entire dominium of variation (**the entire cloud**) **of** building variants by **different classes of energy needs** for heating and cooling with indication of minimum/mean/maximum global cost.
- G) **Ways to reach the nearly zero-energy building target**: statistical analysis of the “new building” variants characterized by lower net primary energy consumption values and lower global costs over 30 years (considering financial perspective with RIR of 4% and the **cost data 2010**). The exact ranges of global costs and net primary energy analysed are indicated in the table at the bottom, and identify what we call the “benchmark area”, e.g.

“benchmark area”	Min	Max
Range of NET primary energy [kWh/m^{2}y]:	0	15
Range of Global Costs over 30 years [€/m2]:	2397	2756
Number of Building Variants:	189	

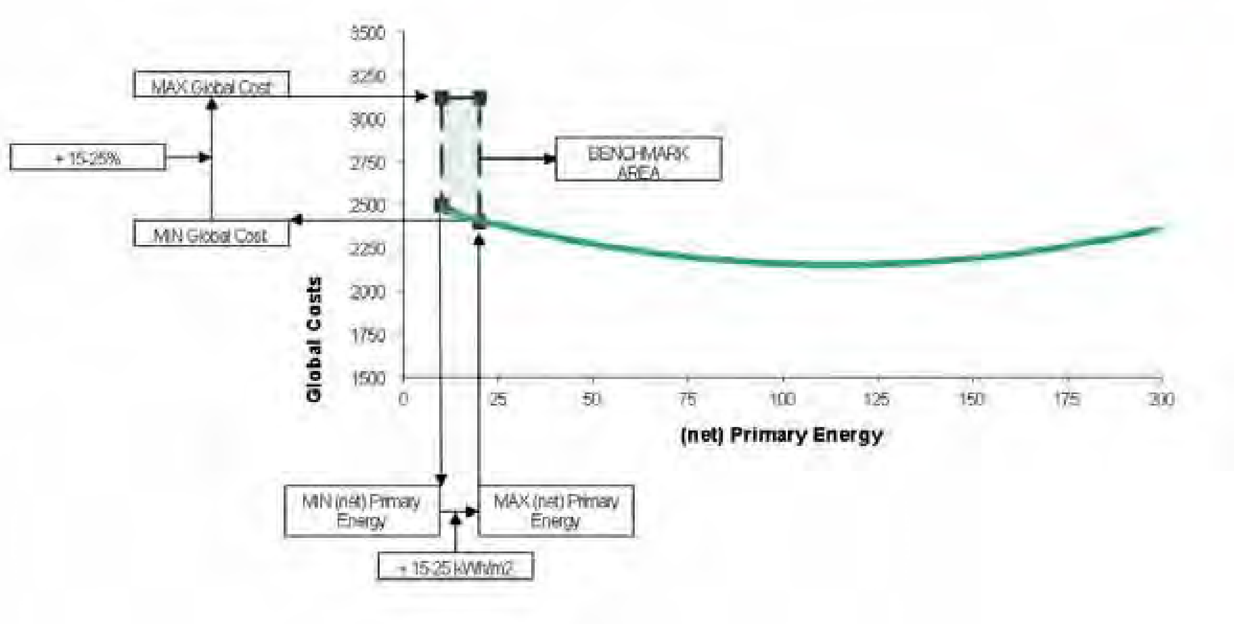


Figure 51: Steps to define the benchmark area

The “benchmark area” is determined in the following way:

- Determine the variant with minimum net primary energy,
- Consider an increase of 15 to 25 kWh/m2y,
- At this new level of net primary determine the variant with minimum global cost,
- Increase global cost by 15-25%.

The size of the area is adjusted in order to contain in the order of 200 variants; these 200 best variants are then analysed and the frequency with which certain measures and packages appear is reported in graph G.

Analysis G) gives an indication of the types of technologies that, for each building typology and climate and under the given assumptions for economic perspective, rooftop availability (40% ot total roof area for offices and 30% for single houses to consider limitations due to shading, orientation, etc.), etc. are available for reaching the “nearly zero-energy zone”, identified by the ranges described in the table “benchmark area”.

Depending on the specific constraints that the building might experience some of the technology packages might not be available, but other packages are available in the same energy and cost range. For example in dense urban centres ground source heat pumps (GSHP) and /or PV might not be available for some buildings. In that case the remaining available packages will comprise technologies with even higher performance in the envelope (lower energy needs) and plants (lower delivered energy) to compensate the non-availability of PV and GSHP. Other technologies not considered in this analysis and/or that will become technologically and market mature later might also be available. Some technologies as biomass burning might be available if one considers also the possibility of “importing” renewable energy to the building site, but might have also their own limitations (e.g. in a valley or an area with low air movement and frequent thermal inversion phenomena in the low atmosphere like the Pianura Padana n Italy, the PM10 produced by biomass burning might strongly restrict its potential use). For example in the case of Milano in winter, about 30% of total PM10 in the lower part of atmosphere is due to biomass burning, and global PM10 level are much higher than allowed by European legislation [Bolzacchini et al. 2011].

Further analyses:

- H) Indication of the energy **needs** for heating **and cooling** (both sensible and latent components) for the building variants within the benchmark area “nearly zero-energy zone” defined at the previous step.
- I) Indication of the share of the considered <u>solar</u> renewable sources (photovoltaic and solar thermal) for the building variants within the benchmark area “nearly zero-energy zone”. On the horizontal axis of this graph it is reported the primary energy that the building would consume in a year in case there were no solar plant on the roof and hence solar energy for self-consumption or export to the grid would not be available. On the vertical axis there is the total energy credit for solar generation on the roof due to both self-consumption and export to the grid in a year; both generated (self-consumption plus export) and delivered energy are transformed into primary energy by using the same (**symmetric**) conversion factor assumed to be the official national conversion factor (ratio primary to delivered) of the energy vectors (electricity, gas) in **2010**. In the nearly zero-energy building definition used in this chapter the primary energy credits accrued via electricity generation in summer are used to offset electricity consumption for a period of one year (some of it concentrated in winter, e.g. lighting) and possibly fuel consumption in winter. We are not evaluating the mismatch index in this analysis. Large mismatches might imply large consumption of fossil fuel resources in some parts of the year. *A* way to reduce the absolute value of the mismatch is to reduce the energy needs and in the group of variants included in the nearly zero-energy building benchmark MS might decide to privilege the ones with very low energy needs also in view of reducing the mismatch.

6.1.6.3 Catania - Office

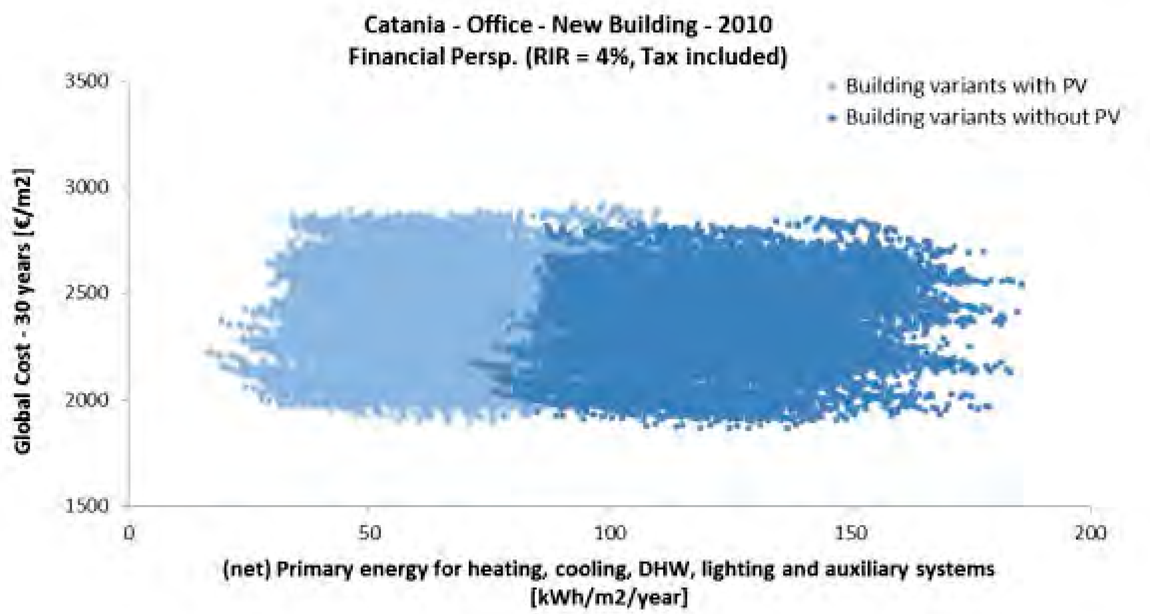


Figure 52. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

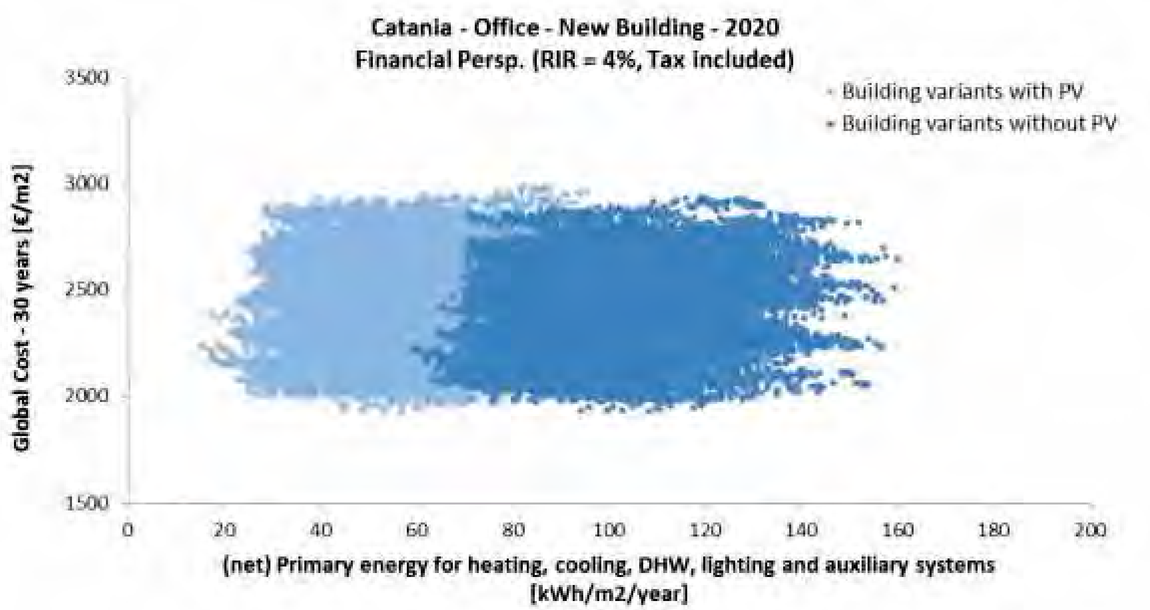


Figure 53. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

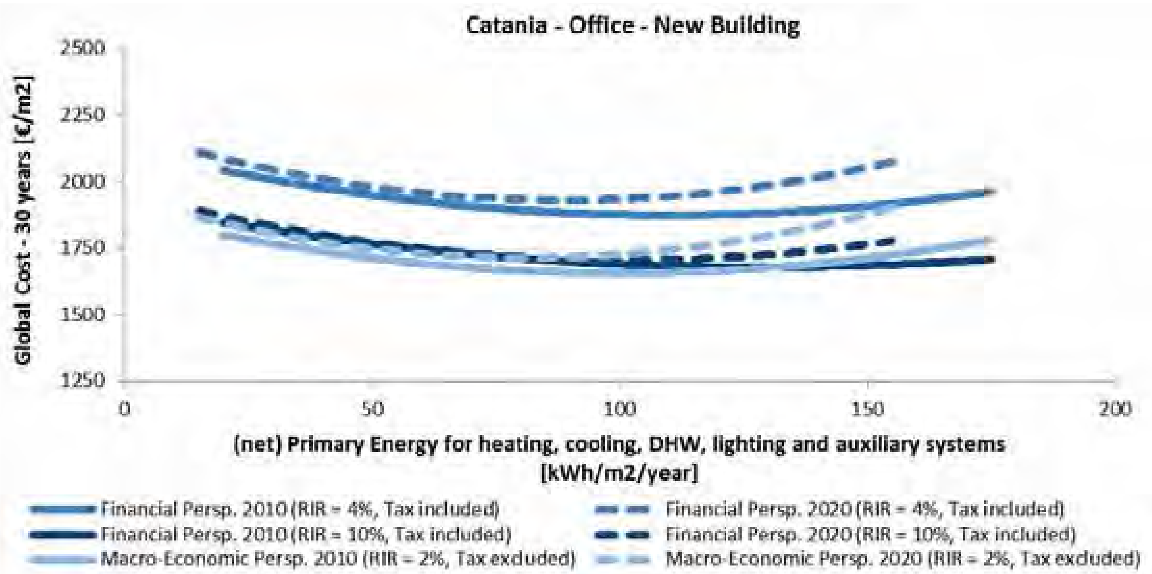


Figure 54. New building: sensitivity analysis on the lower profile of the energy/cost domain as a function of several key economic perspectives and different cost database (2010/2020).

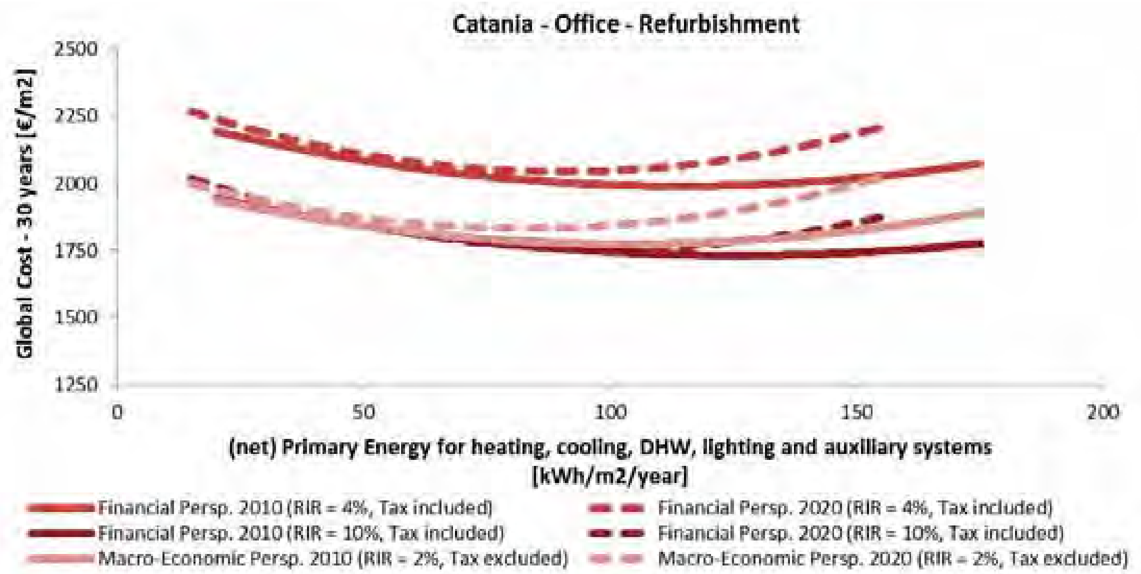


Figure 55. Refurbishment: sensitivity analysis on the lower profile of the energy/cost domain as a function of several key economic perspectives and different cost database (2010/2020).

The effect of a lower primary energy factor for electricity by 2020 has two visible effects in all climates: the net primary energy demand is lower than in 2010 (the cloud shifts to the left and is more condensed, Figure 52 and Figure 53).

Higher real energy prices by 2020 lead to a change in the slope of the whole cloud and the Pareto curve of minimum cost (higher consumption of energy has higher weight in 2020 than 2010 in raising global costs). Variants with high primary energy consumption get more expensive compared to variants with low primary energy and thus less and less attractive. It is worth while noting that the performance of the technologies is assumed to be the same by 2010 and 2020. Generally more speed in innovation will always let the 2020 results look even better compared to 2010 than in the analysis presented here.

Qualitatively the cost optimum clearly moves to lower net primary energy between 2010 and 2020.

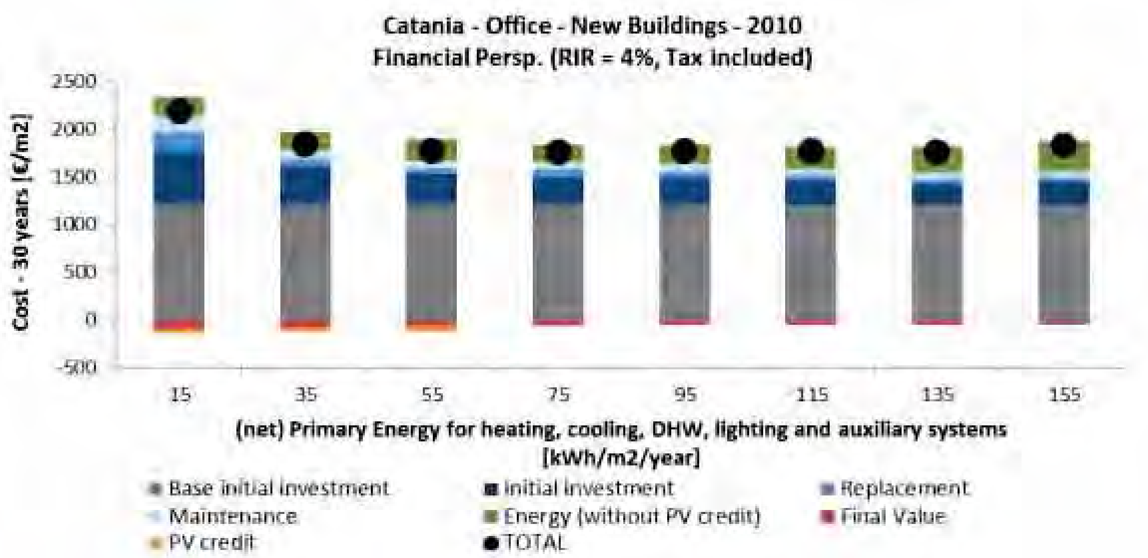


Figure 56. Disaggregation of building costs for several building variants on the lower profile of the energy/cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

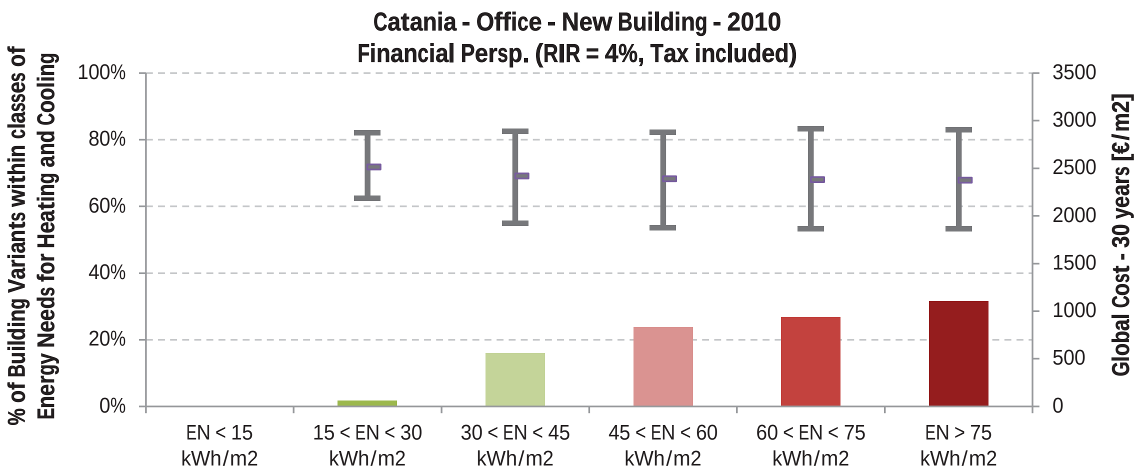


Figure 57. Percentage of building variants by different classes of energy need for both heating and cooling with indication of minimum/mean/maximum global cost within the whole dominium of variation.

In this Catania example (Figure 56, where total cost is the net cost considering the positive bar of costs and the negative bar of gains by PV generation) there is quite little difference in global cost until 35 kWh/m^{2}a net primary energy demand. Only the lowest category is relatively more expensive in 2010.

Interestingly (Figure 57) there are lots of building variants, where not only low net primary energy is achievable at low global cost but also thermal energy needs are very low; there are some variants with energy needs between 15 and 30 kWh/m^{2}a and a significant number of buildings in the energy need class between 30 and 45 kWh/m^{2}a thermal energy need at slightly lower global costs. We remind here that we are considering the energy needs for both heating and cooling – sensible and latent – and not only heating as in some existing labels.

The class 30 and 45 kWh/m^{2}a has a similar minimum and average cost as buildings with low energy performance, i.e. high energy need. From the point of view of risk reduction and flexibility for energy from different renewable sources this is advantageous. Figure 58 shows the distribution of technologies within the nearly zero-energy building benchmark area. The variants with high efficient envelope (e), windows (w) and passive cooling (c) prevail (top graph).

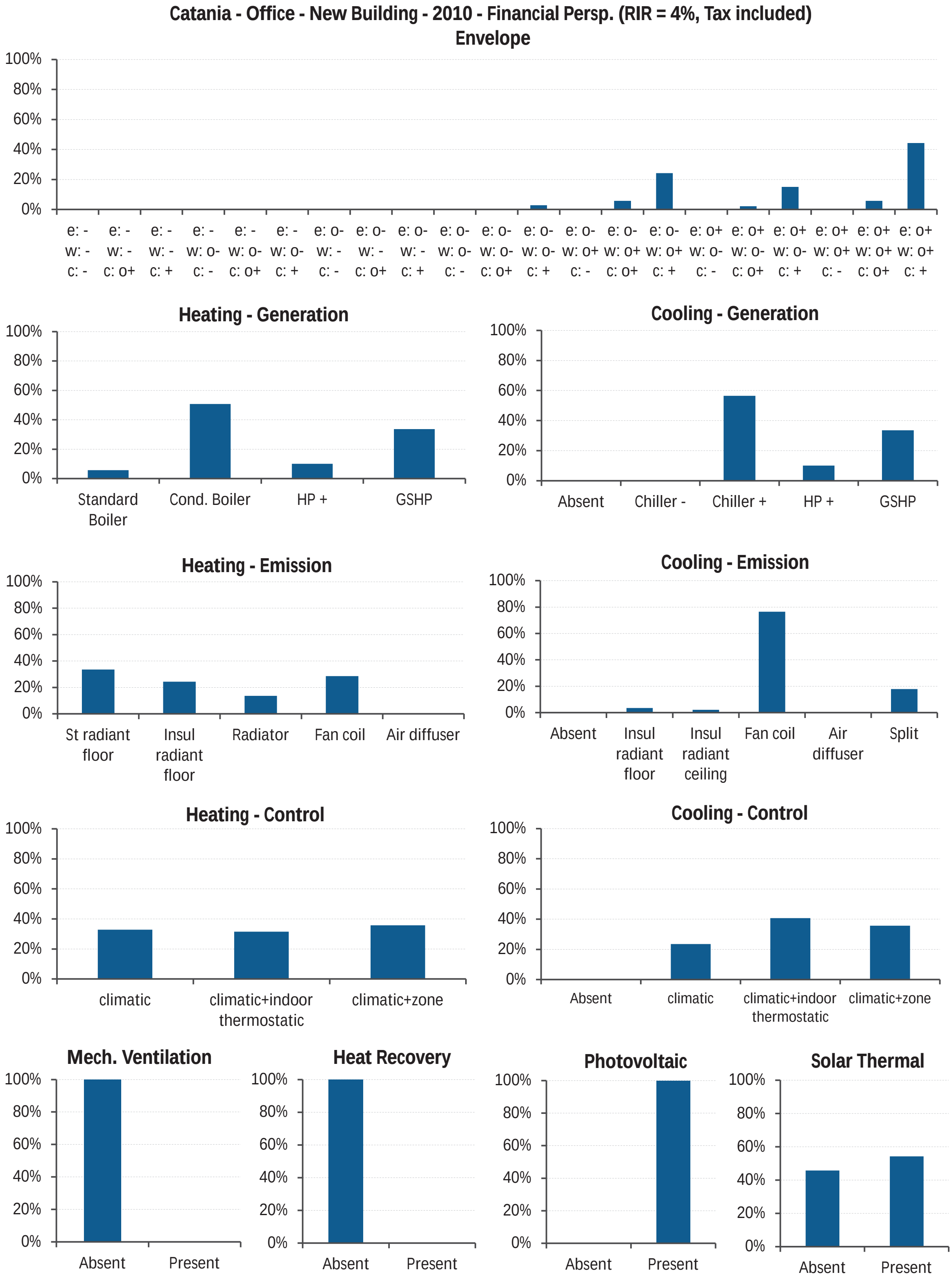


Figure 58. Ways to reach the nZEB target, Statistical analysis of technologies, Catania, Office

	Min	Max
Range of Primary Energy [kWh/m²/y]:	17	30
Range of Global Costs [€/m²]:	1968	2264
Number of Building Variants:	140	

Figure 59. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the "new building" variants

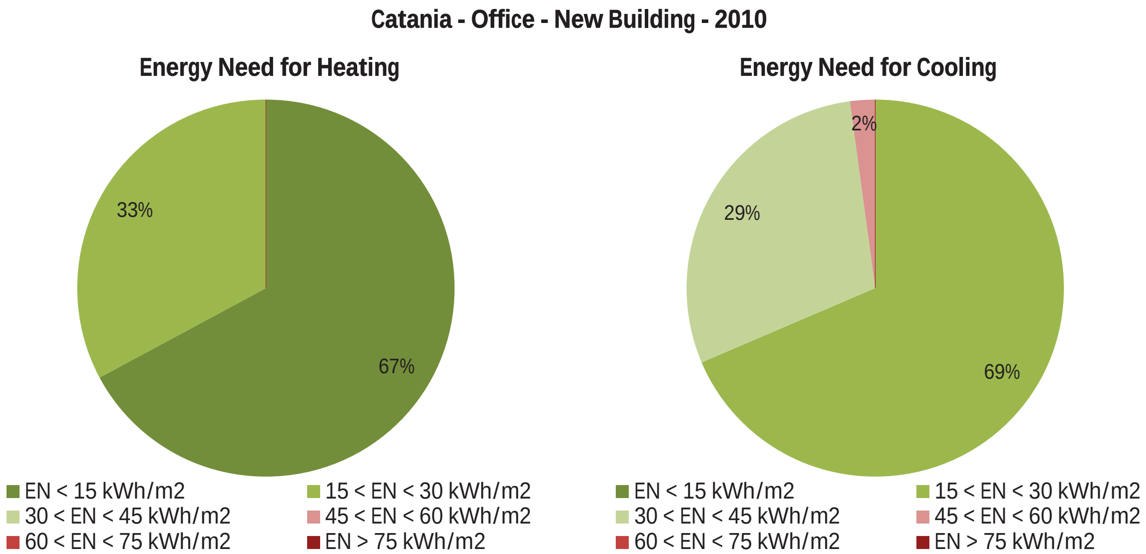


Figure 60. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

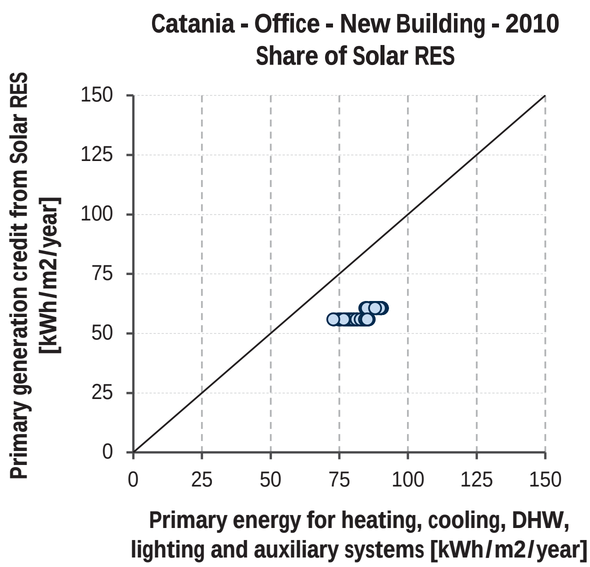


Figure 61. Indication of the share of solar renewable sources (photovoltaic and solar thermal) for the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.4 Catania – Single House

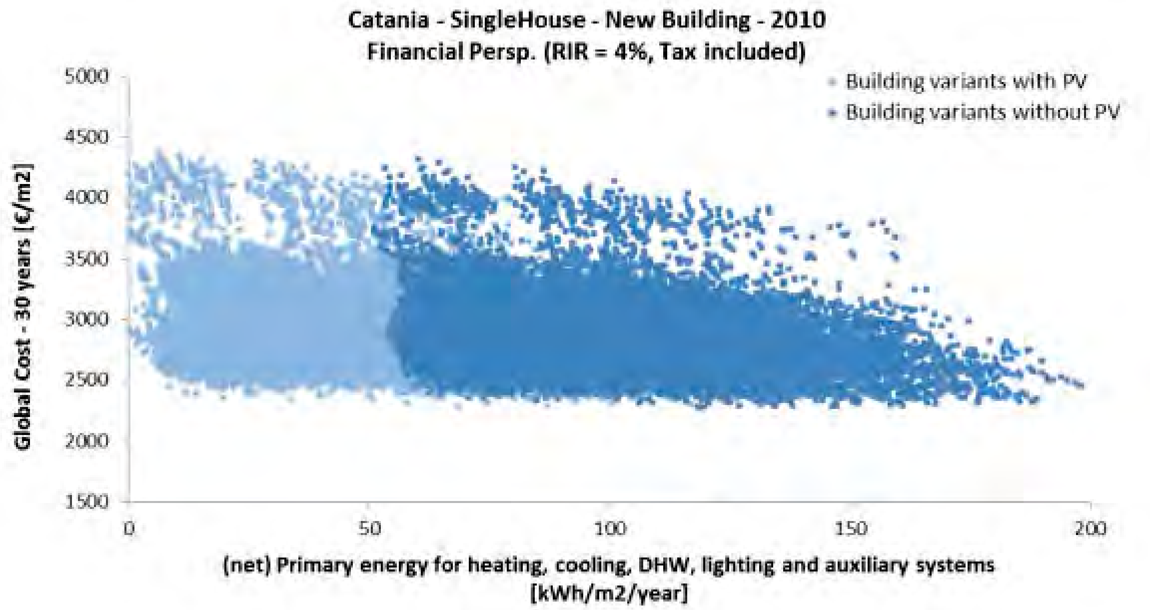


Figure 62. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

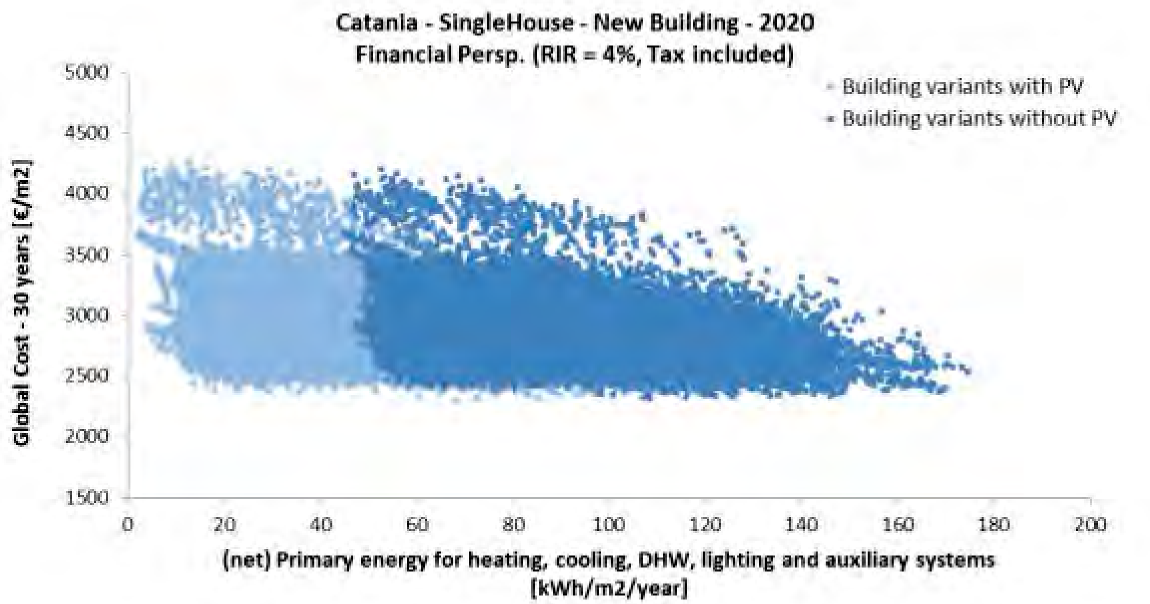


Figure 63. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

In this smaller building there is relatively more space available for on-site renewables, considered here. This leads to close to zero net primary energy variants at attractive global cost.

0

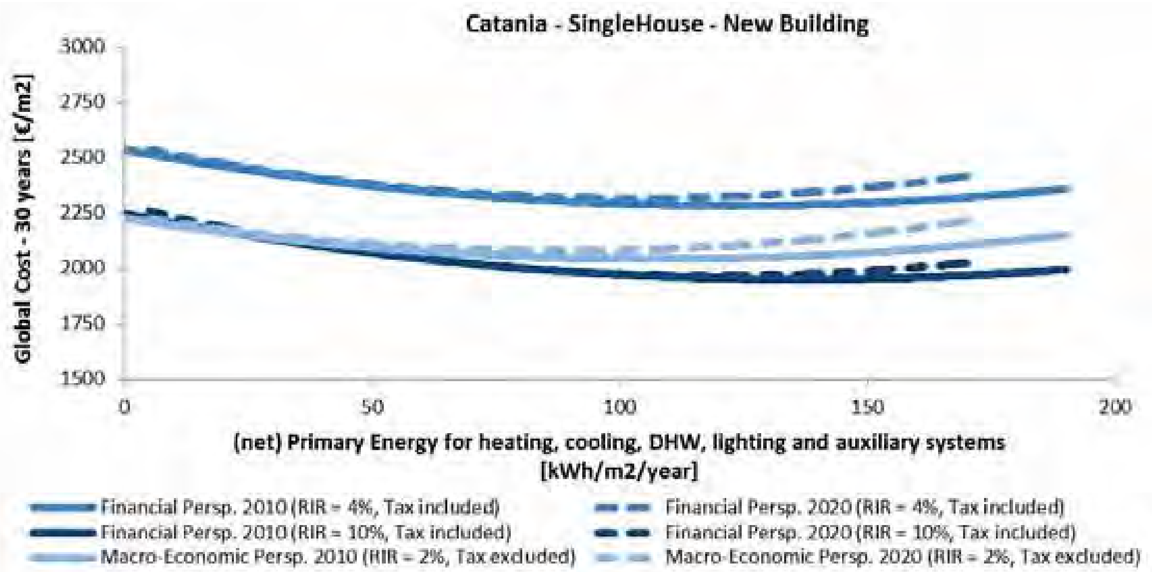


Figure 64. New building: sensitivity analysis on the lower profile of the energy / cost domain in function of several key economic perspectives and different cost database (2010 / 2020).

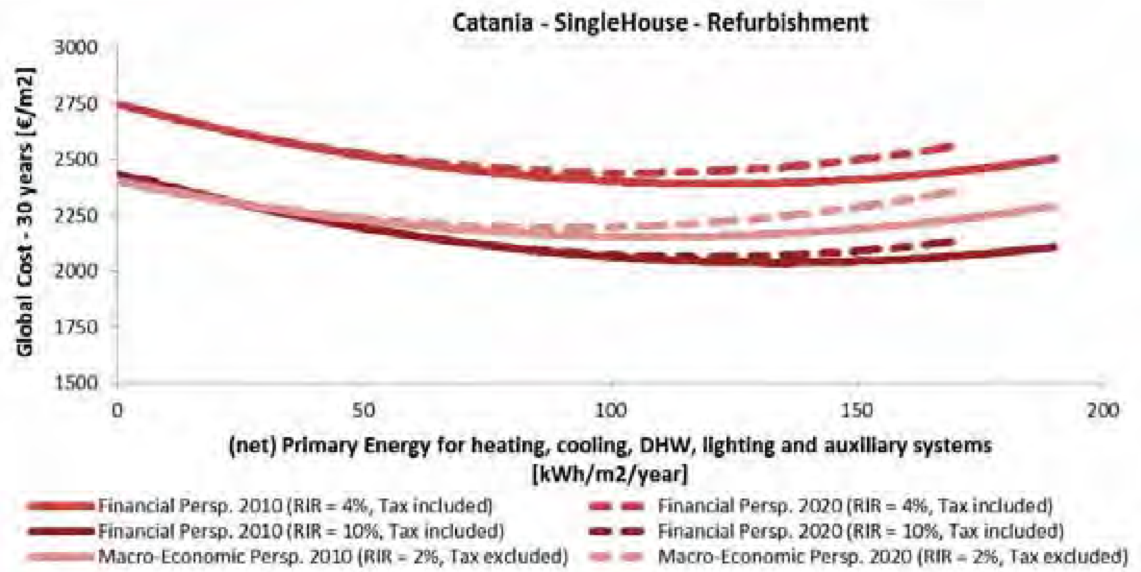


Figure 65. Refurbishment: sensitivity analysis on the lower profile of the energy / cost domain in function of several key economic perspectives and different cost database (2010 / 2020).

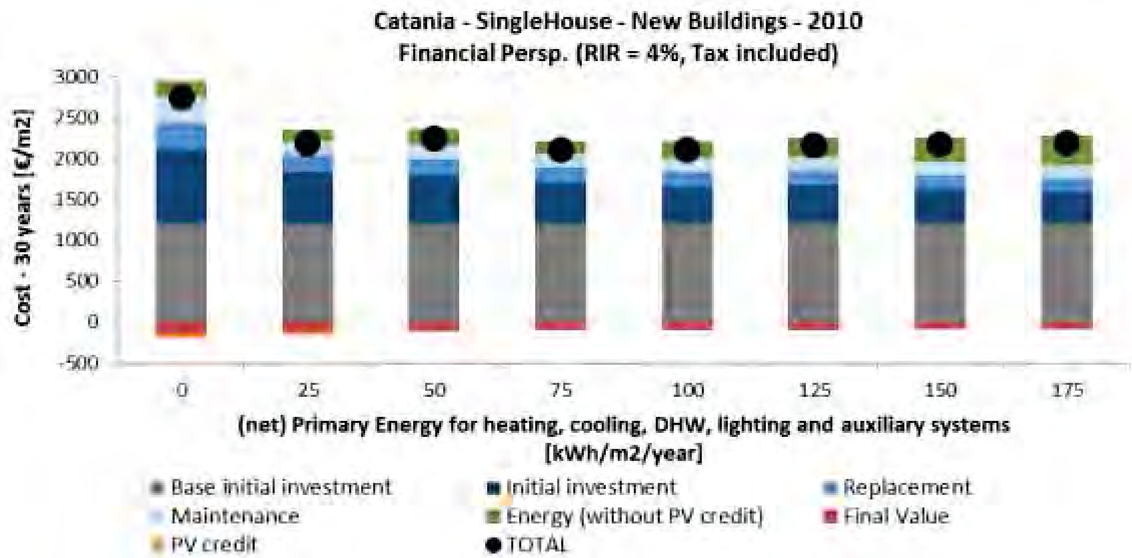


Figure 66. Disaggregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4 %) and the cost data 2010.

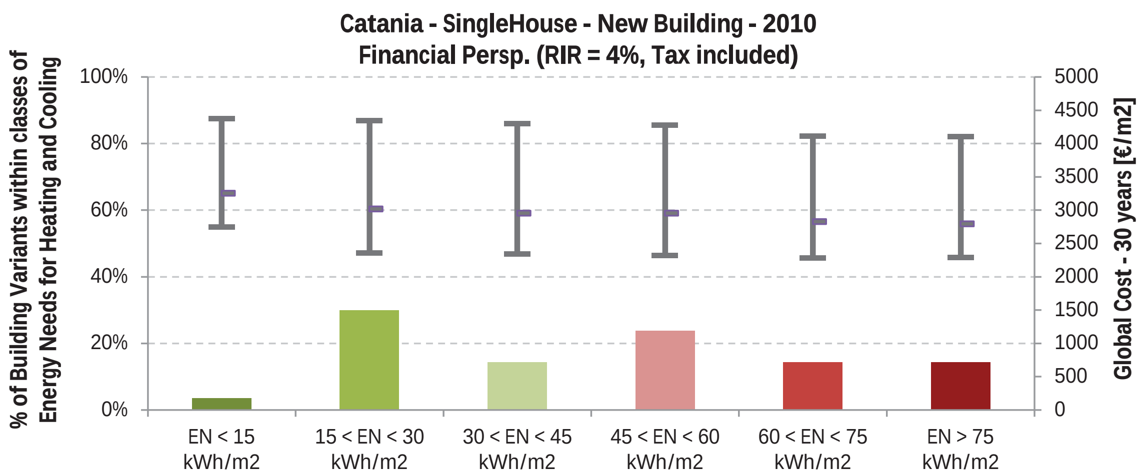


Figure 67. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

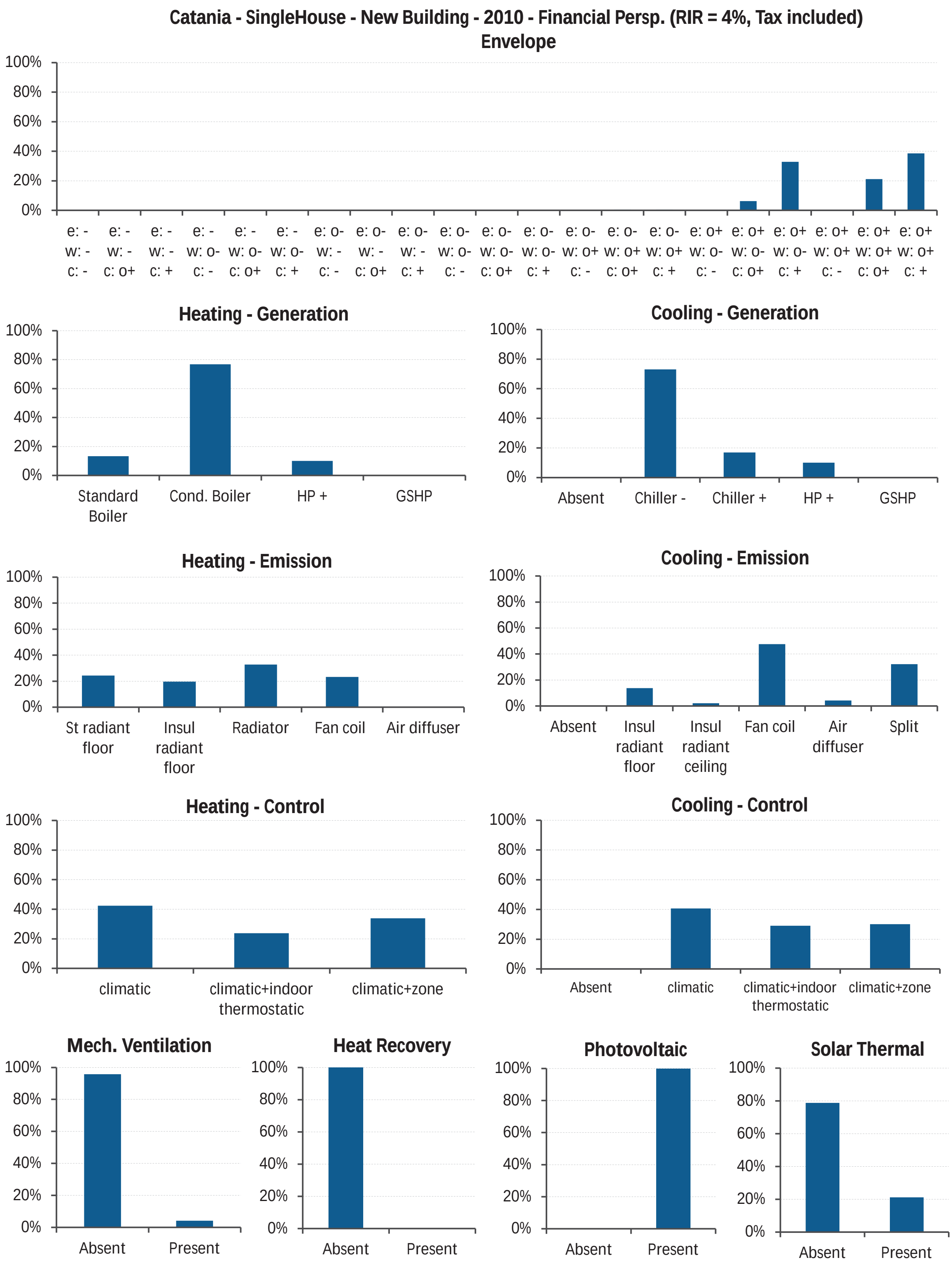


Figure 68. Ways to reach the nZEB target, Statistical analysis of technologies, Catania, SFH

	Min	Max
Range of Primary Energy [kWh/m2/y]:	0	15
Range of Global Costs [€/m2]:	2397	2756
Number of Building Variants:	189	

Figure 69. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

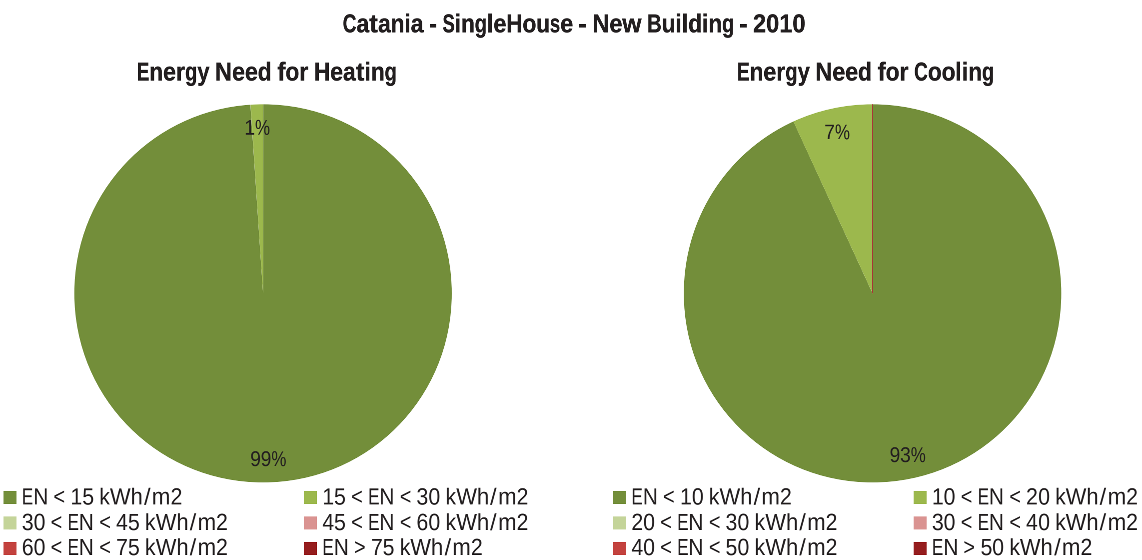


Figure 70. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

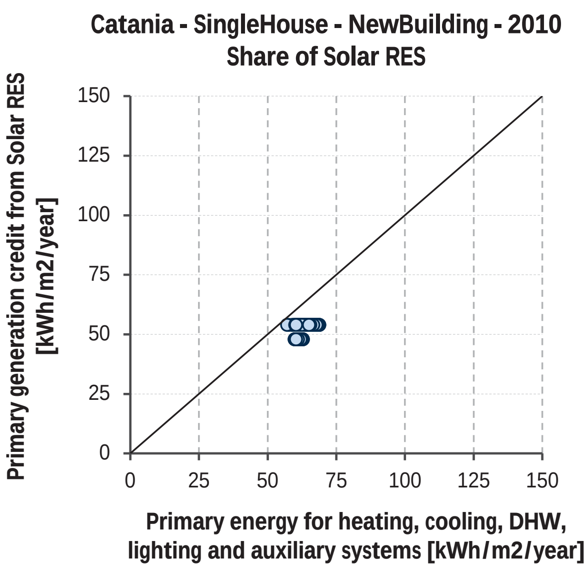


Figure 71. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.5 Paris – Office

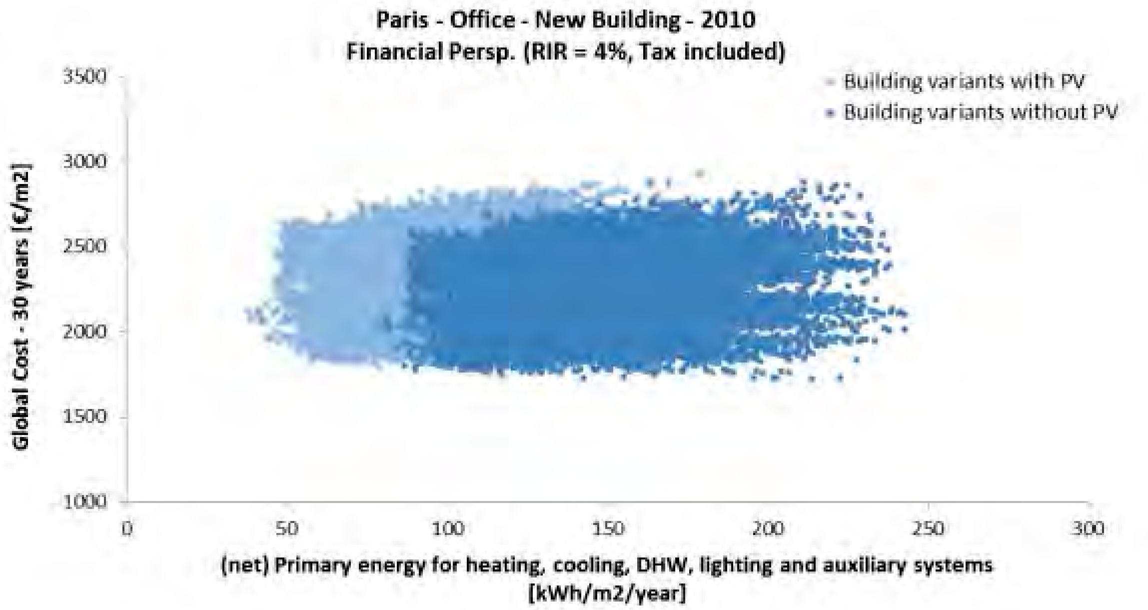


Figure 72. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

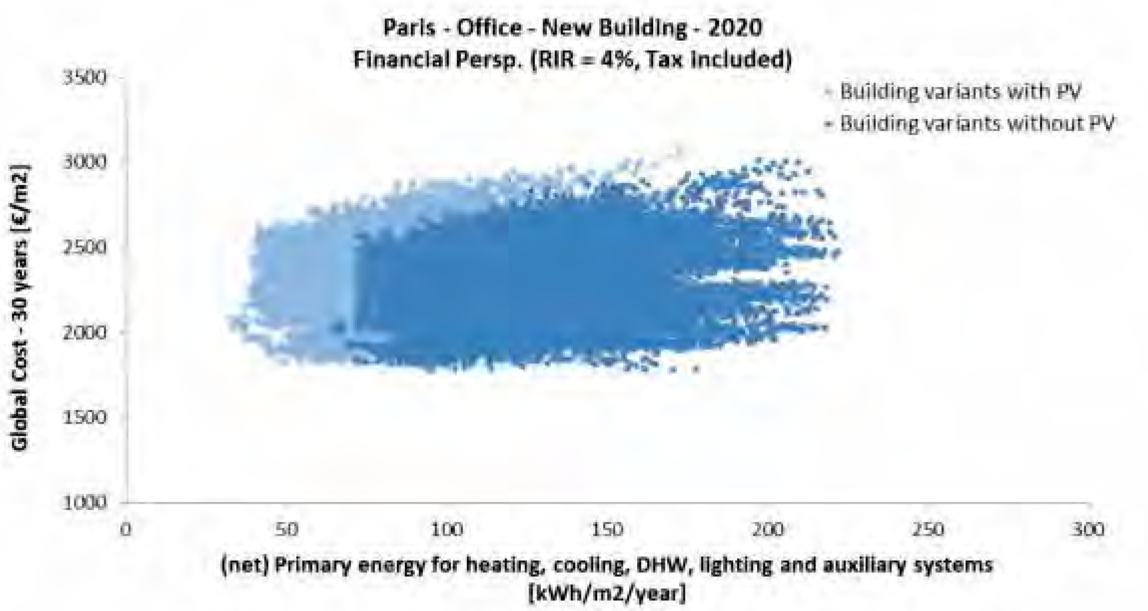


Figure 73. Global costs versus (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

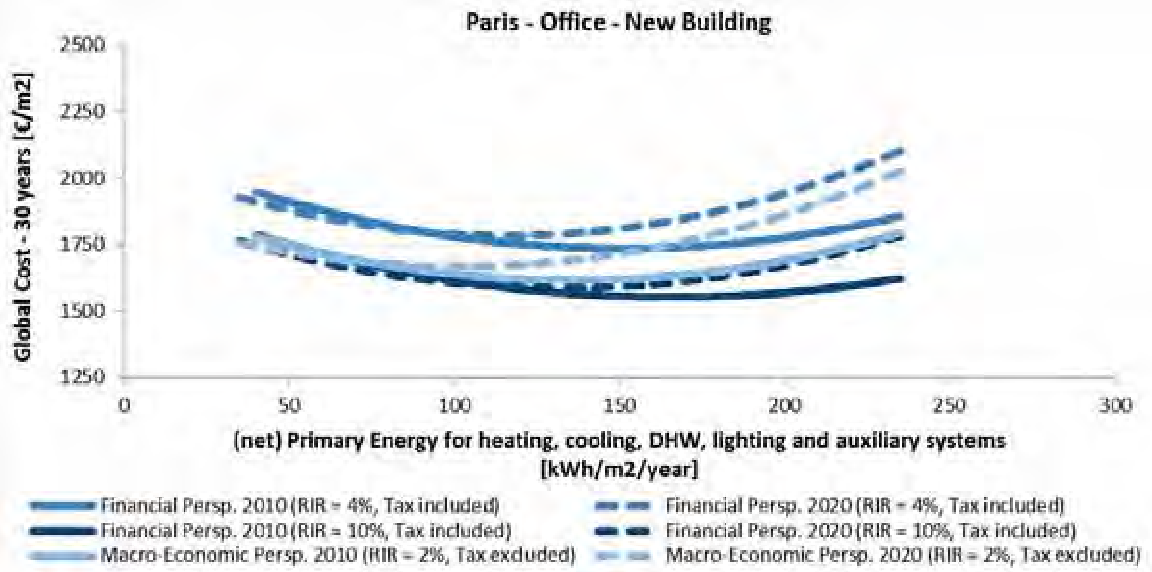


Figure 74. New building: sensitivity analysis on the lower profile of the energy/cost domain as a function of several key economic perspectives and different cost database (2010/2020).

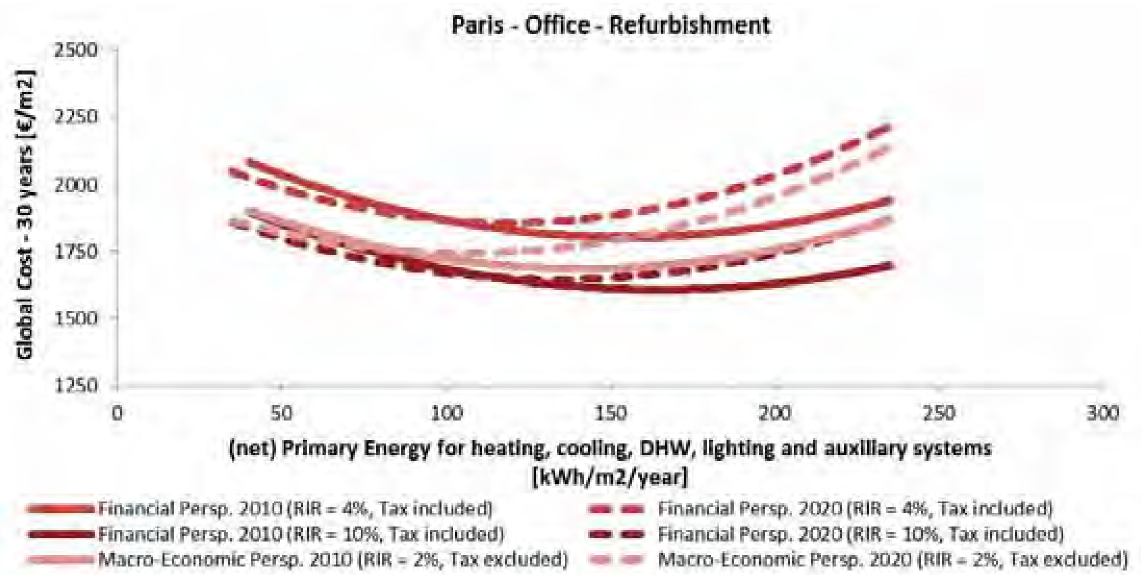


Figure 75. Refurbishment: sensitivity analysis on the lower profile of the energy/cost domain as a function of several key economic perspectives and different cost database (2010/2020).

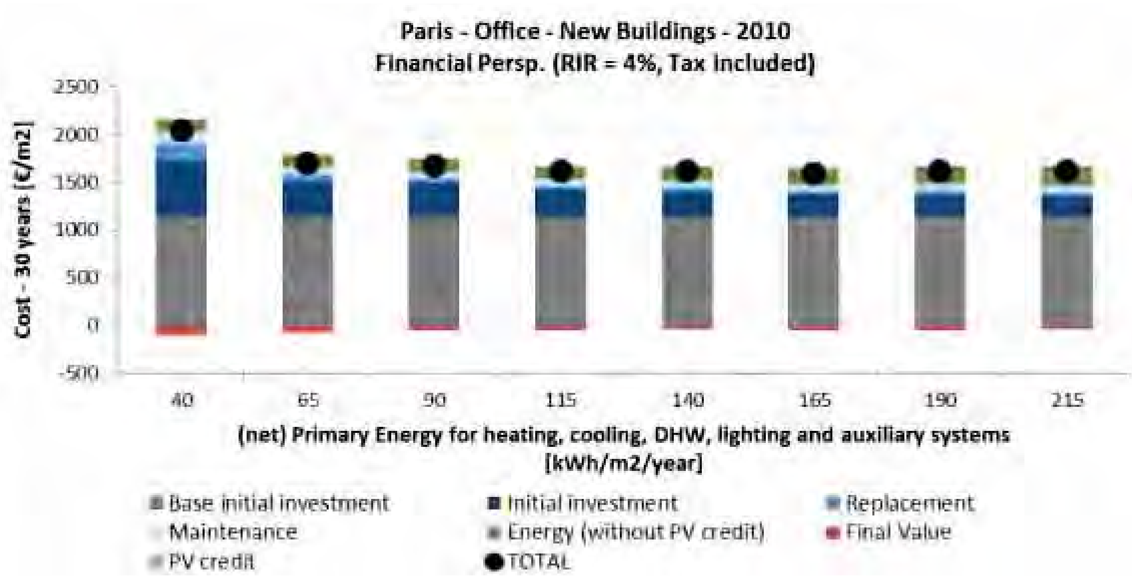


Figure 76. Disaggregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

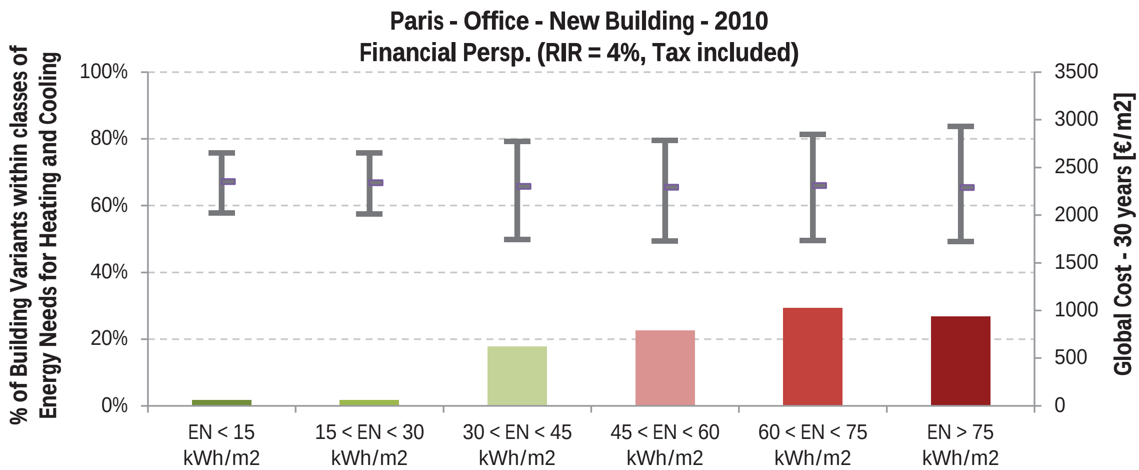


Figure 77. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

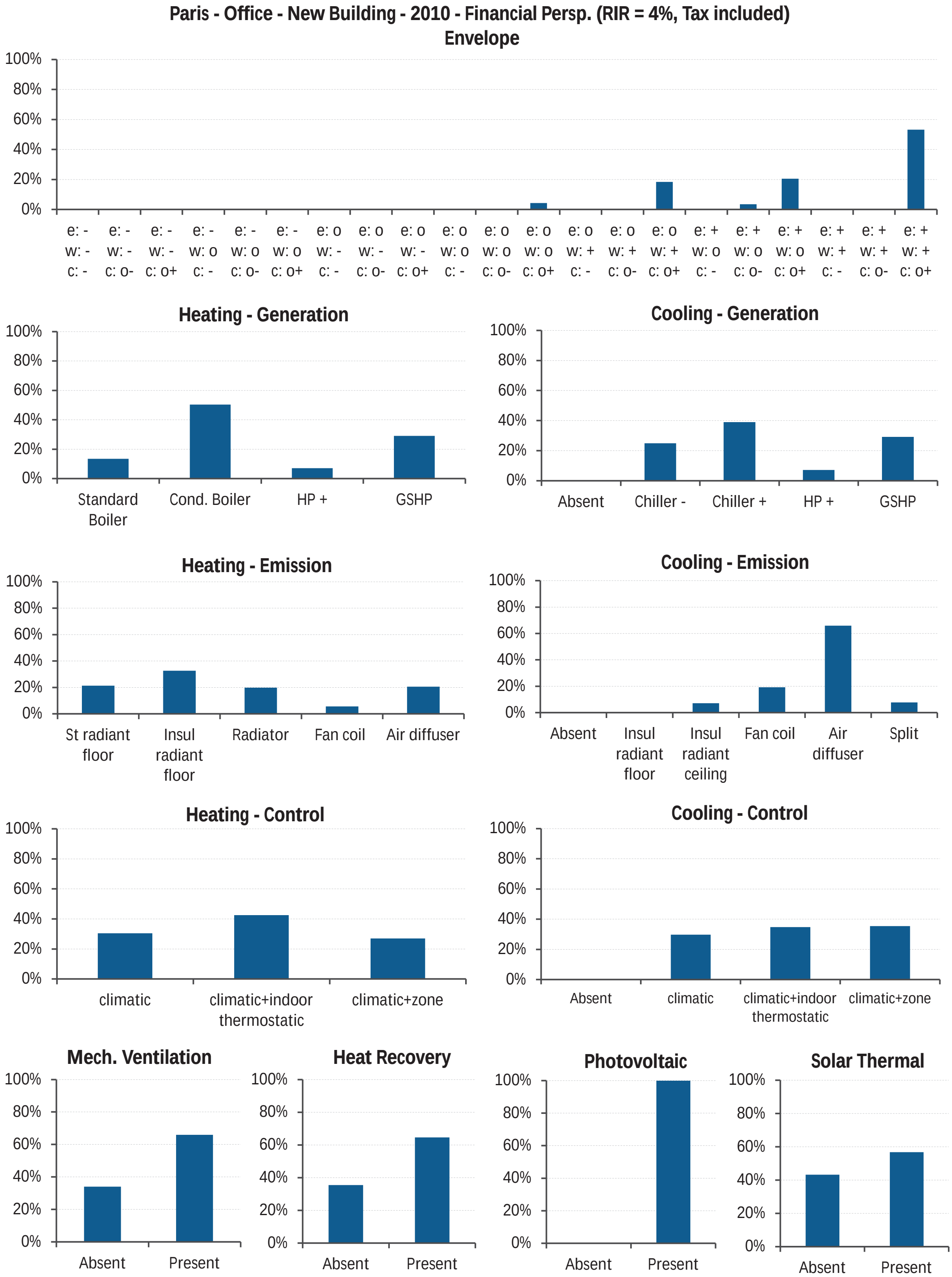


Figure 78. Ways to reach the nZEB target, Statistical analysis of technologies, Paris, Office

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	Min	Max
Range of Primary Energy [kWh/m²/y]:	38	55
Range of Global Costs [€/m²]:	1869	2242
Number of Building Variants:	141	

Figure 79. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

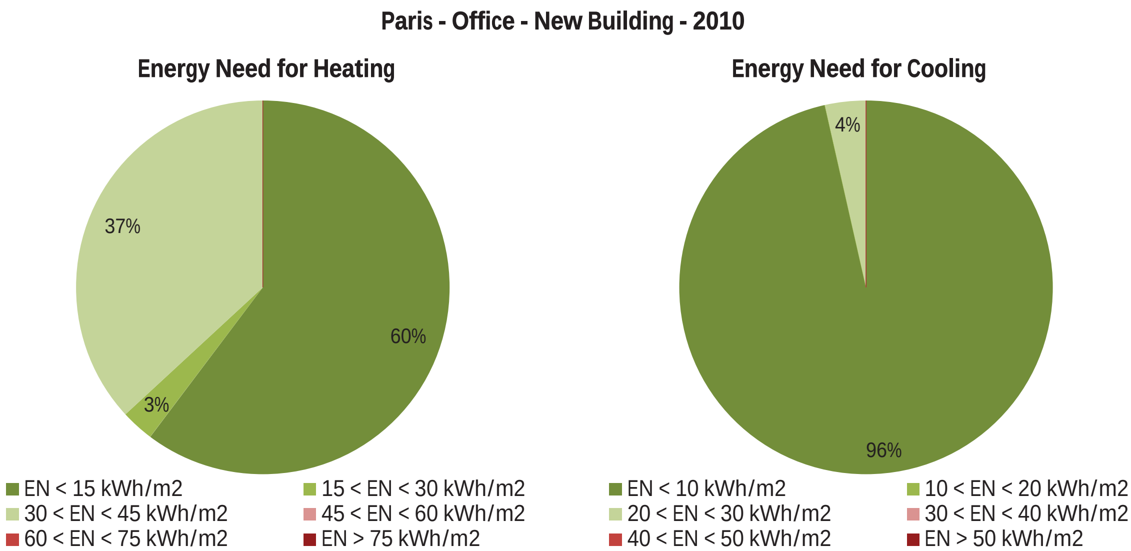

Figure 80. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

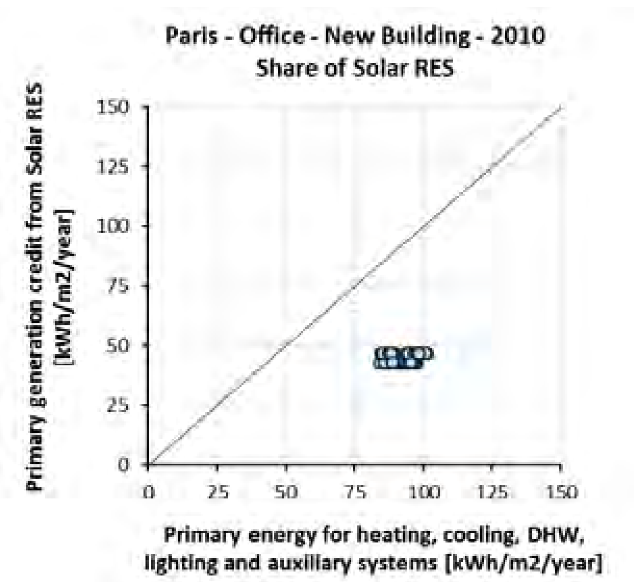

Figure 81. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

0

6.1.6.6 Paris – Single House

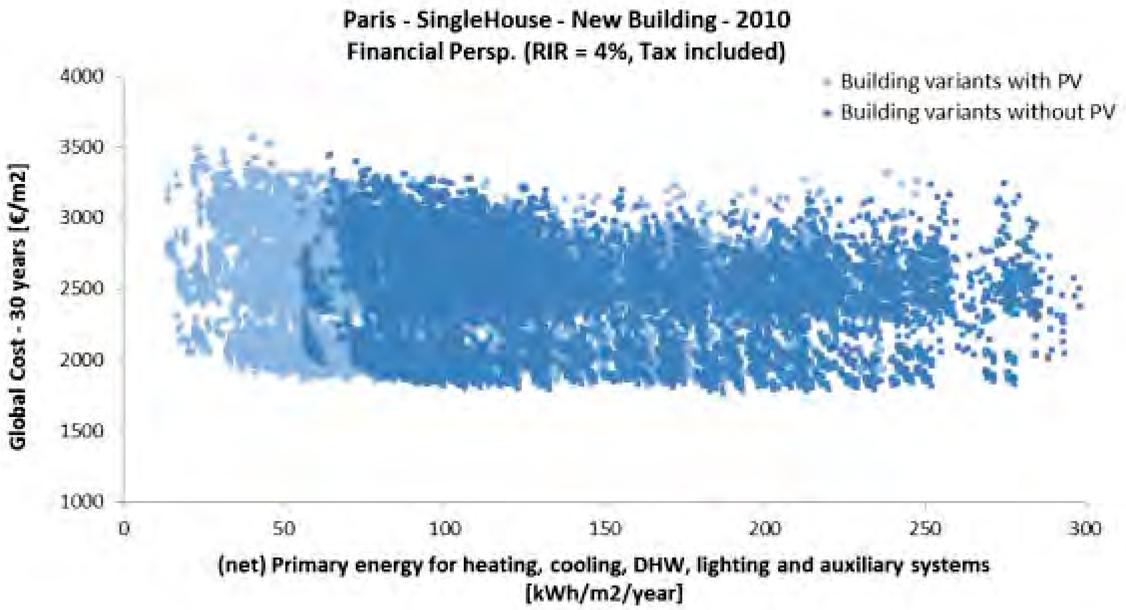

Figure 82. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

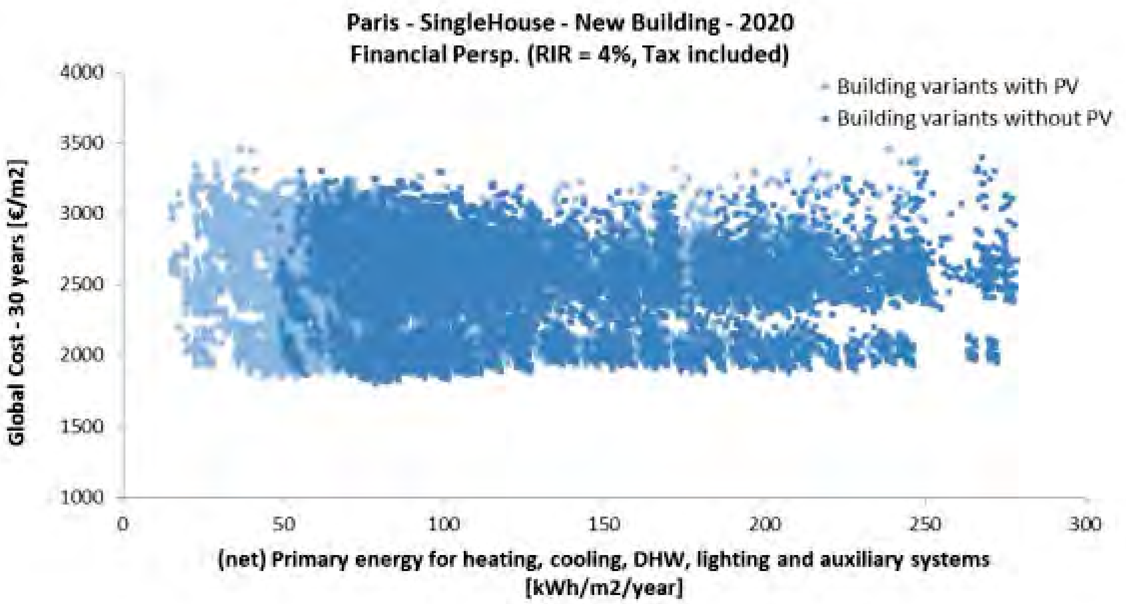

Figure 83. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

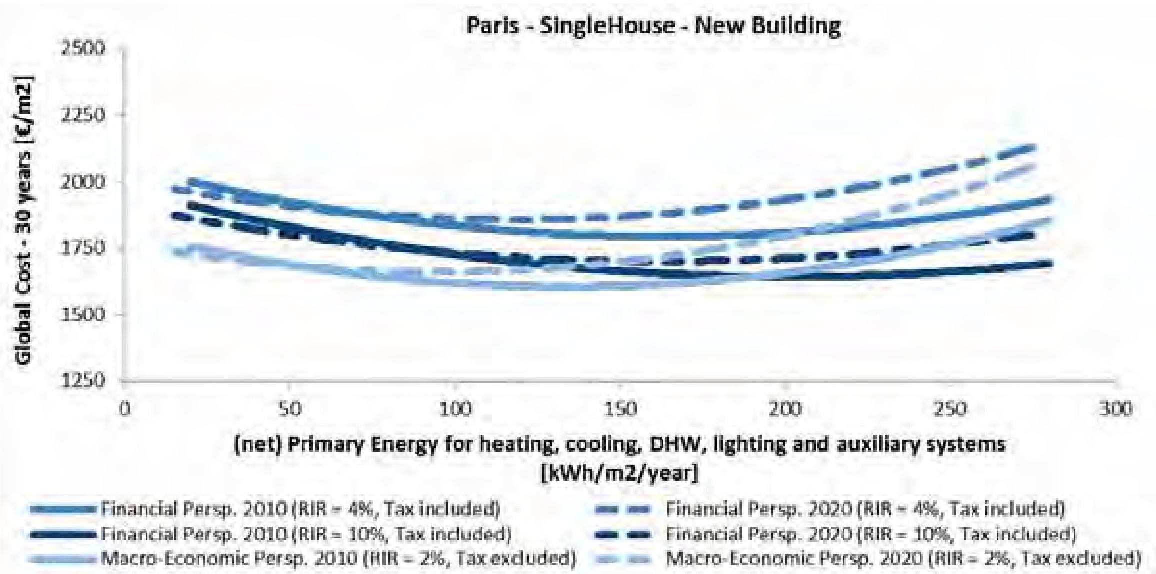

Figure 84. New building: sensitivity analysis on the lower profile of the energy / cost domain as a function of several key economic perspectives and different cost database (2010 / 2020).

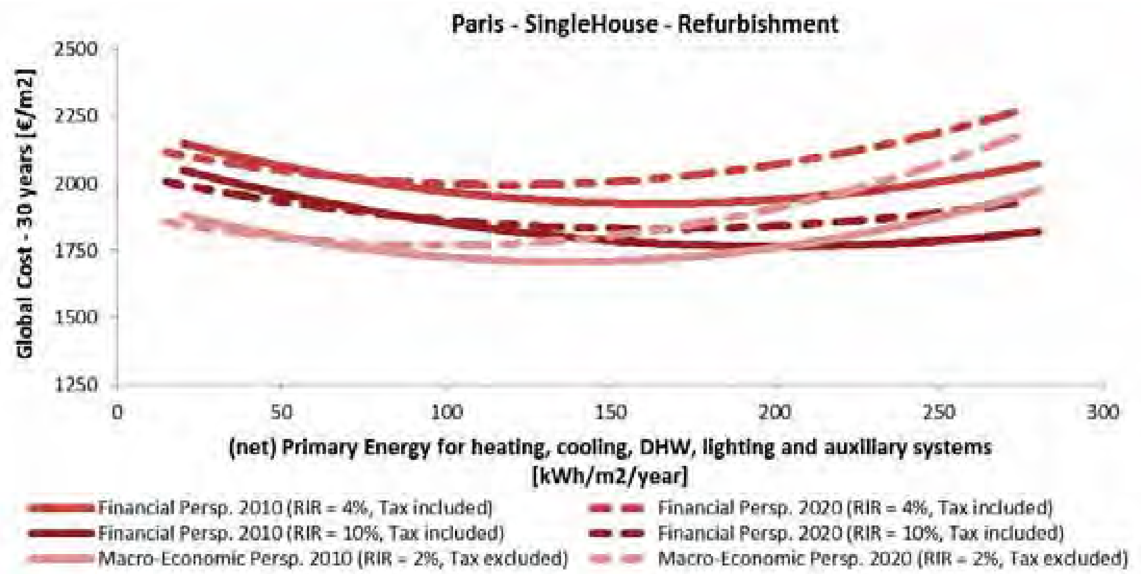

Figure 85. Refurbishment: sensitivity analysis on the lower profile of the energy / cost domain as a function of several key economic perspectives and different cost database (2010 / 2020).

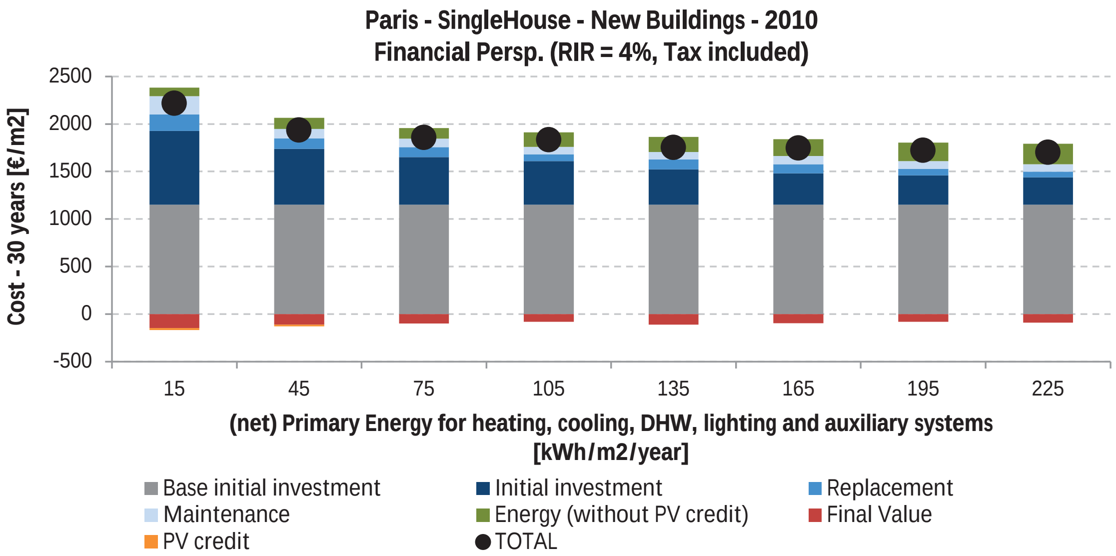

Figure 86. Disaggregation of building costs for several building variants on the lower profile of the energy/cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

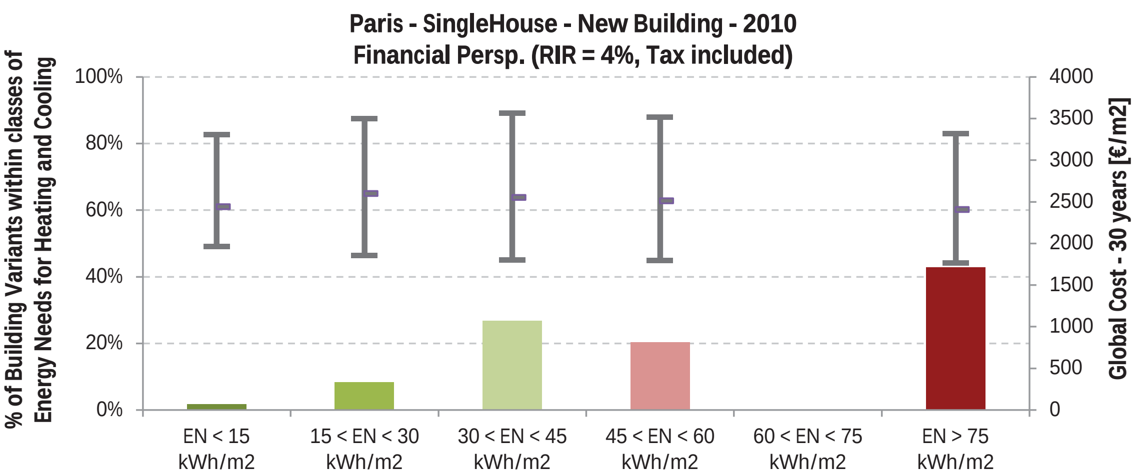

Figure 87. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum/mean/maximum global cost within the whole dominium of variation.

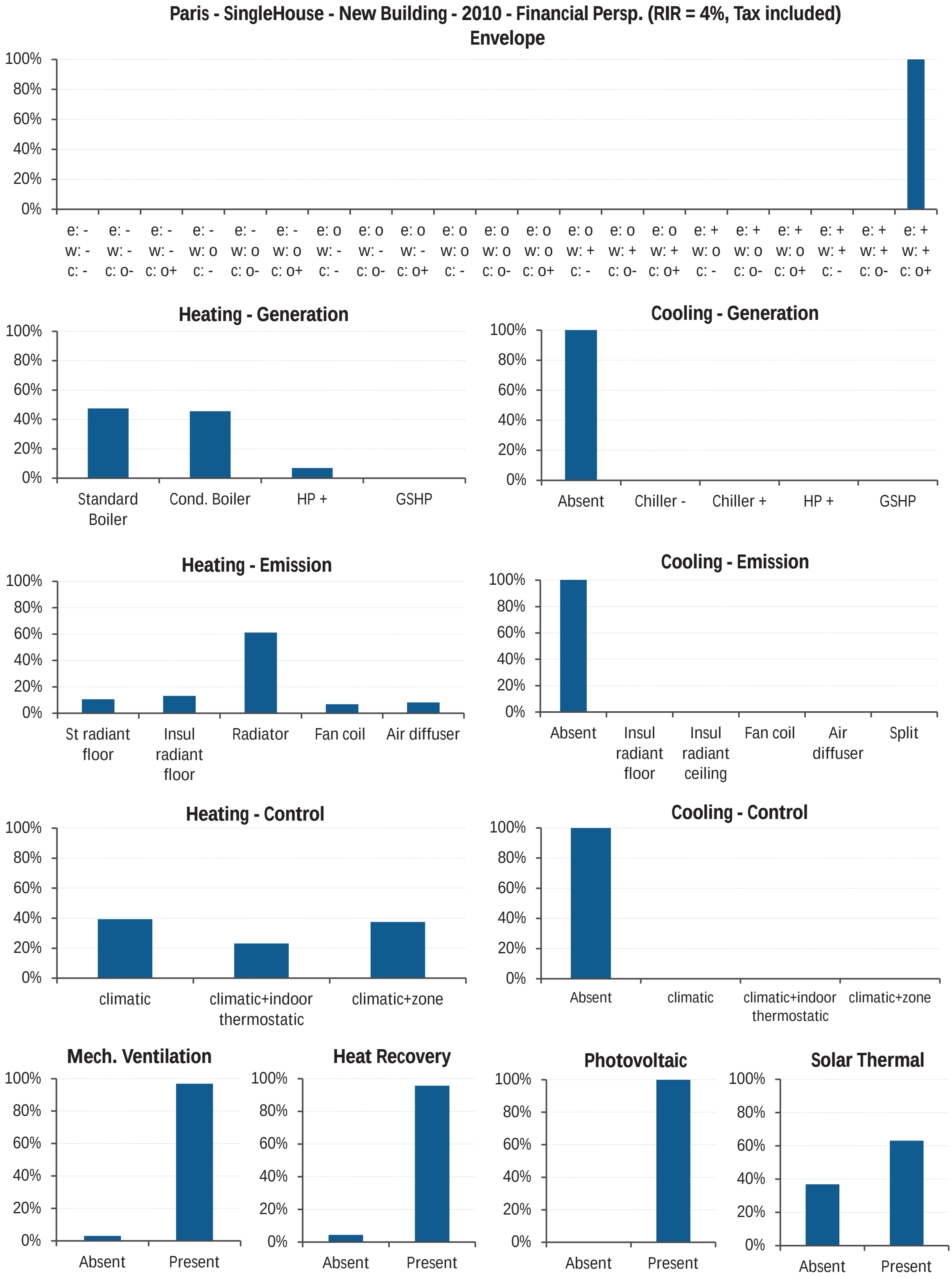

Figure 88. Ways to reach the nZEB target, Statistical analysis of technologies, Paris, SFH

	Min	Max
Range of Primary Energy [kWh/m²/y]:	14	30
Range of Global Costs [€/m²]:	2078	2493
Number of Building Variants:	160	

Figure 89. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

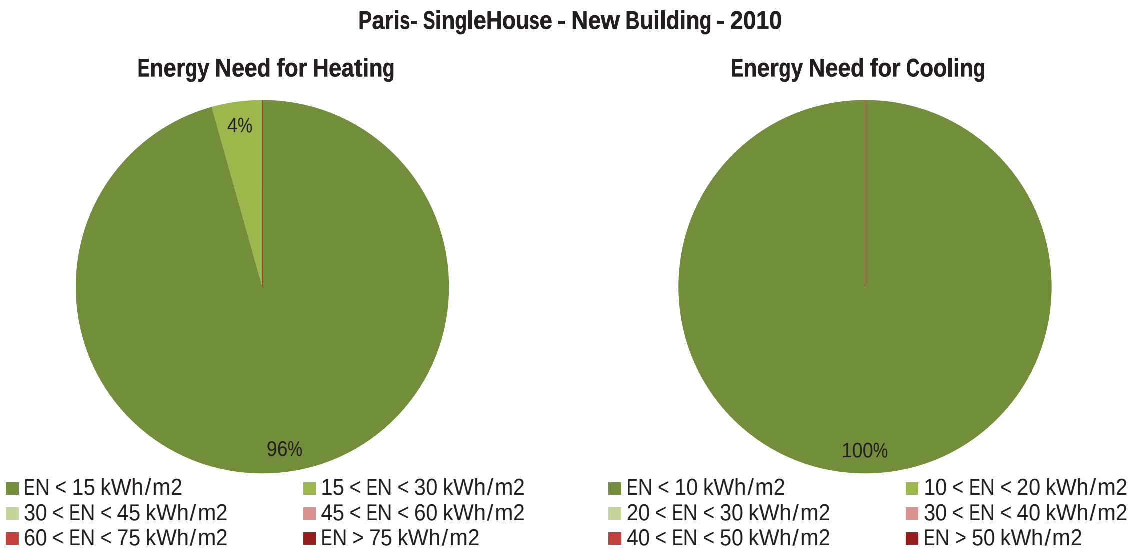

Figure 90. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

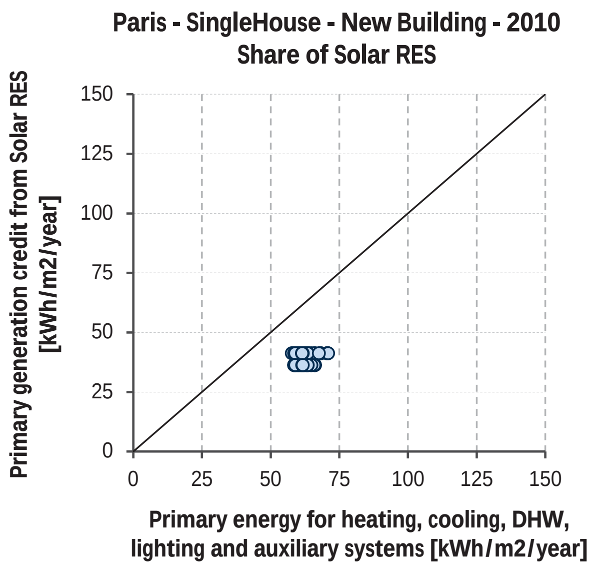

Figure 91. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.7 Budapest – Office

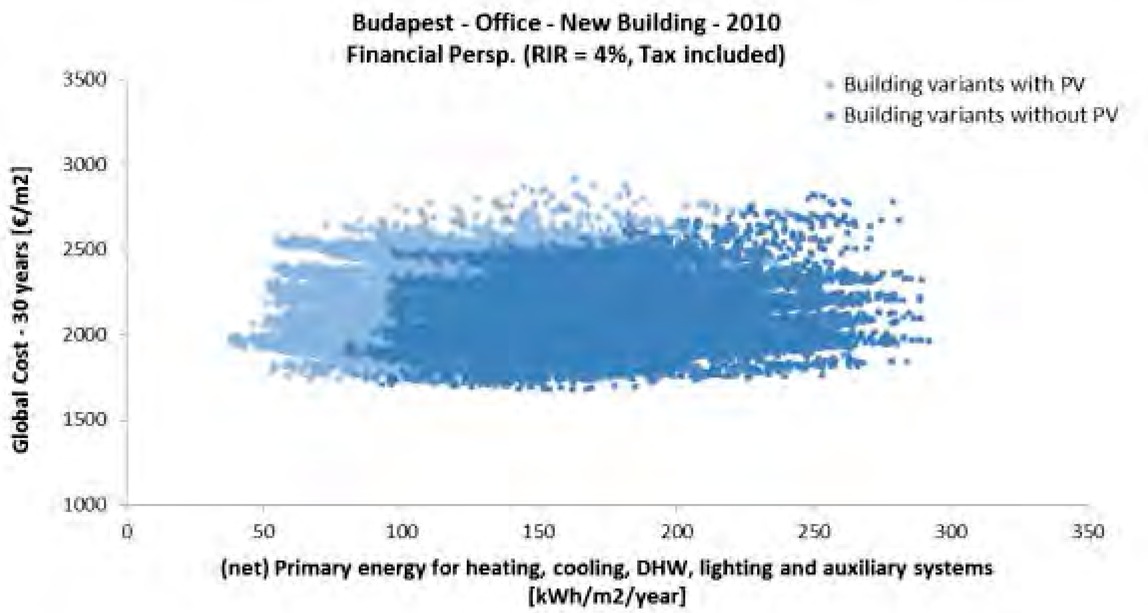

Figure 92. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

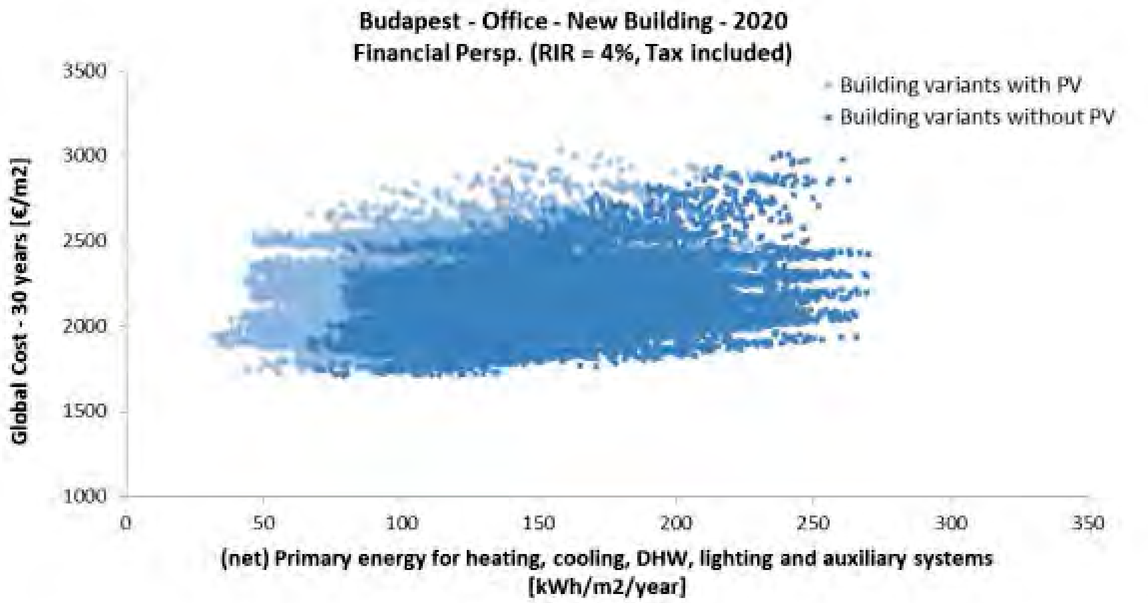

Figure 93. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

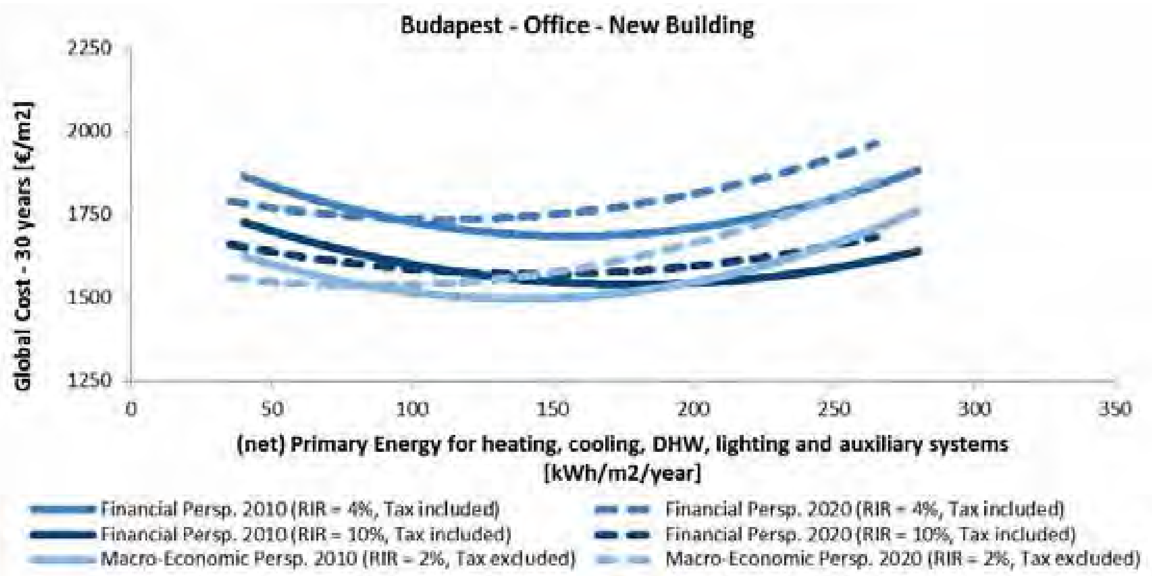

Figure 94. New building: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

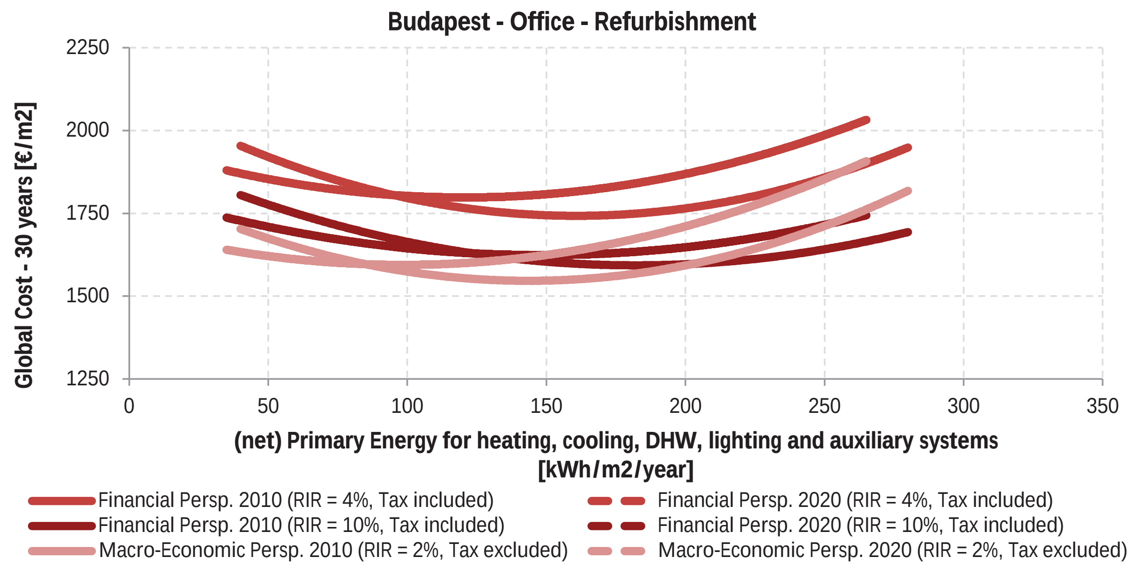

Figure 95. Refurbishment: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

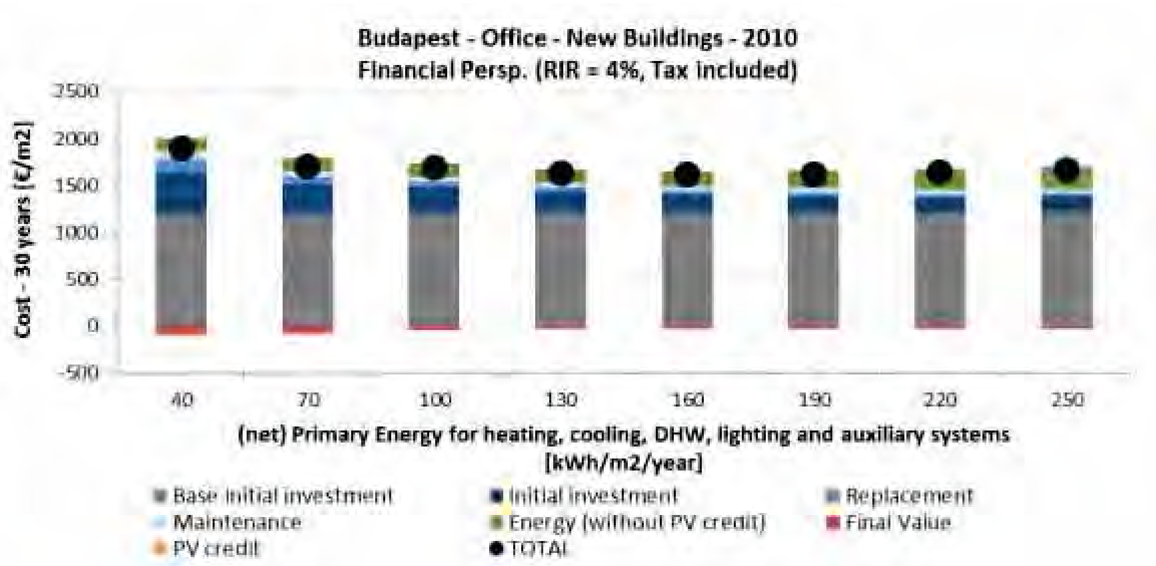

Figure 96. Disaggregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

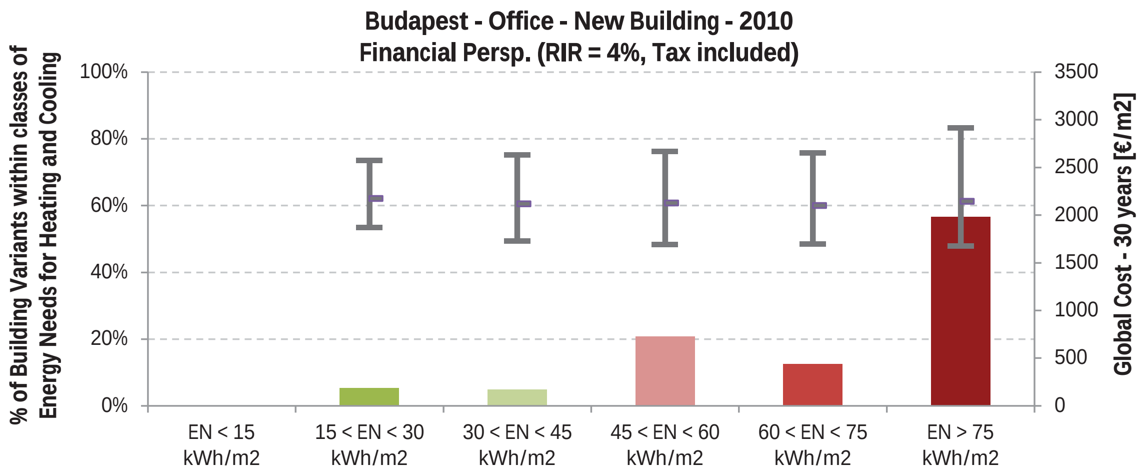

Figure 97. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

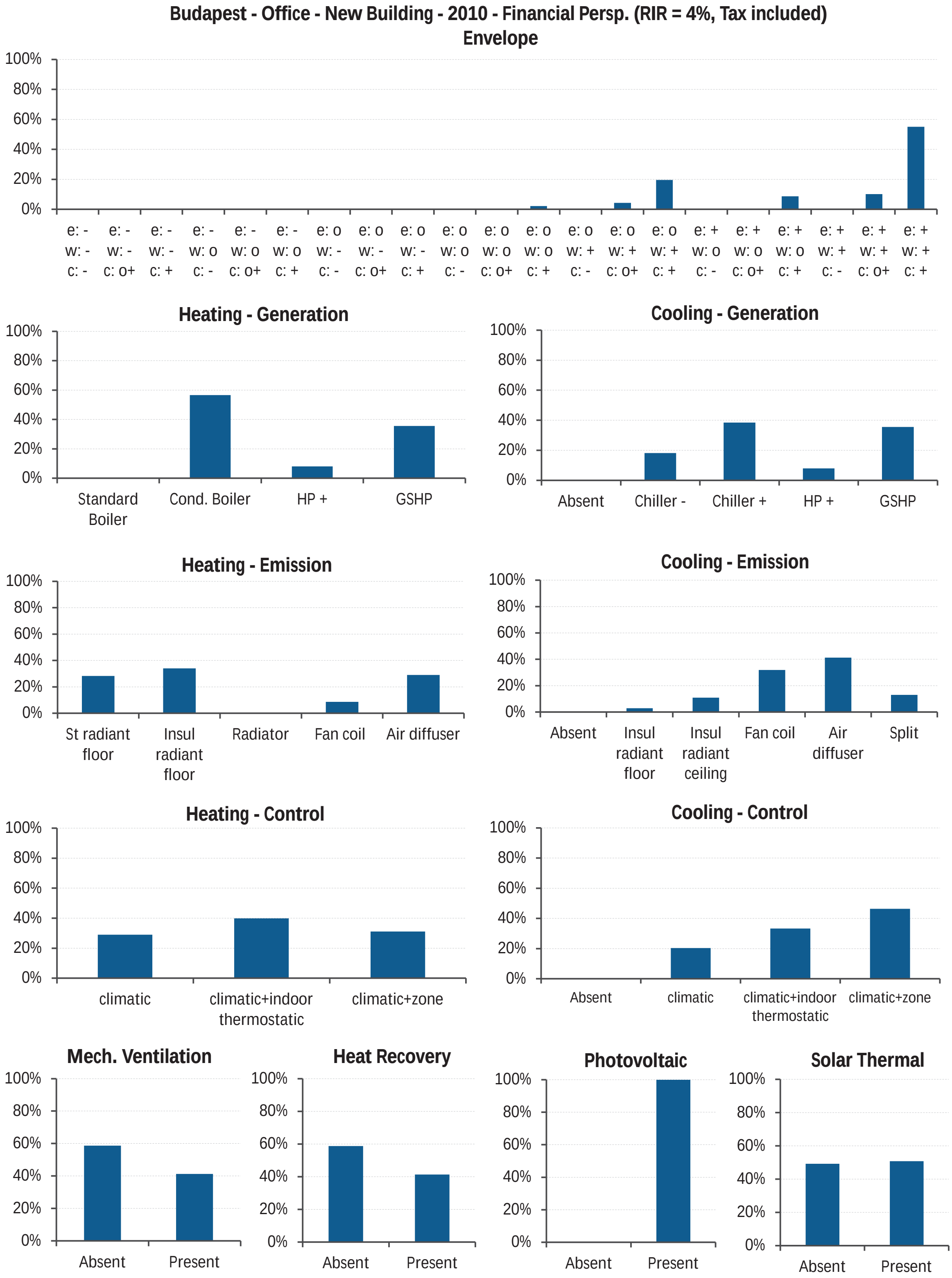

Figure 98. Ways to reach the nZEB target, Statistical analysis of technologies, Budapest, Office

	Min	Max
Range of Primary Energy [kWh/m²/y]:	38	55
Range of Global Costs [€/m²]:	1778	2133
Number of Building Variants:	138	

Figure 99. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

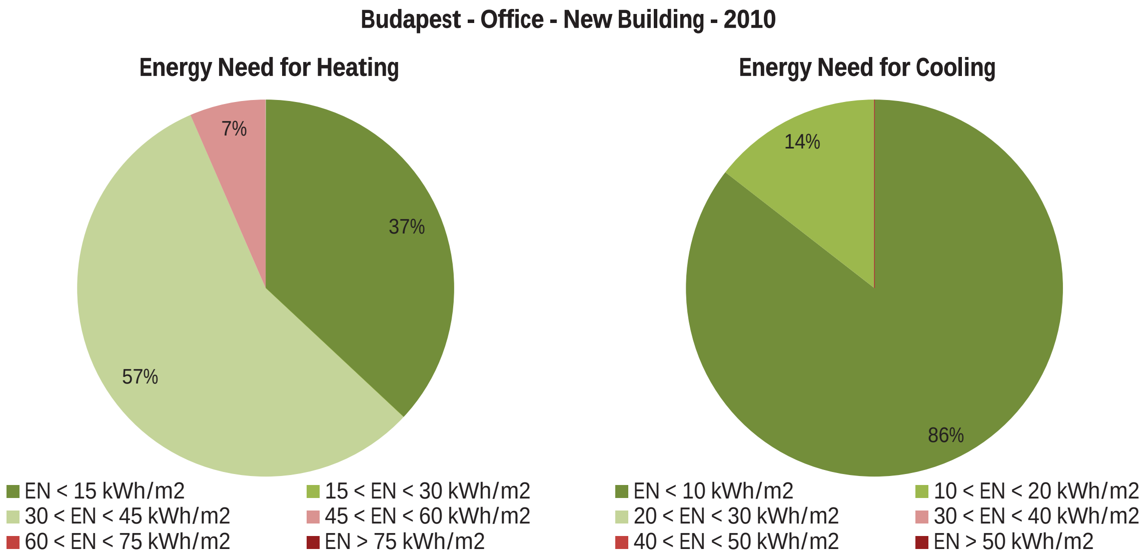

Figure 100. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

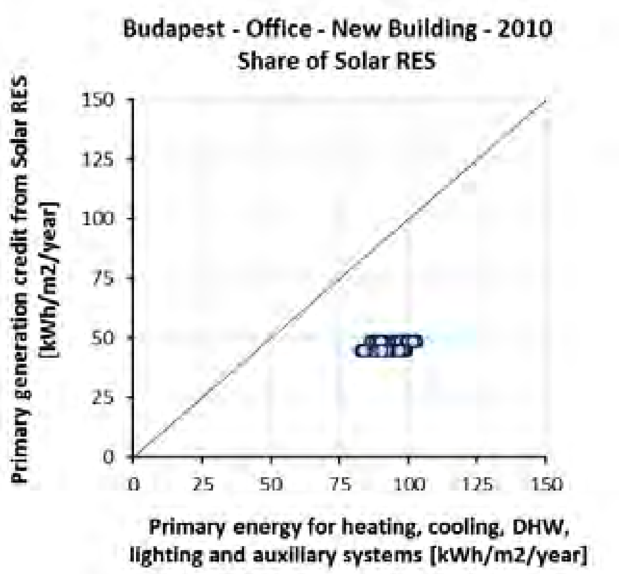

Figure 101. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.8 Budapest – Single House

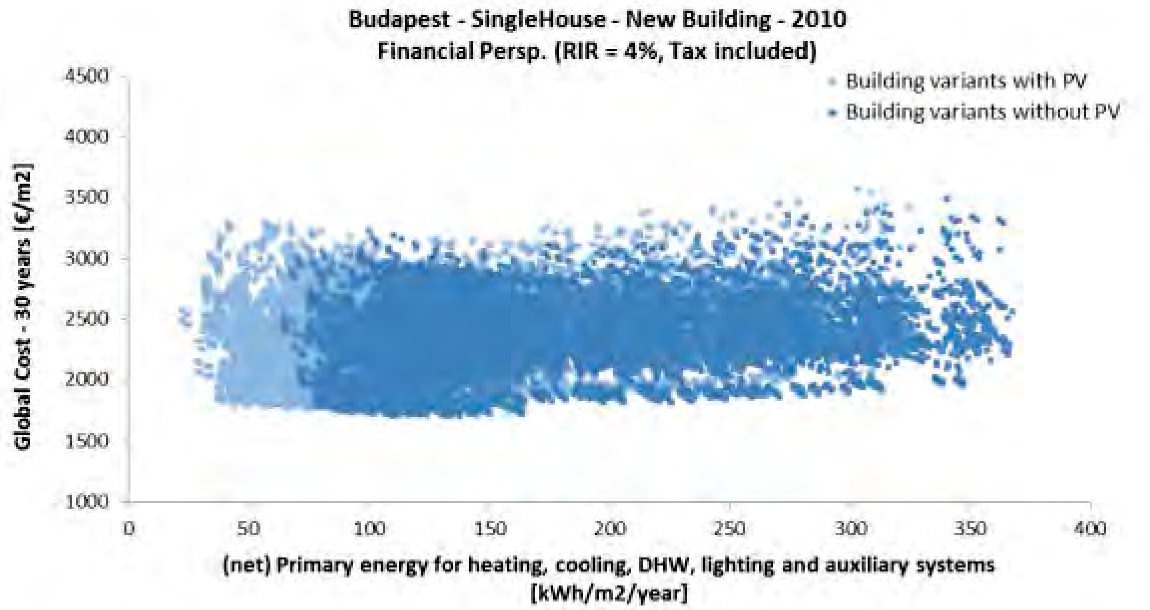

Figure 102. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

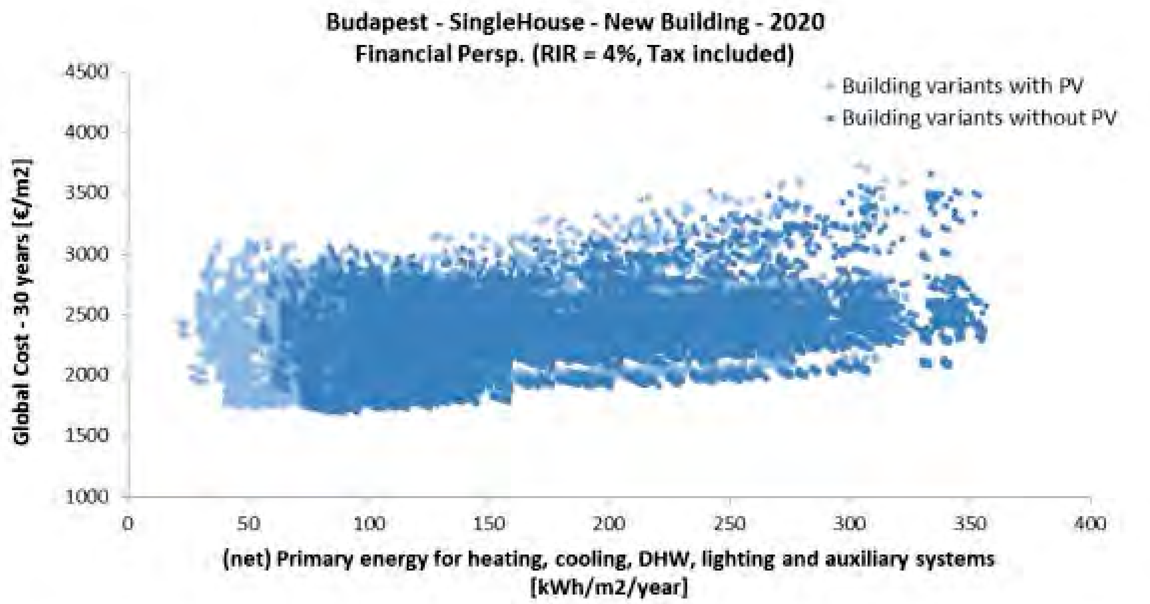

Figure 103. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

0

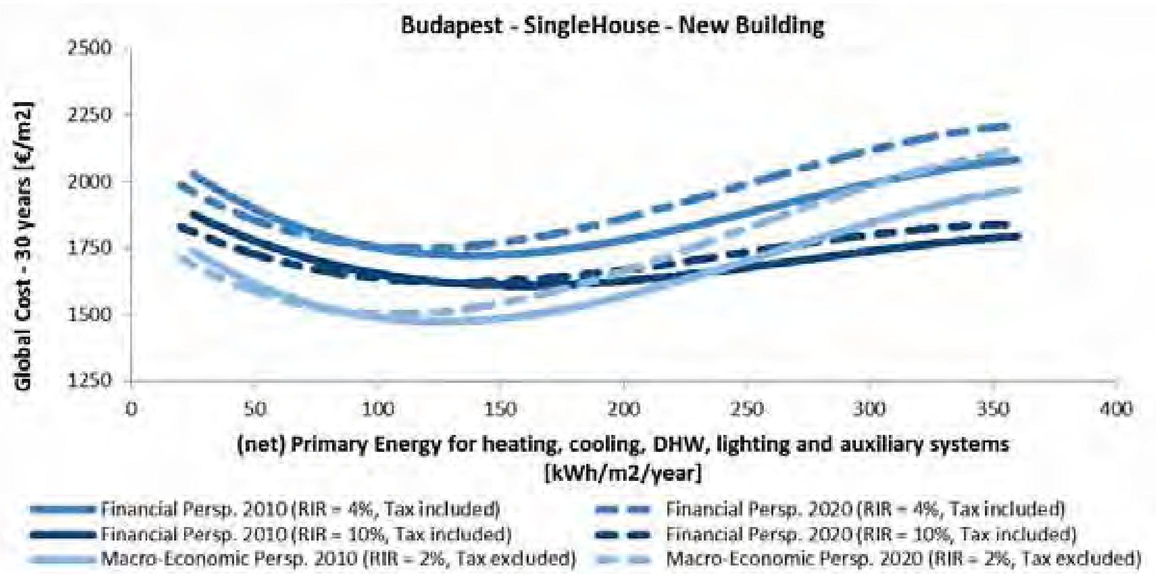

Figure 104. New building: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

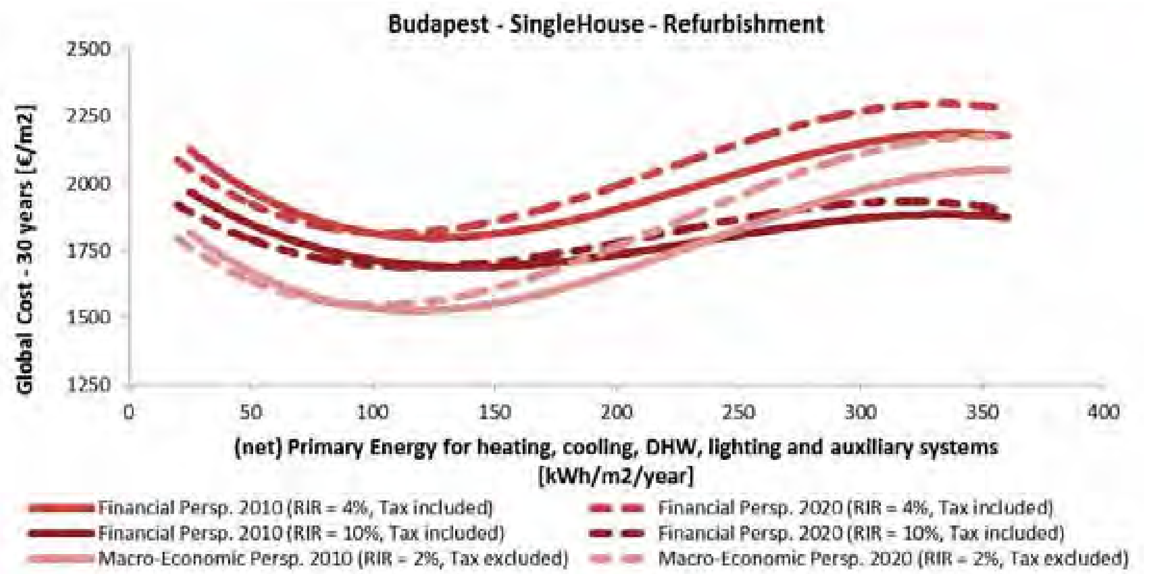

Figure 105. Refurbishment: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

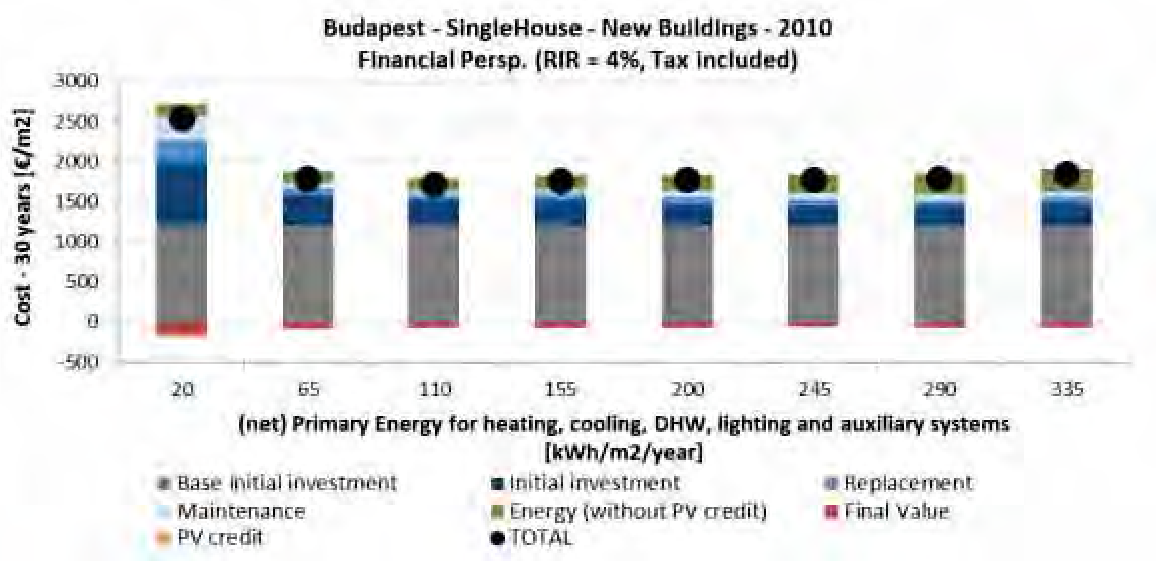

Figure 106. Disagregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

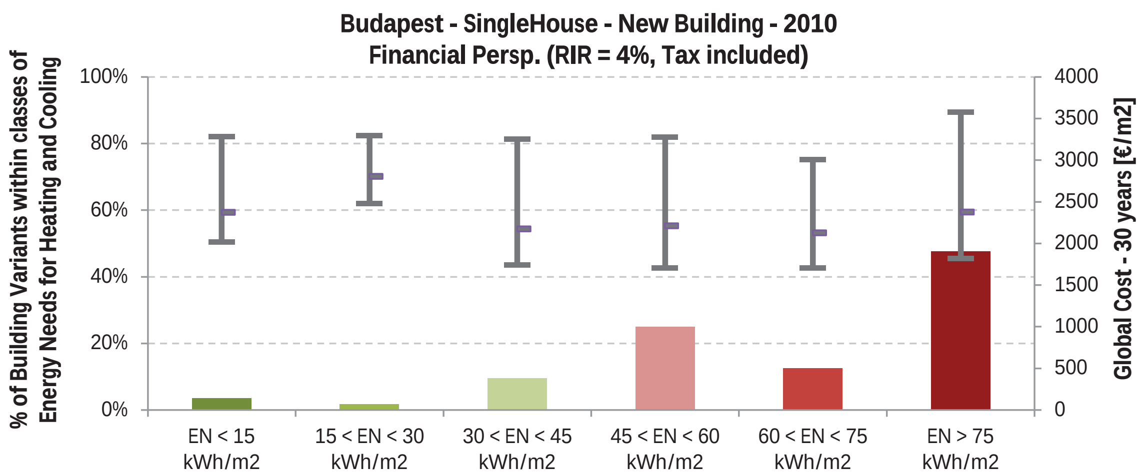

Figure 107. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

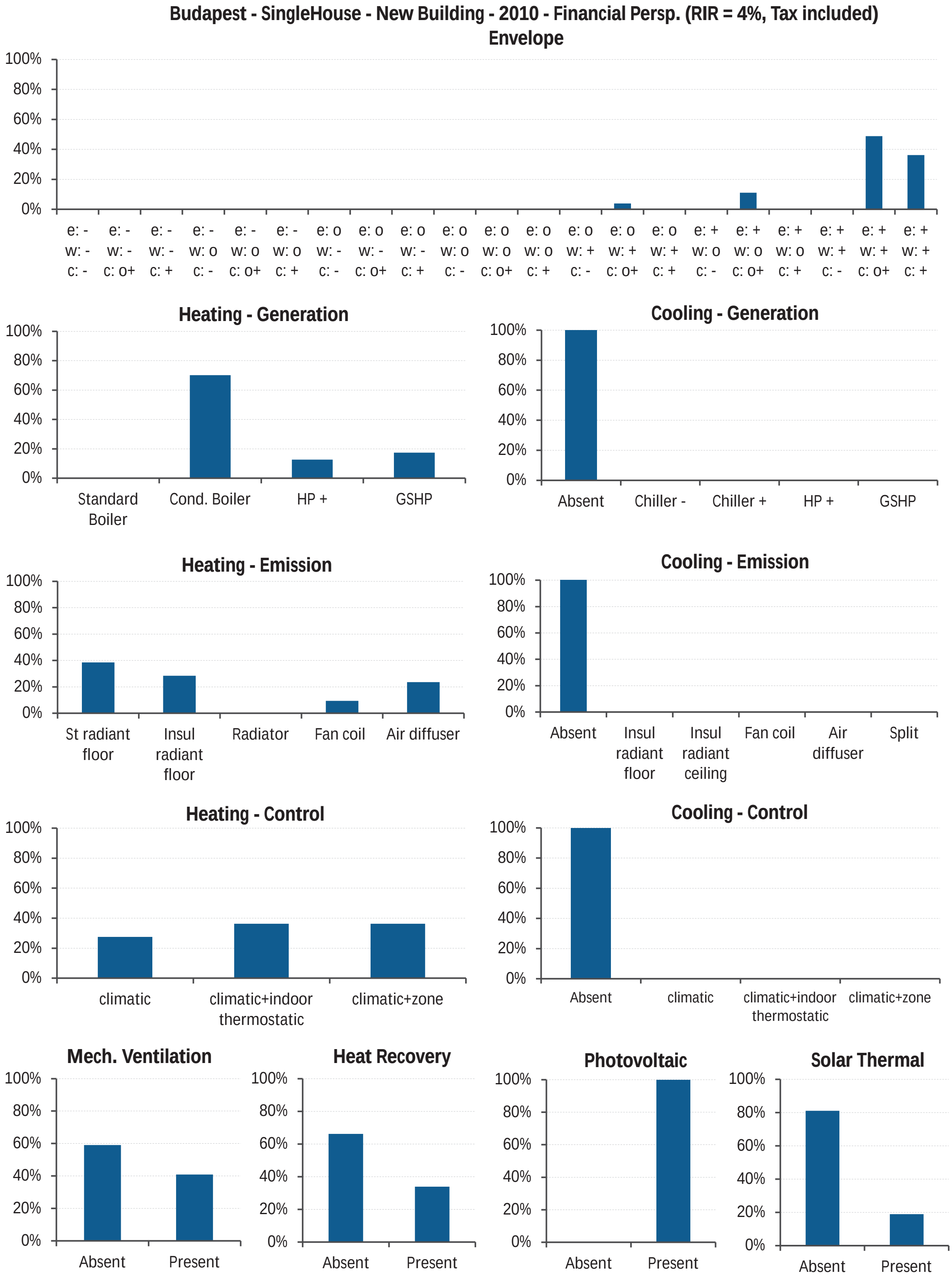

Figure 108. Ways to reach the nZEB target, Statistical analysis of technologies, Budapest, SFH

	Min	Max
Range of Primary Energy [kWh/m²/y]:	22	40
Range of Global Costs [€/m²]:	1824	2463
Number of Building Variants:	127	

Figure 109. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

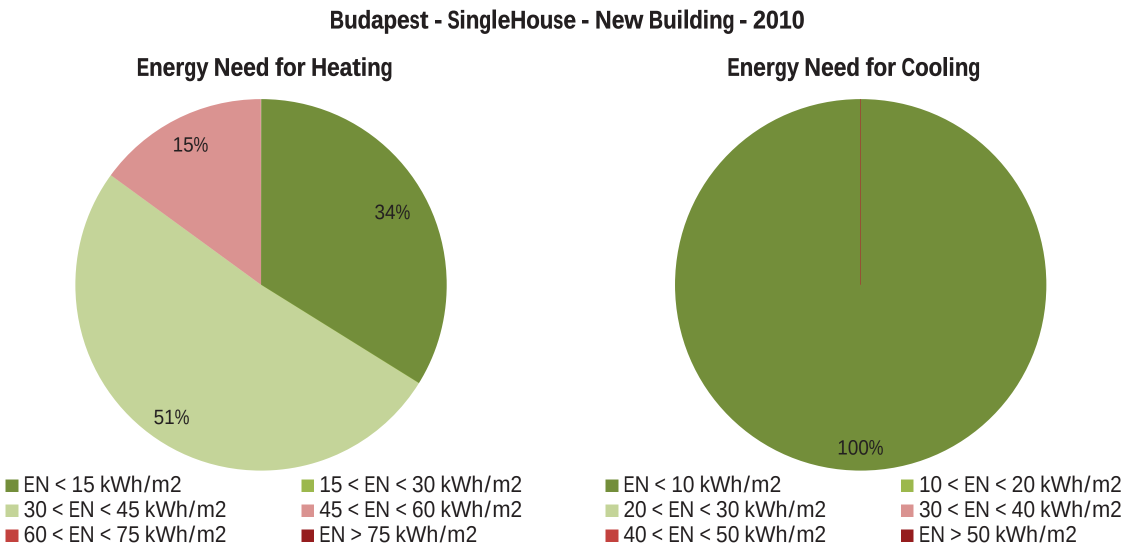

Figure 110. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

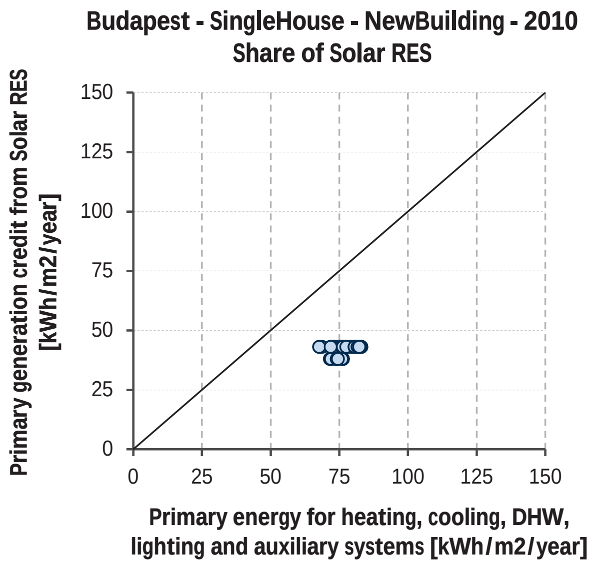

Figure 111. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.9 Stockholm – Office

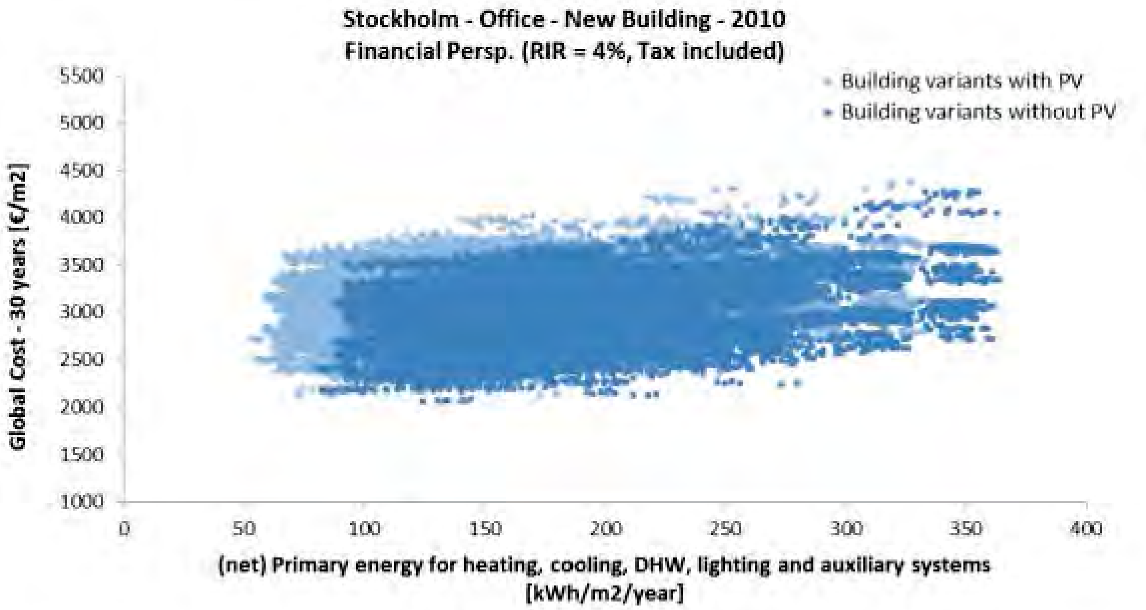

Figure 112. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

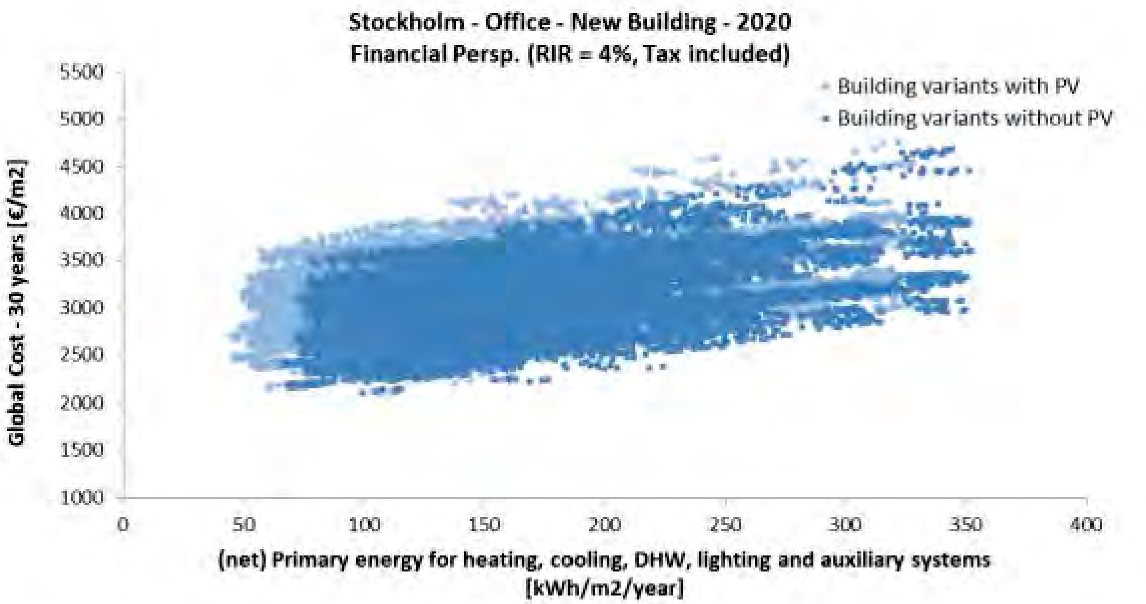

Figure 113. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

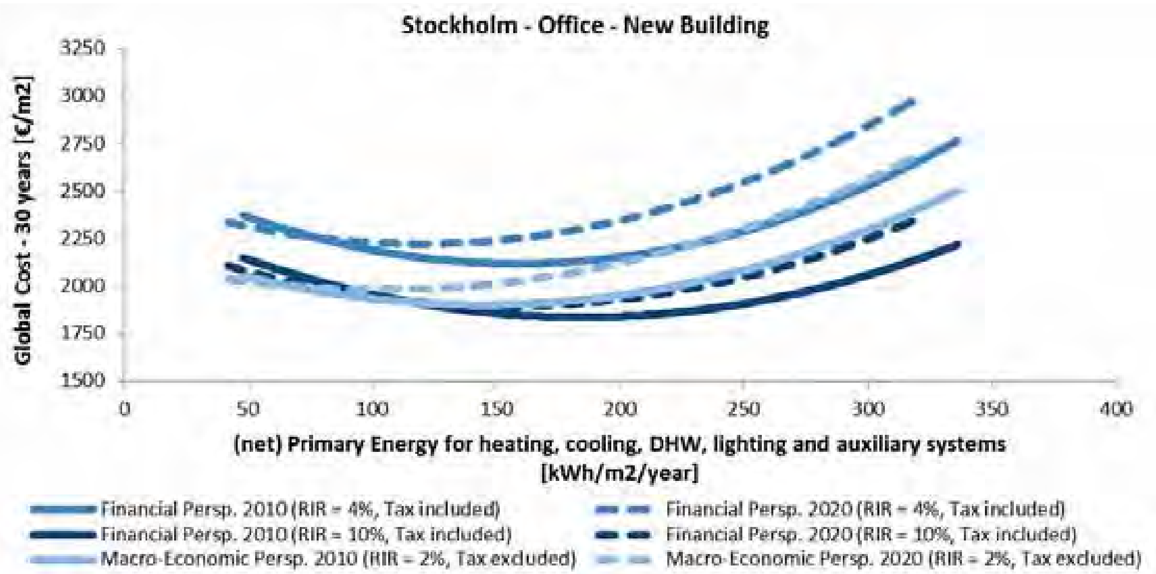

Figure 114. New building: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

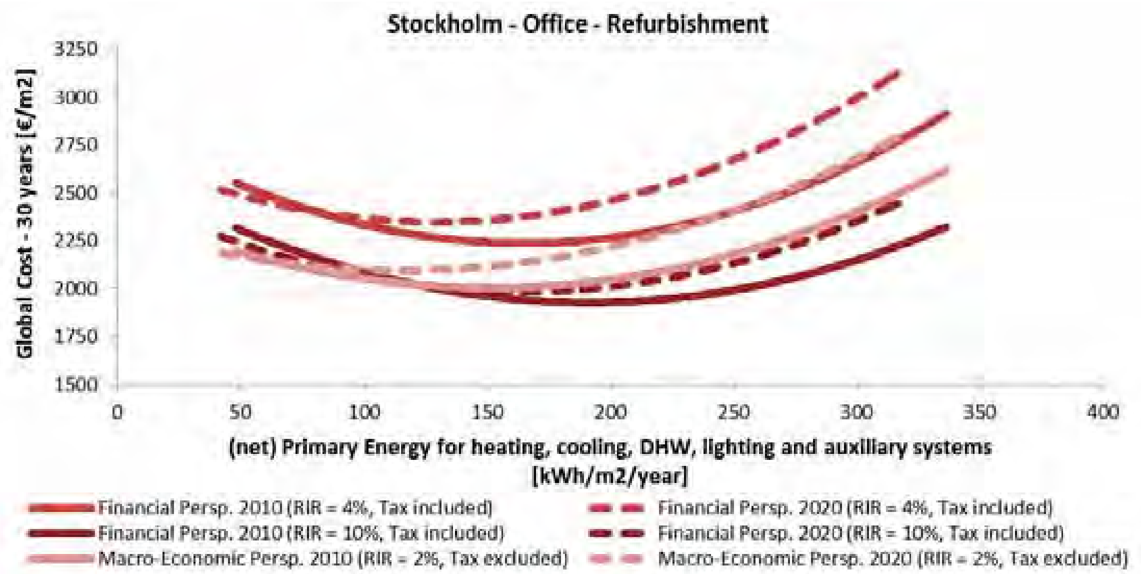

Figure 115. Refurbishment: sensitivity analysis on the lower profile of the energy/cost domain in function of several key economic perspectives and different cost database (2010/2020).

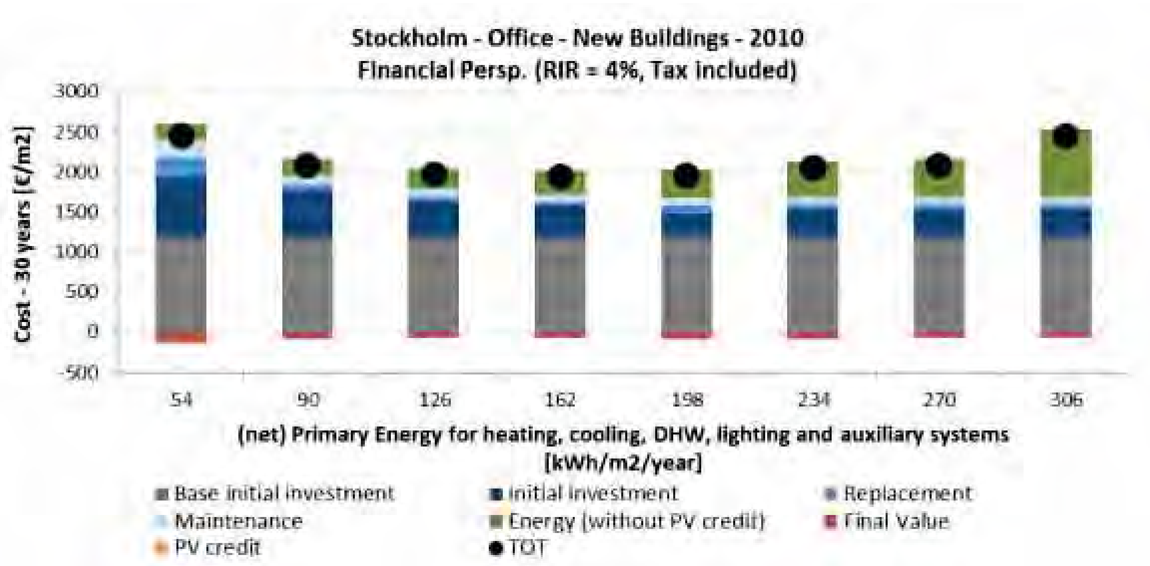

Figure 116. Disagregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

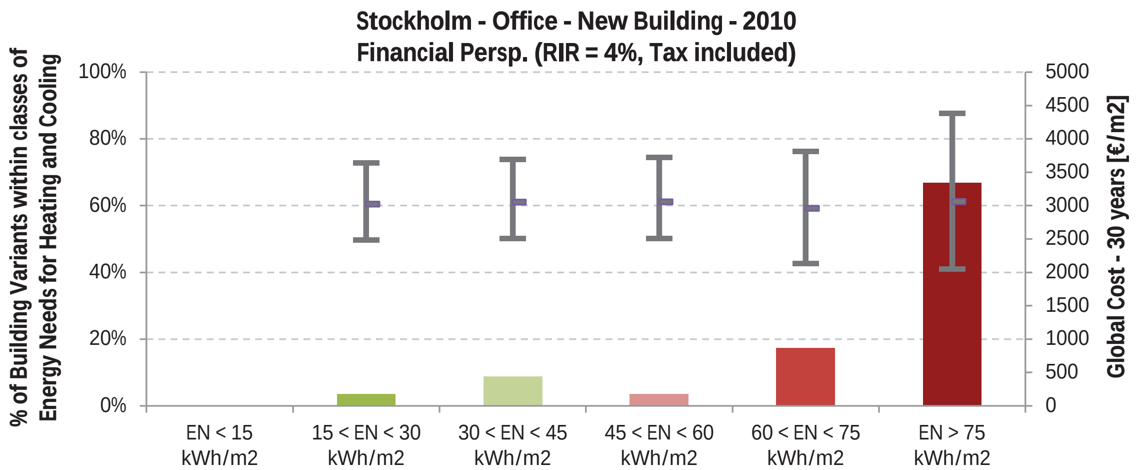

Figure 117. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

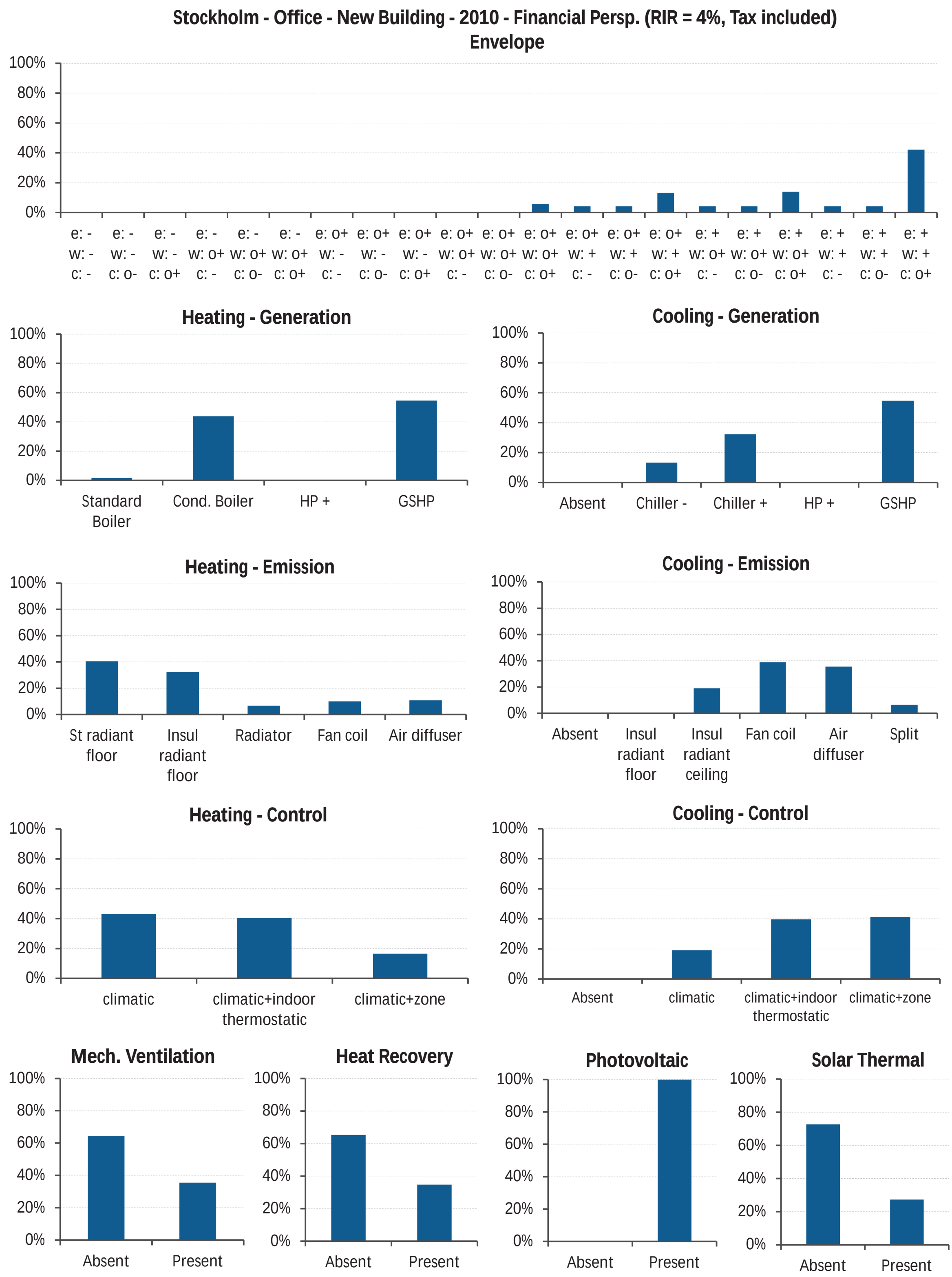

Figure 118. Ways to reach the nZEB target, Statistical analysis of technologies, Stockholm, Office

	Min	Max
Range of Primary Energy [kWh/m^2/y]:	54	72
Range of Global Costs [€/m^2]:	2138	2779
Number of Building Variants:	121	

Figure 119. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

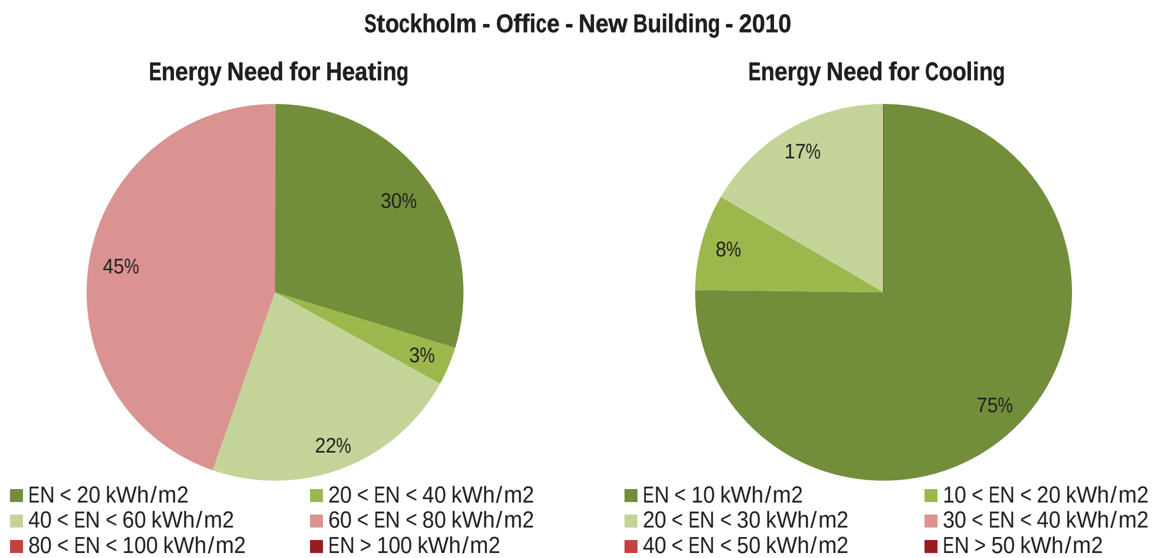

Figure 120. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

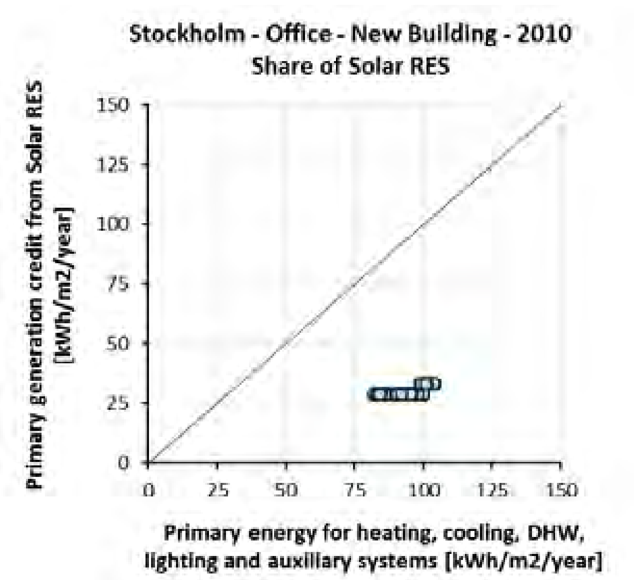

Figure 121. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy

6.1.6.10 Stockholm – Single House

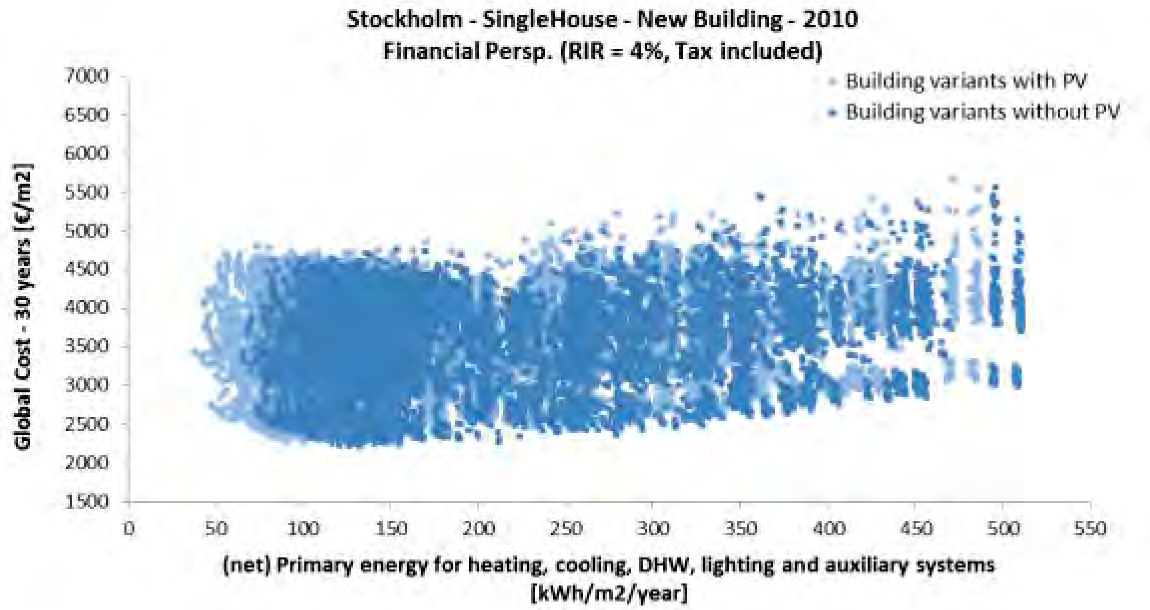

Figure 122. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2010.

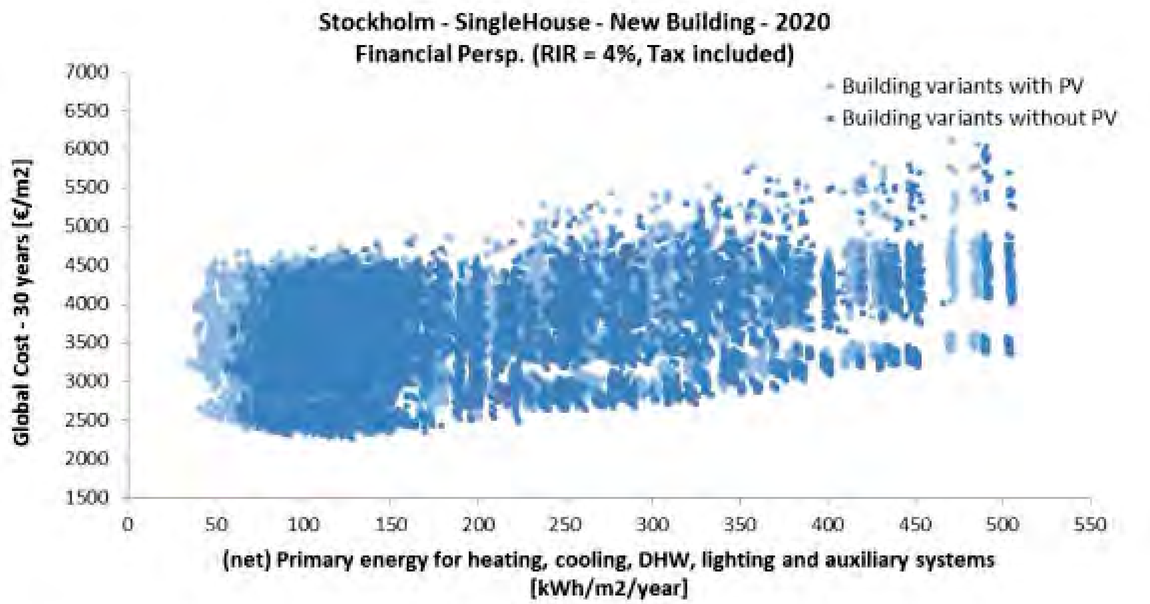

Figure 123. Global costs per (net) primary energy performance calculated for new buildings in financial perspective (RIR = 4%), considering the cost data 2020.

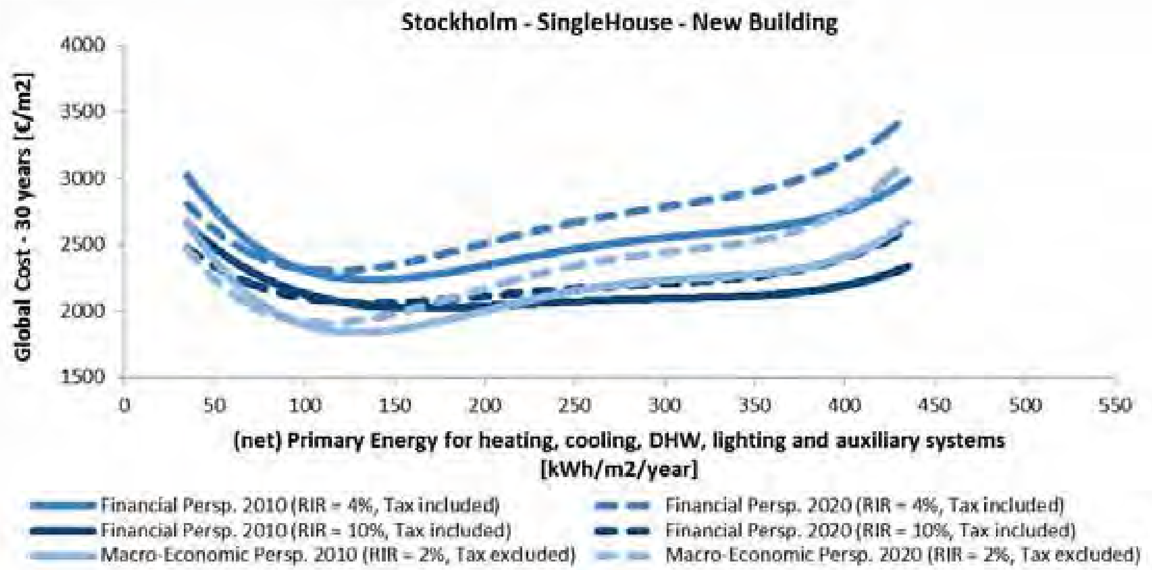

Figure 124. New building: sensitivity analysis on the lower profile of the energy / cost domain in function of several key economic perspectives and different cost database (2010 / 2020).

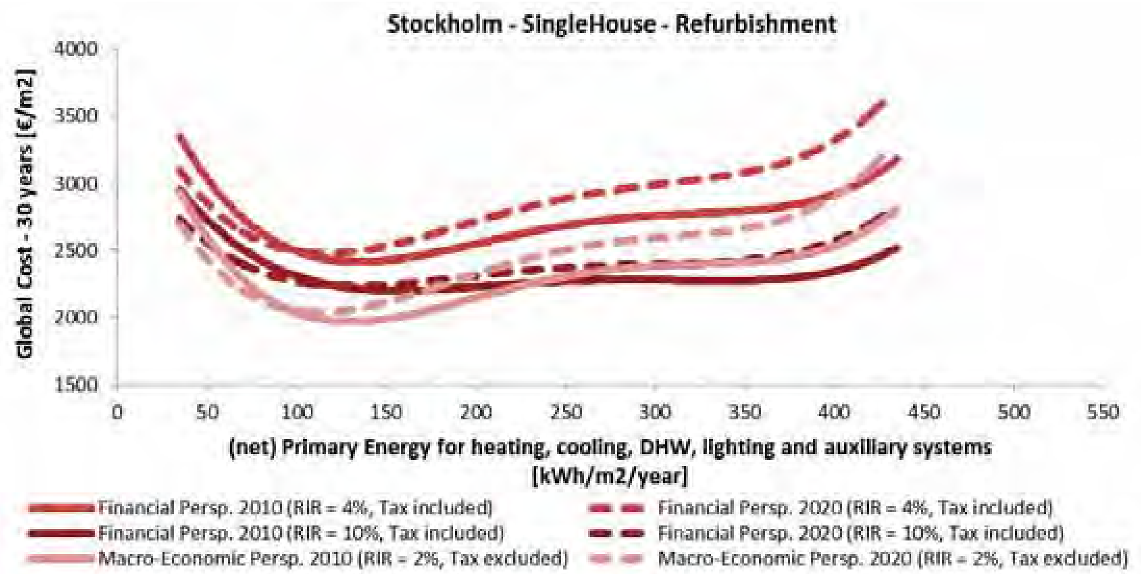

Figure 125. Refurbishment: sensitivity analysis on the lower profile of the energy / cost domain in function of several key economic perspectives and different cost database (2010 / 2020).

0

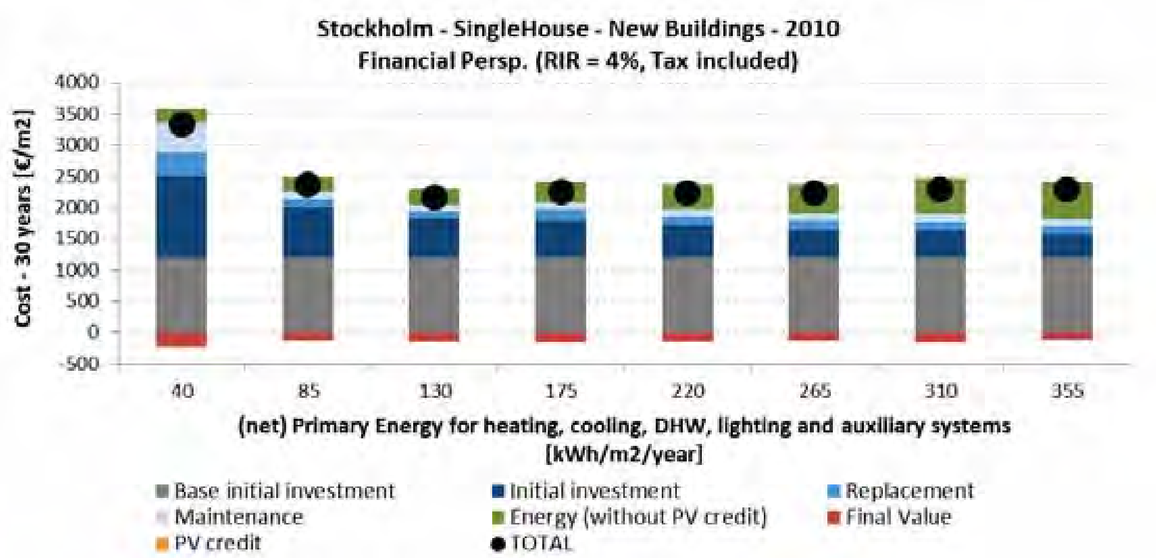

Figure 126. Disagregation of building costs for several building variants on the lower profile of the energy / cost domain, considering a financial perspective (RIR = 4%) and the cost data 2010.

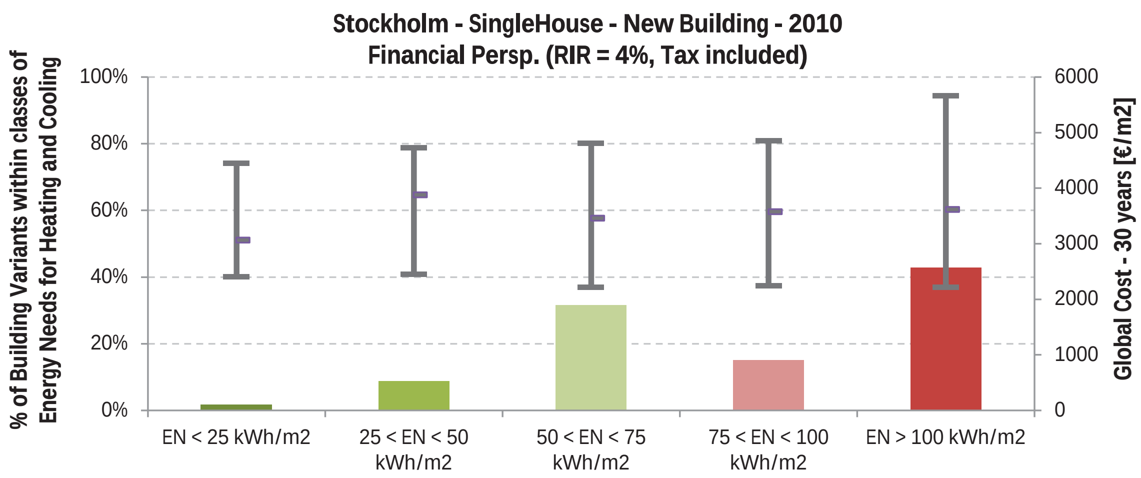

Figure 127. Percentages of building variants by different classes of energy need for both heating and cooling with indication of minimum / mean / maximum global cost within the whole dominium of variation.

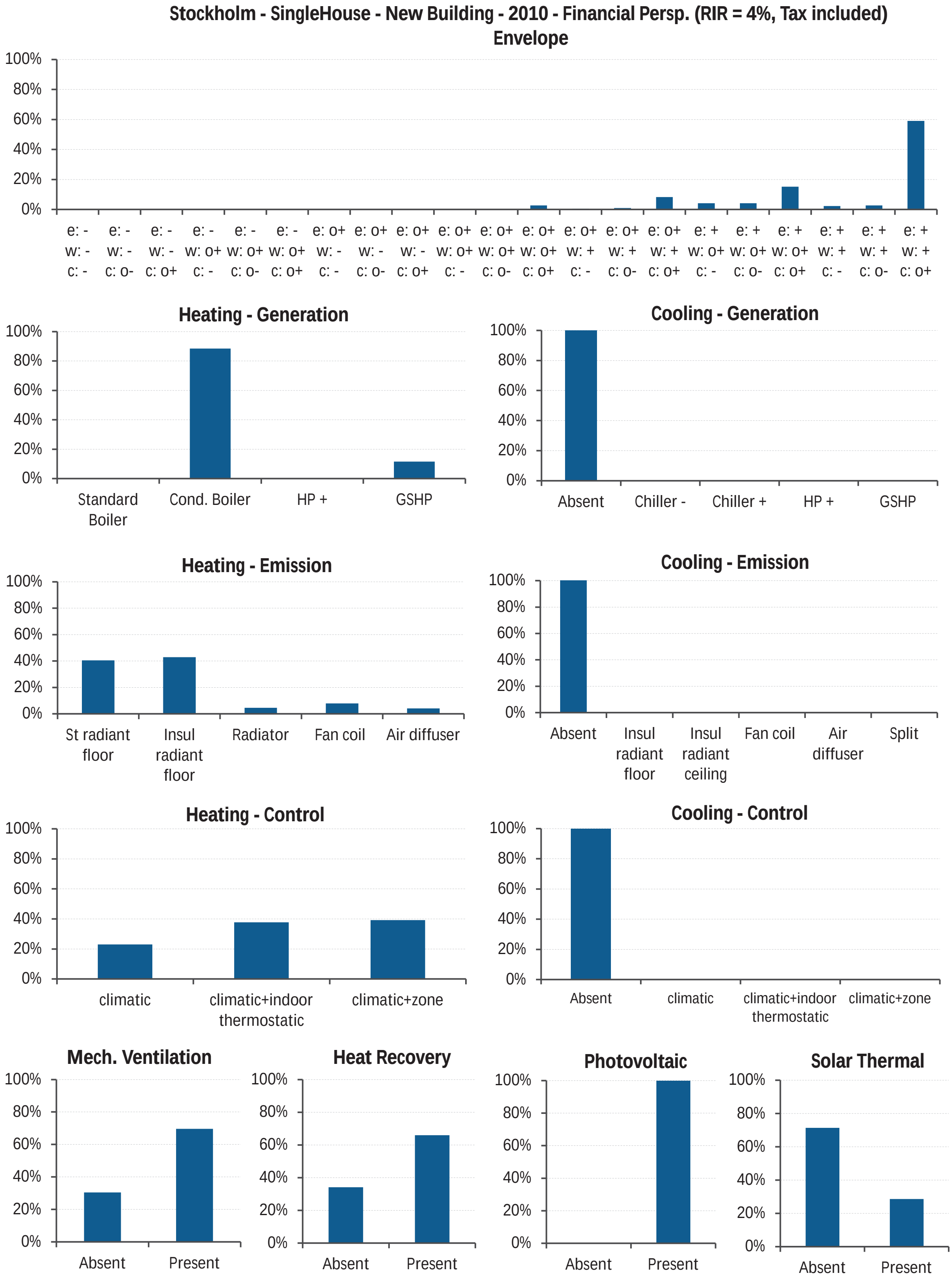

Figure 128. Ways to reach the nZEB target, Statistical analysis of technologies, Stockholm, SFH

	Min	Max
Range of Primary Energy [kWh/m²/y]:	39	65
Range of Global Costs [€/m²]:	2579	3482
Number of Building Variants:	217	

Figure 129. Ways to reach the nZEB target (net primary energy): statistical benchmarks on the new building variants

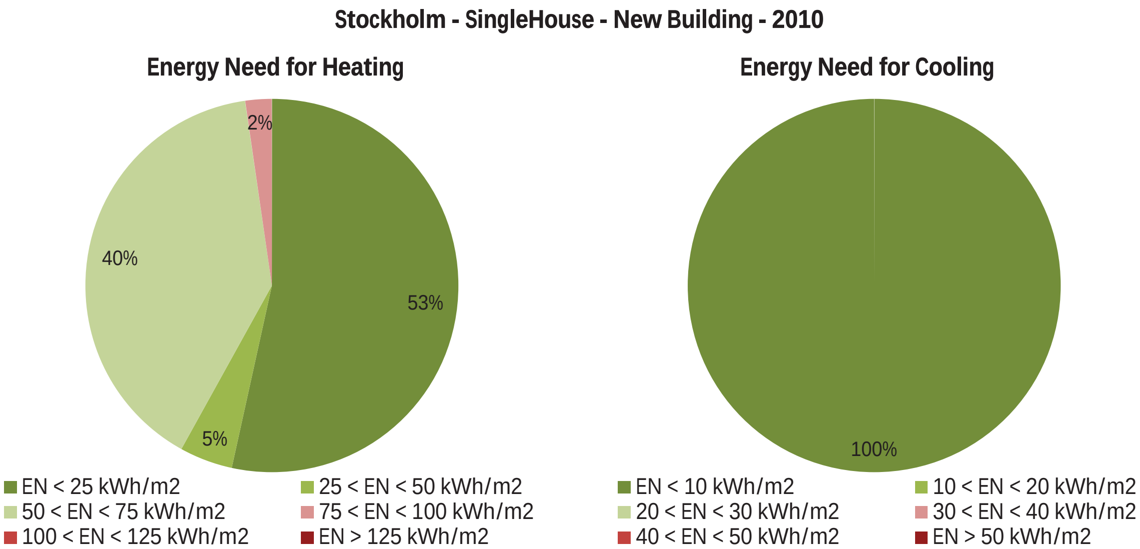

Figure 130. Indication of the energy needs for heating and cooling relative to the building variants within the benchmark area.

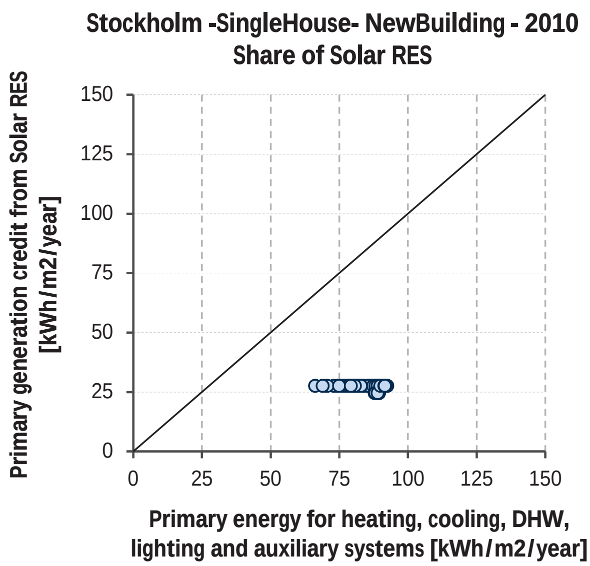

Figure 131. Indication of the share of solar renewable sources (photovoltaic and solar thermal) relative to the building variants within the benchmark area.

- Horizontal axis: primary energy without on-site solar plant (PV, solar thermal)
- Vertical axis: credit for annual on-site solar generation (same PEF as for delivered energy)
- Vertical distance to diagonal line: (positive/negative) distance to net zero primary energy.

In all the cost calculations only market prices are considered and external costs related to environmental or health damages different from CO_2 (at 50 €/ton) are not included yet.
In the following example we assume an increase (with respect to the previous scenarios) of the price of energy bought from the grid of 1.8 €cents/kWh in 2010 and of 7 €cents/kWh in 2020. We show below the graphs global cost versus net primary energy in the macroeconomic perspective (real interest rate 2%) for a single house in Stockholm.

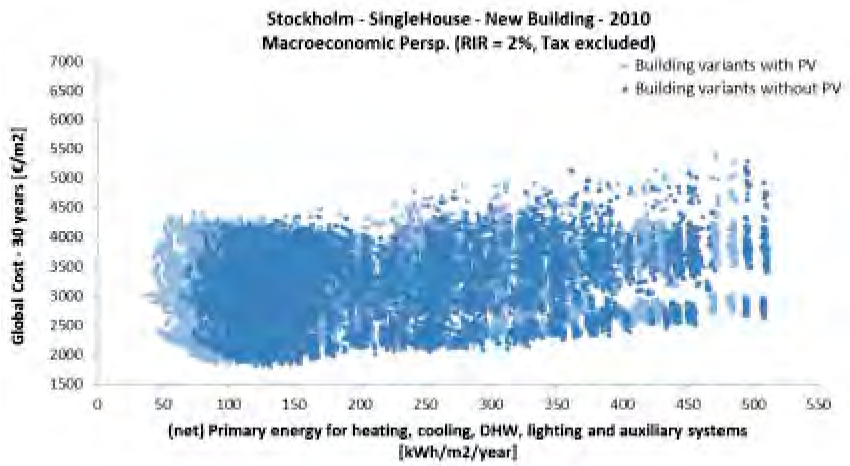

Figure 132. Impact of higher energy prices, SFH, Stockholm, microeconomic

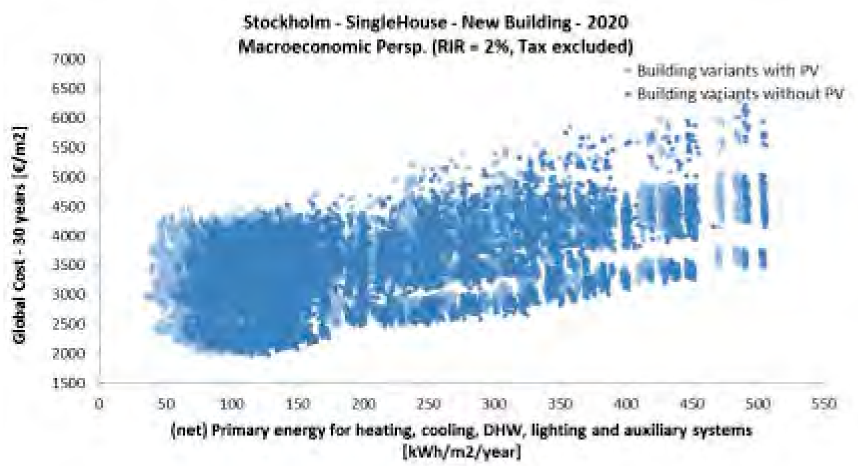

Figure 133. Impact of higher energy prices, SFH, Stockholm, macroeconomic

6.1.7 Lessons learned on the methodology and on the way to zero energy, under the assumption of this study

This study presents a methodology for analysing and presenting data about performance of nearly zero energy buildings, which offers utmost transparency:

- It is coherent with EN calculation methods, definition of physical variables and terminology.
- It is coherent with the cost-optimal framework methodology.
- It follows a calculation procedure highlighting clearly and explicitly the calculation at various boundary levels (energy needs, energy use, delivered energy, primary energy, net primary energy).
- It provides an example of how to explicitly present all the input variables and assumptions and calculation methodology.
- It can serve as an example for ways to analyse and display the technological and economic features of the "nearly zero-energy area", the "cost-optimal area" and trends resulting from changes in energy and component prices, primary energy factors and progress in the efficiency of components (not considered here) between 2010 and 2020.

It can hence serve as an example of how MS may construct their own methodology or it can be used directly in the (nearly) zero energy reporting exercises by MS.

6.1.7.1 Assumptions at the base of the study and quality data requirements

The quantitative results obtained in this study applying the methodology are obviously depending on the <u>hypothesis made on the typologies of buildings</u> (e.g., widow-to-wall ratio, surface-volume ratio, etc.) and can hence result different under different boundary conditions.
One should also consider that in a large scale study as the present one, which used quite conservative assumptions, <u>certain assumptions cannot be as detailed as it would be possible in a national or regional study or in the design of a specific building</u>. More specialised design exercises will be able to consider components, packages and strategies better adapted to local climate and conditions, which will generally lead a higher number of efficient options than presented here or even more efficient buildings in absolute terms by making a stronger use of integrated design, which is key to fully exploit the benefits of individual components and their ability to work in synergy with the sorrounding climate and context [MaTrID 2013].

What is extremely important for a proper use of the results is that in this and other similar studies the assumptions, boundary conditions and methodology should be explicitly and thoroughly presented so that results can be compared and lessons learned from them for the design of actual buildings, preparation of legislation, etc.

In particular, Member States might pay special care in ensuring that good to high quality data are available about:

- Cost data of building components and plant components explicitly and clearly correlated to their physical and performance features; analysis of potential technological and cost evolution of main components; at present those data in many cases do not seem to be easily available to policymakes, designers,

- Climate data of the quality specified in EN standards, on a grid of a few kilometres pace and both based on recent measurements and on forecasts of future weather evolution, as e.g. available in UK by CIBSE.

The implications of these input data on the best variants in terms of energy, comfort and global costs are quite relevant and an effort in the direction of ameliorating public availability of quality data would clearly be beneficial.

Keeping hence in mind the crucial importance of the actual boundary conditions that might differ in the considered context and analysis, one might conclude the present exercise by discussing some of the implications of the analysis, **under the boundary conditions and approximations assumed in this study.**

6.1.7.2 Recommendations for the design process

This analysis confirms and adds to analysis available in literature and case studies that a successful path aiming at zero or nearly zero conventional energy requirement (both for the designers and policy makers) will most probably have the following priority order (which is the spirit of EPBD and can be made explicit in the detailed definition of nZEB):

- Aim at low thermal energy needs for heating, cooling and hot water (noting that energy needs depend on building envelope, microclimate around the building and chosen comfort set points within the building and hence all of those should be addressed in the definitions and implementation) Aim at low energy use of electricity for lighting, ventilation, auxiliaries and appliances (which also contributes to low thermal energy needs).
- Aim at high value of the load matching index (good hourly match of on-site generation and consumption) in order to maximise self-consumption and avoid drawing energy from the grid(s) which has a high content of conventional energy and/or requires costly storage infrastructure.
- Aim at high share of renewables (if the previous steps are all included in the definition and are all fullfilled in implementation, it becomes less crucial where renewable energy is produced, otherwise it becomes more important to define strictly what is the meaning of nearby).

Overall there is an indication that mild climate and abundant solar irradiation make zero energy houses in southern climates of Europe technologically feasible with global costs over 30 years that equal or are lower than those of ordinary buildings built today. Heating energy needs can be reduced to a minimum, via the use of highly insulated envelopes, air tightness and heat recovery on ventilation; with relatively low internal loads the cooling energy needs can be also reduced to low values by using passive technologies (solar protections and controls, night ventilation, etc.) which complement the protection from external climate provided by the highly insulated envelope. In southern regions however cooling energy needs would raise when internal loads and ventilation rates are relatively high (e.g. in our simulation exercise in offices we assumed 10 W/m^2 installed power for lighting, 10 W/m^2 for office equipment, 0,95 air changer per hour [h$^{-1]}$). Those internal loads can be reduced to lower values (not considered in this study which has more emphasis on thermal uses). For example, the case studies analysed in IEA Annex 45 “Energy Efficient Electric Lighting for Buildings” show very good visual comfort obtained with installed power of 6 W/m^2.

Energy use by office and domestic appliances and ICT equipment improvements are ongoing under the ecodesign directive and manufactures initiative [Topten 2013, PrimeEnergyIT 2013].

In northern climates harsh winter and relatively low solar irradiation make things more challenging, when trying to achieve nearly zero-energy building relying on onsite renewables. Envelope performance becomes even more crucial (and should be probably brought even higher than considered in our scenarios, especially in cases where renewable sources accessibility can have limitations, as in urban centres).

Other possibilities of delivering to buildings the renewable sources to cover the residual low energy needs for heating and cooling (and further reduced energy uses for lighting, office equipment and domestic appliances) not considered in this study might indeed be available. On site or nearby generation by off site renewables might be considered by MS as an option for dense urban settings; off-site renewable electricity might also play a more prominent role in nearly zero-energy building designs than today. Nevertheless some of these options might have their own limitations beyond primary energy considerations or greenhouse gas emissions: e.g. biomass burning might be impossible in certain areas due to its contribution to PM10 emissions or require relatively costly filtering at stack.

Envelope technologies to reduce energy needs for eating and cooling (low transmittance walls and windows, selective glazing, solar protections, heat recovery on ventilation for IAQ) and efficient lighting design, lighting sources, appliances will be anyway available mostly irrespective of the building location and hence an essential part of the effort towards zero in every context and climate

In this study we have been relatively conservative and have considered technologies well established, available on the market and have considered consolidated packages. Higher levels of energy performance are possible with today and near to market technologies.

To further move towards the zero-energy target, compared to what shown in this example calculation, ways available will:

- Reduce the heating and cooling energy needs at 10 kWh/m^2a or better in most cases, e.g. Passivhaus level or better, by:
    - Even more performance of the envelope thanks to improvements or cost reduction in technologies and an extension of their use and integration (e.g. low emissivity plastic films to reduce weight and costs of triple glazing, vacuum insulation, aerogel and other superinsulation technologies to obtain higher insulation levels for the same thickness, especially useful in retrofits); windows and openings designed for easier use and control for night ventilation, demand controlled ventilation (occupancy, CO_2 driven..), etc.

- Influence surrounding microclimate by accurately using trees and vegetation on facades and roofs, cool surfaces, by protecting from wind, etc.
- While designing for Category II comfort upper limit (- 0,5 <PMV< +0,5, see EN 15251 and ISO 7730), make correct use of the flexibility offered by the Fanger comfort model, e.g. allowing a easy adaptation of clothing insulation to season (adopting flexible dressing codes as in the United Nations and Japan government initiatives [CoolBiz UN 2008], [CoolBiz UN 2008a], [CoolBiz and WarmBiz Japan 2008], [CoolBiz Japan 2011]), choosing low insulation chairs in order to have low clothing insulation addition due to the chair in summer (see values in ISO 7730), make use of summer air velocity correction (ISO 7730 and EN 15251) whenever customers are willing to use a little higher air movement in summer [Arens et al. 1998, Pagliano e Zangheri 2010, Sartori et al. 2010].
- For naturally ventilated buildings, the adaptive comfort model and comfort ranges may be used, which change in summer according to the running mean temperature of the previous days. In winter there are examples (France) of regulation proposing a setpoint at 19°C and correspondingly a slightly higher clothing insulation.

- Reduce electricity use (and connnected summer cooling loads) due to electric uses of lighting and appliances and auxiliaries by high efficient design and components by
  - Enhanced daylighting use (light redirection to interior spaces by means of prismatic glazing or other optical devices at windows, north oriented skylights, light pipes, etc.); use task lighting, suspended luminaires for direct/indirect lighting in order to achieve e.g. the 500 lux on the task areas in offices and lower levels in the surrounding areas (as suggested by EN 12464-1.), use of innovative light sources with high lm/W and good colour rendering may allow to reduce lighting power density to about 6W/m^2 with good luminous comfort, reducing the risk of glare on computer screens, etc.
  - Further reduce delivered energy required by appliances by choosing high efficiency and low-standby appliances on the market [Topten 2013]. The EU might also enact progressive labelling (efficiency should increase with size of the appliance such that total consumption per appliance cannot exceed a fixed level as e.g. in some energystar and California labelling [Calwell 2010]. Similar indexes that are related to function and no longer proportional to size have been proposed also for buildings (e.g. kWh per apartment per year; rather than kWh/(m^2a), similar to the new “progressive labelling” of television).
- Aim at very low polluting buildings by careful choice of materials and appliances (which implies lower air change requirements according to EN 15251); when appropriate choose air-diffusion systems which require relatively reduced airflow (e.g. displacement ventilation). Installation of high efficiency pumps, straight pipe layout and large diameters to reduce pressure losses; Installation of high efficiency fans, variable velocity electronic controlled, demand controlled ventilation (occupancy, CO_2 or OVC driven, etc.).Integrate renewables generation with higher likelyhood of achieving a large share of renewables, having kept energy demand low in absolute terms.

We give here some more details on hot water energy needs and use, lighting power density and lighting energy use, mechanical ventilation energy use.

6.1.7.3 Lighting power density

As for **lighting power density** we report here some of the results of IEA Annex 45 “Energy Efficient Electric Lighting for Buildings”. Ingélux Consultants and ENTPE tested 26 work places, during 6 months in the area of Lyon, France [Fontoynont and Escaffre 2006]. Each of work places had a specific lighting scheme (Figure 134). The goal was to identify directions in preferred lighting schemes requiring less electrical power. Every user of each of the 26 workstations could adjust the power of the lamps in the luminaire. The preferred lighting schemes were carefully recorded through measurements of illuminance distribution, luminance values in the field of view and electric power required by the lighting installation for the selected lighting scheme, including suspended direct-indirect luminaries shared by two occupants (6 W/m^2). Very low power densities were found for task/ambient solutions (below 8 W/m^2). Power densities of about 6 W/m^2 are achievable, with very high visual performances [Fontoynont and Escaffre 2006].

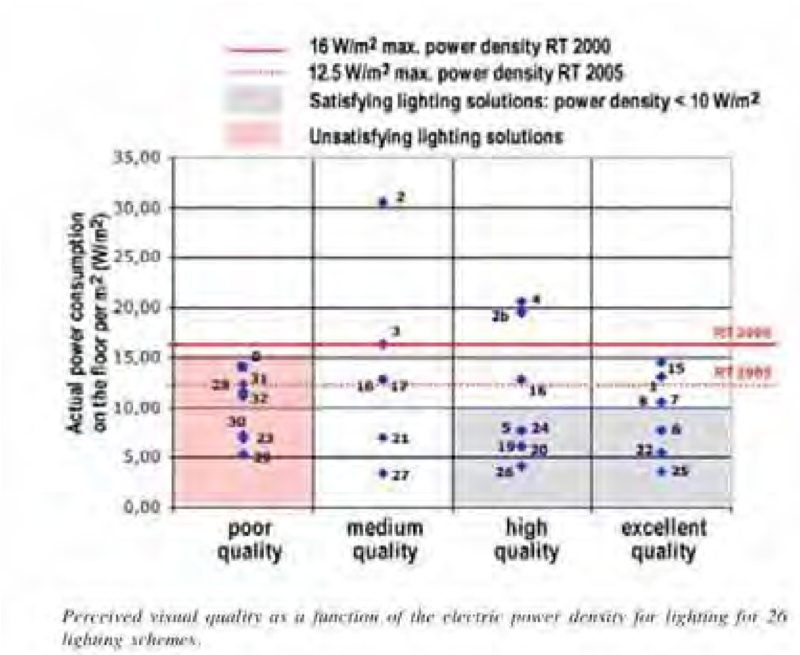

Figure 134. Actual power for lighting and visual quality. Reproduced from [Fontoynont and Escaffre 2006]

Private communications with various lighting experts support these conclusions.

6.1.7.4 Lighting energy use

As for **energy use for lighting**, EN 15193:2007 defines:

- Total annual energy used for lighting $W = W_L + W_P$ [kWh/year] where $W_L + W_P$ are respectively an estimate of the annual electric energy required to fulfil the illumination function and purpose in the building (W_L) and annual parasitic energy (W_P) required to provide charging energy for emergency lighting and for standby energy for lighting controls in the building**.**
- Lighting Energy Numeric Indicator (LENI) for the building that shall be established using the following equation: LENI = W/A [kWh/(m^2a). A is the total useful floor area of the building [m^2].

Energy use obviously depends from installed power density, and hours of use, which depend on daylight availability, controls, occupant behaviour, etc. E.g in SIA 380/4: 2006 the number of hours of use is reported as a function of the ratio glazed surface/floor surface in an office used 11 hours a day and of various illuminance targets and control typologies.
For example, for 25% ratio glazed surface/floor surface, automatic illuminance control at 500 lux one finds 3,8 hours of use per day (averaged over the seasons); considering 5,5 days per week and 50 weeks, this would add up to about 1050 h/a; at a lighting power density of 6 W/m2 this would represent a WL of 6,3 kWh/(m2a) and at 8 W/m2 a WL of 8,4 kWh/(m2a). It is very important to choose for energy efficient control systems in order to keep parasitic energy WP at low values.
For comparison, we can consider that the Norwegian standard NS 3071:2012 “Criteria for passive houses and low energy buildings. Non residential buildings” requires for offices a LENI lower than 12,5 kWh/(m2a) at the latitude of Norway. The passivhouse standard which contains this requirement will become mandatory for all new buildings starting in 2015 (with possible modifications).
To calculate full load hours when using occupancy sensors, the Swiss norm proposes also a correction factor k_{Pr}, k_{Pr} = 1 for constant presenc, k_{Pr} : 0,8-0,7 for normal presence, k_{Pr} : 0,6-0,5 for low presence.

6.1.7.5 Domestic hot water

For the residential sector reference values can be found for example in the Swiss regulation which assumes as a order of magnitude a value of 1 l/m^2 per day, corresponding to an energy need of 75 MJ/m^2a or 20,85 kWh/m^2a. Measurements of DHW usage made in a number of buildings in Zurich have found values ranging from 36 to 60 l/person per day, or about 1 l/m^2 perday. Those measurements were made some years ago and with a very limited penetration of low flow showerheads and faucets (Private communicaion, J. Nipkow). Measurements presented in IEA SHC Task40/ECBCS Annex52 for the Alstonvale House report an equivalent hot water consumption of 130 l/day for 4 occupants (32,5 l/day/person), considering the use of low flow showerheads.

Measurements reported in “*Cahier technique maison passive economiques 38*” published by maison passive France refers to 20 residential buildings show an average consumption of 15 l/person per day corresponding to 14,2 kWh/(m^2a). The PassivHaus Planning Package assumes a DHW demand of 25

l/person per day of water at 60°C, with an inlet cold water at 10°C, and an occupation rate of 35 m^2/person, corresponding to about 15 kWh/(m^2a).
The relatively low water use in certain households might be connected to the presence of low flow showerheads and faucets and to energy-concerned user behaviour. Switzerland has enacted an *"Energy Label Regulation for Sanitary Fittings"* [Swiss Energy 2011] which ensures both quality specifications for the service and water savings, test procedures, random checks and fines for non-compliance. Figure 135 and Figure 136 report two tables referring to showerheads and mixer taps.

5.1 Criteria

	Shower heads with built-in regulator Standard water volume	Shower heads without regulator (throttle valve) Adjusted water volume
Class A =	≥ 4 to < 6 litres/minute	≥ 4.1 to < 6.3 litres/minute
Class B =	≥ 6 to < 9 litres/minute	≥ 6.3 to < 10.0 litres/minute
Class C =	≥ 9 to < 12 litres/minute	≥ 10.0 to < 14.7 litres/minute
Class D =	≥ 12 to < 15 litres/minute	≥ 14.7 to < 21.7 litres/minute
Class E =	≥ 15 to < 18 litres/minute	≥ 21.7 to < 36 litres/minute
Class F =	≥ 18 to < 21 litres/minute	≥ 36 litres/minute
Class G =	≥ 21 litres/minute	
		(For details, see Annex 1.3 Adjusted water volume)

Figure 135. Criteria for showerheads with and without regulator. Reproduced from [Swiss Energy 2011]

6. Criteria for single-level mixer taps and thermostatic mixer taps

6.1 Criteria

	Wash basin or bidet Water volume permitted	Kitchen Water volume permitted	Shower Water volume permitted
Class A =	≥ 4 to < 6 litres/minute	≥ 4 to 9 litres/minute	≥ 9 to < 12 litres/minute
Class B =	≥ 6 to < 8 litres/minute	≥ 9 to < 12 litres/minute	≥ 12 to < 15 litres/minute
Class C =	≥ 8 to < 10 litres/minute	≥ 12 to < 15 litres/minute	≥ 15 to < 18 litres/minute
Class D =	≥ 10 to < 12 litres/minute	≥ 15 to < 18 litres/minute	≥ 18 to < 21 litres/minute
Class E =	≥ 12 to < 14 litres/minute	≥ 18 to < 21 litres/minute	≥ 21 to < 24 litres/minute
Class F =	≥ 14 to < 16 litres/minute	≥ 21 to < 24 litres/minute	≥ 24 to < 27 litres/minute
Class G =	≥ 16 litres/minute	≥ 24 litres/minute	≥ 27 litres/minute
Bonus	Single-lever mixer tap with central cold water setting receive a bonus of one class	Single-lever mixer tap with central cold water setting receive a bonus of one class	--

Bath mixer taps with a connection point for a shower hose

Bath mixer taps with a connection point for a shower hose can receive the Energy Label. The water volume at the outlet to the shower is measured according to the same criteria which apply to showers. There are no requirements for the outlet to the bathtub.

Figure 136. Criteria for single-level mixer taps. Reproduced from [Swiss Energy 2011]

6.1.7.6 Drain Water Heat Recovery

Various techniques can be used to capture heat in water from showers and sinks to be used to preheat incoming water. In the gravity falling-film method, surface tension and gravity cause falling films of water to spread and cling to the inner wall of a vertical drainpipe. This enables a high rate of heat transfer. The cold incoming water passes through a coil that is tightly wrapped around the vertical drainpipe. This system can recover 45–65% of the available heat in the wastewater, warming the incoming water up to about 20°C [Vasile 2005, Vasile 2008]. Simulations performed by Maison Passive France for a building with 23 apartments and an individual house find similar savings and estimates a cost of recovered energy between 3 and 7 €c/kWh.
Efficiency of generation system and pipe insulation is discussed in EN 15316.

6.1.7.7 Mechanical ventilation systems

As for **energy use for ventilation**, it is defined as electrical energy input to the ventilation system for air transport and heat recovery (not including the energy input for preheating the air). Such energy use is directly influenced by Specific Fan Power, (SFP). EN 13779 (Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems. Revision, 2007) defines SFP in Appendix D and efficiency classes.

At whole building level, SFP for a given system and operating point (combination of flow rate and pressure drop) is defined as:

$$SFP = \text{sum of power over all fans [kW] /gross amount of air circulated } [m^3/s]$$

And it is expressed in kW/(m^3/s) or W/(l/s).
If the ventilation system has different operating points at different times of the year, the annual average SFP can be calculated as a weighted average of the SFP at the various operating points.
Means of reducing SFP are the minimization of demand (e.g. low-emission building materials, passive cooling design); the minimization of flow resistance, by aerodynamic design of fan inlets/outlets and ductwork layout (optimal location of plant rooms and duct risers, to reduce duct length), large sizing of components in the duct system, etc; and finally the improvement of the efficiency of the fan, drive, motor, and variable speed drive.
Several countries have set, either as requirements or as recommendations, maximum values for SFP.

As an example, along the path to zero energy, Norway has established in NS 3700 (2010) "criteria for low energy and passive houses –residential buildings", a maximum value of 1,5 kW/(m^3/s) for passive houses and 2,0 or 2,5 kW/(m^3/s) for low energy houses (classes 1 and 2 respectively).
In NS 3701 (2012) "criteria for low energy and passive houses –non residential buildings", SFP maximum values are set at 1,5 kW/(m^3/s) for passive level and 2,0 kW/(m^3/s) for low-energy level.
The mentioned passive house standards will become mandatory for Norway in 2015 (with possible modifications/improvements), along the path to zero energy regulation in 2020.

In UK, the 'Part L' of the building regulations (2010) proposes:

- For exhaust systems: SFP_{BLDG} < 0.6 kW/(m^3/s),
- For balanced ventilation with heat recovery: SFP_{BLDG} < 1.0 kW/(m^3/s).

SFP_{BLDG} at 25% of design flow rate should not exceed SFP at 100%. Motors should have efficiency class IE2 (EFF1). SFPi < 0.2 kW/(m^3/s) for non-ducted local ventilation (wall fans, even if intermittent operation).
Hybrid ventilation systems (fan assisted natural ventilation) can use less than 0.1 kW/(m^3/s).

6.1.7.8 Prescriptive approach in regulation along the path to nearly zero energy

Overall, a number of national and regional **regulations moving towards zero energy take a prescritptive approach on a number of building and plant components** to ensure energy efficient devices and design techniques. We give here a few examples.
On July 12, 2009 the Brussels government passed an order imposing the passive standard on all regional new public buildings by 2010, and on May 3, 2011 adopted new energy target regulation for all new construction (housing, offices and schools) by 2015. The "passive" standard became an important first step towards achieving the zero energy objectives of EPBD.
The legislation installs:

- A net heating requirement of less than 15/kWh/m2/yr
- A net cooling requirement less than 15/kWh/m2/yr (only for offices and schools)

- An air tightness of 0,6 volume .h^{-1}
- An overheating over 26°C time -limited to 5%
- A primary energy consumption limited to:
  - 45 kWh/m2/yr for housing (heating, hot water, ventilation, pumps and fans);
  - 90 – (2,5 x compacity) for offices and schools.

The Norway voluntary schemes NS 3701 (2012) "criteria for low energy and passive houses – non residential buildings" and NS 3700 (2010) "criteria for low energy and passive houses – residential buildings" include quantitative prescriptions on thermal trasmittances, thermal bridges, air tightness, heat recovery efficiency (> 80% for passivhus level), Specific Fan Power, lighting energy, energy need for heating, etc...
The Norwegian Parliament has voted that these passiv house standards will become mandatory (possibly with modifications/improvements) for all new buildings starting in 2015, along the path to nearly zero energy regulation in 2020.

Certain voluntary certification labels for buildings also include lighting and plug loads (also called user loads) in the requirements, such as Minergie A certification, which requires the use of efficient lighting taken from the website www.toplicht.ch and efficient appliances from the website www.topten.ch, and the passivhayus certification which requires a total primary energy requirement (including plug loads) lower than 120 kWh/(m^2a).

6.1.7.9 Outlook to 2020, external costs and grid interaction

The variations that can be seen to happen between the case of a new building constructed in 2010 or in 2020 are due to the interplay of various factors that have been included in the analysis:

i. The real escalation rate of energy costs (assumed here at 2,5% per year).
ii. The evolution of costs of materials and components for energy efficiency and renewables, which is detailed in annex 10.4.2 (certain are assumed to get cheaper due to volume and learning curve, others to get a little more expensive due to their relatively high embedded energy and raising cost of fossil fuels).
iii. The assumed reduction in the primary energy conversion factors of energy vectors due to a higher share of renewables in the national generation mix (this should avoid double counting the on-site renewable generation).

Due to the intentionally conservative approach of this study it has NOT been assumed an improvement between 2010 and 2020 in efficiency of components at constant (or even decreasing prices). This could be observed for glazing, where in recent years U-values decreased significantly at almost unchanged real prices, for LEDs, etc., but we assumed here the same performance for all technologies in 2010 and 2020.

Factor i) would tend to favour over time those building variants with even lower energy needs and use of on-site renewables while factor iii) would tend to smooth the impressiveness of this change since grid energy with lower primary energy content would also be a factor of reduction of net primary energy.

Nevertheless the analysis clearly showed that already today in almost all building types and climate regions there are few to many variants with very low energy **needs** or heating and coooling amongst the ones with lowest global cost. Therefore due to uncertainty in other parameters and the unlikeliness of decreasing energy prices this seems to be the major pillar towards nearly zero-energy building which at the same times offers highest possible flexibility not only for the use of energy from renewable sources but also for achieving a very significant share of renewable energy in covering the very little energy demand of nearly zero-energy building.

This analysis being conservative about the choice and performance of technologies is also conservative in terms of assumptions about the value of external costs (damage to environment and natural resources not accounted for in energy prices at the moment).
Considering some of the studies on the value of those externalities, from the Stern report to the recent report presented at the Davos Summit, one might want to look at a scenario with an assumption that those external costs are actually internalised and monetised via an increase of the price of energy. A sensitivity analysis performed on a single family house in Stockholm shows the significant shift of the cost optimal area towards the nearly zero area as a consequence of a hypothesis of inclusion of external costs into energy prices. (see figure 138)

From the extensive numerical analysis based on the methodology presented in this report and applied using as an example the family A definition (ZEB limited) with a symmetric weighting factor, it appears that, under quite conservative assumptions about the performance and availability of energy efficiency technologies, buildings constructed with very low energy needs for heating, cooling and hot water in a scenario of prices as of 2010 have global costs over 30 years lower or comparable to buildings with high energy needs.
From a sensitivity analysis these results seem relatively robust towards changes in various economic parameters, e.g. the assumed interest rates.
The economic attractiveness of low energy need buildings grows when considering the scenario of constructing a building in 2020, assuming no amelioration of performance of envelope and plant technologies and slight reduction of costs of technologies that have moderate level of embedded energy.
Even with conservative assumptions the 2020 buildings the cost optimum area in all cases moves towards the nearly zero energy area and this effect would be more pronounced with less conservative assumptions.
This result is reinforced in case energy prices would raise more significantly than assumed here in order to fully incorporate external costs (e.g. environmental and health damage costs), which are only assumed here at a comparatively low level. Low energy need buildings prove hence significantly less prone to risks connected to volatility of costs/prices of conventional and renewable energy during their lifetime.
It is likely to be a good economic investment to continue support for innovation by public policy to stimulate the building industry to continue improving perfomance for the same real price and to completely close the gap between cost-optimal and zero energy.

Positive benefits other than energy savings are also neglected, even though they might be relevant, e.g in variants with high performance building envelope better distribution of temperatures, avoidance of draft might, higher availability of daylighting, in a word higher thermal and visual comfort, might increase the usability of costly floor surface and productivity of workers according to various surveys.
Many of the energy efficiency technologies which contribute to buildings with low energy needs are applicable both in rural and urban dense areas, while renewable energy sources (be solar or ground exchange, or imported biomass, ...) may have limitations of production or impact in dense urban areas. Finally the calculation of energy needs does not require any additional assumption on weigthing factors to take into account time of use, interaction with the grid, conversion factors to primary energy changing for hour to hour and over the years.

About the issue of interaction with the grid, it is a shared opinion of many energy experts that a simplified energy balance over a year "*does not show the complete interaction with the grid; assumes that the grid is an infinite storage; allows for «lazy» design: no concern about timing of electricity generation and use*" [Hogeling 2012]. Large mismatches might imply large consumption of fossil fuel resources in some parts of the year. A way to reduce the absolute value of the mismatch is to reduce the energy needs.
All of those reasons support the usefulness of using energy needs for heating, cooling and hot water , energy use for lighting, ventilation,... as import parameters in defining nZEBs and setting corresponding benchmarks.

6.2 Task 3b: Analytical framework for analysing national plans

EPBD article 9 not only asks the MS to draw up National Plans for increasing the number of nearly zero-energy buildings but also the Commission to evaluate these plans, "notably the adequacy of the measures envisaged by the Member States in relation to the objectives of this Directive", to give recommendations to the MS and to publish tri-annual progress reports summarising the progress and the results of the Commission's evaluation. Based on "*that report the Commission shall develop an action plan and, if necessary, propose measures to increase the number of those buildings and encourage best practices as regards the cost-effective transformation of existing buildings into nearly zero-energy buildings."*

To support the Commission in conducting an equitable and systematic evaluation of the impact and process described in the national plans, in this chapter we developed a suitable evaluation framework. The Commission will be able to use this framework for structuring the evaluation process, deriving meaningful recommendations for closing potential gaps between target and actual value and as a starting point for the progress reports and action plans mentioned in the EPBD recast.

As described in chapter 5.3 (Task 2), the new reporting template for national plans for increasing the number of nearly zero-energy buildings comprises the following six main categories:

- Application of the definition of nearly zero-energy buildings
- Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings
- Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings
- Policies and measures for the promotion of all new buildings being nearly zero-energy buildings after 31 December 2020
- Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero-energy buildings after 31 December 2018
- Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero-energy buildings

Based on the outcomes of task 1, task 2 and task 3a, for each of these categories, a structured table, including criteria, indicators for these criteria and benchmarks for judging the target achievement in a transparent way has been developed (the complete reporting template including the here developed evaluation framework can be found in the appendix in chapter 10.3.2). We decided to use a grading system allowing the evaluator to give each of the sub-criteria a specific number of points (out of maximum number of possible points) and afterwards summing these up. This way a quantitative evaluation can be conducted which clearly illustrates the difference between really achieved points compared to the maximum number of achievable points. This ratio or delta indicates the grade of target achievement in a transparent way. The delta for each sub criterion should be explained by the MS and will afterwards be summarised by the evaluator on which base he or she will afterwards be able to pronounce recommendations for decreasing the delta. The following chapters 6.2.1 to 6.2.6

contain the specific evaluation tables and explanations for each of the main reporting categories and chapter 6.2.7 proposes a format for an overall evaluation result.

6.2.1 Application of the definition of nearly zero-energy buildings

Although the developed reporting template for the national definition for nearly zero-energy buildings (see chapter 10.3.2) asks for many details ("nice to know"), the more general reporting template for national plans just focuses on the issues specifically required by the EPBD. The following reporting elements have been identified:

- Does a definition exist?
- Is a numerical indicator of primary energy use determined and expressed in kWh/m² per year?
- Are the relevant primary energy factors clearly defined (Also defined whether these are national or regional factors)?
- Are minimum levels of energy from renewable sources in new buildings and in existing buildings defined?
- Is the required energy demand nearly zero or very low and is clearly explained why, from a national point of view, the required value is nearly zero or very low?

Although we developed nearly zero-energy building benchmarks in chapter 6.1, we avoided to set clear quantitative benchmarks for the evaluation, as it is still unsure, how the nearly zero-energy criteria will be converted into real numerical requirements. Thus, we focussed on setting more general benchmarks that also allow a stringent evaluation but which are not just limited to quantitative energy-related benchmarks.

The determined indicators for the reporting criteria can be found in the following Table 29.

Table 29. Evaluation table for requirement 1 of the nearly zero-energy building reporting template

Evaluation of nZEB definition	
Element	**Points**
Does a definition exist? [Yes=1; No =0; In case of no, total points =0]	
Numerical indicator of primary energy use expressed in kWh/m² per year [Yes=1; No=0]	
Primary energy factors clearly defined (Also whether national or regional) [Yes=1; No =0]:	
Minimum levels of energy from renewable sources in new buildings and in existing buildings [Yes, a very significant extent is required (incl. convincing explanation)=2; Yes (RE requirement is part of national nZEB definition)=1; No=0]:	
Energy demand should be nearly zero or very low [Yes and well explained=1; No=0]	
SUM (Grade of target achievement):	**X/6 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No):	
Recommendations for decreasing delta:	

6.2.2 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings

The requirements on the intermediate 2015 targets are clearly defined in the EPBD. They generally have to be separated into targets for 'all buildings' and 'public buildings'. The intermediate targets for 'all buildings are addressed in this chapter whereas the targets on 'public buildings' are addressed in chapter 6.2.3.

The intermediate targets for all buildings specifically have to be defined for residential and for non-residential buildings additionally split into qualitative and quantitative targets. The qualitative targets focus on the definition of nearly zero-energy building and the quantitative targets on the spreading of nearly zero-energy building in order to achieve a demonstration impact. The following reporting criteria have been identified:

- Qualitative target 1: Are requirements on the fraction of renewable energies defined?
- Qualitative target 2: Are requirements on the useful energy demand defined?
- Qualitative target 3: Are requirements on the primary energy demand defined?
- Quantitative target: What is the aimed share of nearly zero-energy building on all newly constructed buildings in 2015?

Also for the intermediate targets, the evaluation indicators have been defined 'softly' in order to allow Member States to develop their own way of achieving the targets don't influence the national process too much.

Table 30 shows the evaluation criteria and chosen indicators for requirement 2 of the nearly zero-energy building reporting template.

Table 30. Evaluation table for requirement 2 of the nZEB reporting template

Evaluation of intermediate targets (all buildings)	
Qualitative 2015 targets: Interim energy related requirements for new buildings	
Requirements on fraction of renewable energies [Yes=1; No=0]	**Residential:** **Non-residential:**
Requirements on useful energy demand [Yes=1; No=0]	**Residential:** **Non-residential:**
Requirements on primary energy demand [Yes=1; No=0]	**Residential:** **Non-residential:**
Quantitative 2015 targets: Number / floor area of newly constructed nZEB buildings according to official nZEB definition	
Share of nZEB: [Yes and it is convincingly explained why it helps to achieve 2020 target =2; Yes, without sufficient explanation=1; No=0]	**Residential:** **Non-residential:**
SUM (Grade of target achievement):	**X/10 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

6.2.3 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings

The intermediate 2015 targets for public buildings are also split into qualitative and quantitative targets. The following reporting criteria have been identified:

- Qualitative target 1: Are requirements on the fraction of renewable energies defined?
- Qualitative target 2: Are requirements on the useful energy demand defined?
- Qualitative target 3: Are requirements on the primary energy demand defined?
- Quantitative target: What is the aimed share of nearly zero-energy building on all newly constructed public buildings in 2015?

Table 31 shows the evaluation criteria and chosen indicators for requirement 3 of the nearly zero-energy building reporting template.

Table 31. Evaluation table for requirement 3 of the nZEB reporting template

Evaluation of intermediate targets (public buildings)	
Qualitative 2015 targets: Interim energy related requirements for new public buildings	
Requirements on fraction of renewable energies [Yes=1; No=0]	
Requirements on useful energy demand [Yes=1; No=0]	
Requirements on primary energy demand [Yes=1; No=0]	
Quantitative 2015 targets: Number / floor area of newly constructed public nZEB buildings according to official nZEB definition	
Share of nZEB: [Yes and it is convincingly explained why it helps to achieve 2020 target =2; Yes, without sufficient explanation=1; No=0]	
SUM (Grade of target achievement):	**X/5 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

6.2.4 Policies and measures for the promotion of all new buildings being nearly zero-energy buildings after 31 December 2020

To evaluate policies and measures is not easy as the framework conditions vary from country to country. For the evaluation of the policies and measures in the national plans we oriented on the ‘National Renewable Energy Action Plans’ (NREAP) and on the ‘National Energy Efficiency Action Plans’ (NEEAP). Based on these documents the following reporting criteria have been defined:

- Relevant regulations
- Relevant economic incentives and financing instruments
- Energy performance certificates’ use and layout in relation to nearly zero-energy building standard
- Supervision (energy advice and audits)
- Information (tools)
- Demonstration
- Education and training

The evaluation has to be conducted for residential and non-residential buildings separately. As policy programs can be very different, it is not possible to define a suitable quantitative development indicator that would fit for all kind of programs, climates, cultures etc. Therefore, a more general approach has been developed. Precisely the by the MS described policies and measures should be graded by giving them a value between 0 and 3. The evaluator has to decide which value fits best for the described activities, but he or she should orient on the following indicators:

- If no policies or measures are implemented, this relates to 0 points
- If the set of policies and/or measures seems to be insufficient for the promotion that all new buildings are nearly zero-energy buildings after 31 December 2020, this relates to 1 point
- If the set of policies and/or measures seems to be sufficient at current point in time, this relates to 2 points
- If an implemented package is completely convincing that it will help to achieve the target, this relates to 3 points.

This way, a consistent evaluation for all Member States can be conducted. The defined criteria and indicators for this reporting requirement (all buildings) are congruent with the criteria and indicators for reporting requirements 5 and 6 (chapter 6.2.5 (new public buildings) and chapter 6.2.6 (major renovation)).

Table 32 shows the complete evaluation criteria and chosen indicators for requirement 4 of the nearly zero-energy building reporting template.

Table 32. Evaluation table for requirement 4 of the nZEB reporting template

Evaluation of policies and measures (all new buildings) Grade the policies and measures by giving them a value between 0-3: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3 points.	
Residential buildings	**SUM residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates' use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
Non-residential buildings	**SUM non-residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates' use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
SUM residential and non-residential (Grade of target achievement):	**X/42 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

6.2.5 Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero-energy buildings after 31 December 2018

According to the described background of chapter 6.2.4, the evaluation of the ‘policies and measures for the promotion that all new buildings occupied and owned by public authorities are nearly zero-energy buildings after 31 December 2018’ follows the same methodology as described in chapter 6.2.4.

Table 33 shows the complete evaluation criteria and chosen indicators for requirement 5 of the nearly zero-energy building reporting template.

Table 33. Evaluation table for requirement 5 of the nZEB reporting template

Evaluation of policies and measures (new public buildings) Grade the policies and measures by giving them a value between 0-3: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3 points.	
Residential buildings	**SUM residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates’ use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
Non-residential buildings	**SUM non-residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates’ use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
SUM residential and non-residential (Grade of target achievement):	**X/42 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

6.2.6 Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero-energy buildings

According to the described background of chapter 6.2.4, the evaluation of the 'policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero-energy buildings' follows the same methodology as described in chapter 6.2.4.

Table 33 shows the complete evaluation criteria and chosen indicators for requirement 6 of the nearly zero-energy building reporting template.

Table 34. Evaluation table for requirement 6 of the nZEB reporting template

Evaluation of policies and measures (major renovation) Grade the policies and measures by giving them a value between 0-3: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3 points.	
Residential buildings	**SUM residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates' use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
Non-residential buildings	**SUM non-residential: X/21**
Relevant regulations	
Relevant economic incentives and financing instruments	
Energy performance certificates' use and layout in relation to nZEB standard	
Supervision (energy advice and audits)	
Information (tools)	
Demonstration	
Education and training	
SUM residential and non-residential (Grade of target achievement):	**X/42 (X%)**
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

6.2.7 Overall evaluation

The following Table 35 summarises the outcomes of the evaluation from requirements 1 – 6 (Table 29 to Table 34) and finally allows an overall evaluation by presenting the average grade of target achievement. This grade is expressed as percentage and thus already on the first view allows to see how far a specific Member State is away from a 100% fulfilment of the EPBD reporting requirements and thus from target achievement.

Table 35. Overall evaluation table for the nZEB reporting template

Overall evaluation	
Category	**Sub-evaluation result:**
Application of the definition of nearly zero	%
Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero	%
Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero	%
Policies and measures for the promotion of all new buildings being nearly zero	%
Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero	%
Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero	%
Overall evaluation result [(ΣSub-evaluation result) / 6]:	**%**
Summarise main recommendations for decreasing the delta:	

Also in this table, the evaluator has space for giving main recommendations to the specific Member State on how to decrease the delta (perhaps a summary of the recommendations for decreasing the delta of reporting requirements 1- 6). These final recommendations additionally facilitate the development of the later action plan that the Commission has to prepare as there is a 'central' position in the evaluation forms where the most emerging issues are clearly stated.

7 Task 4: Analysis of the link and consistency between the definition of nearly zero-energy performance of buildings and the cost-optimal levels of minimum energy performance requirements

7.1 Task 4a: Assessment of technological and cost gap (new buildings)

While cost optimality is the current framework regarding the ambition level for both renovation of existing buildings and new buildings, the principle of nearly zero-energy buildings will be guiding for new buildings as from 2021 (public buildings 2019) on. Therefore it is important that there is a smooth and consistent transition of policies and markets from cost optimality to nearly zero-energy buildings.

In this chapter, the estimated gap for new buildings between the principle of cost optimality and the principle of nearly zero-energy buildings is assessed in terms of:

- Availability and technical feasibility of technologies needed
- Differences in life cycle (global) costs

Figure 137 illustrates the methodological process and the following chapters contain the analysis regarding the technological gap (chapter 7.1.1) and the cost gap (chapter 7.1.2).

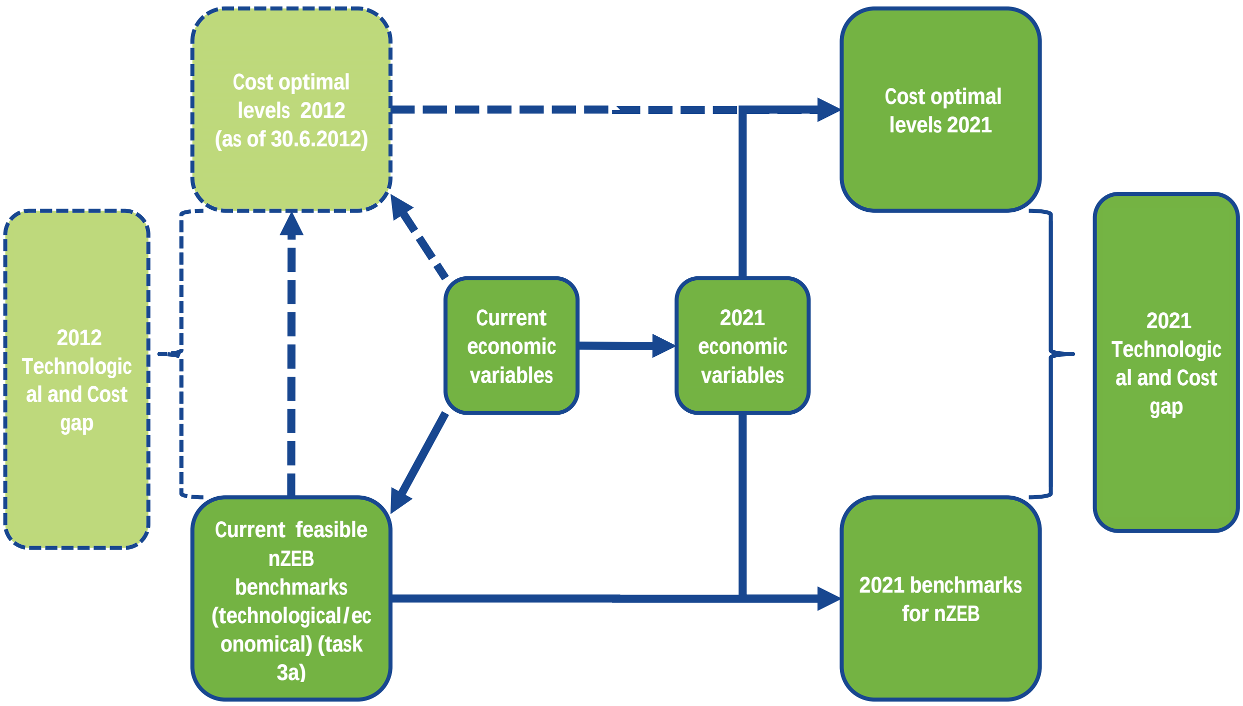

Figure 137. Assessment of technological and cost gap (new & existing buildings)

7.1.1 Technological gap

In general, current technologies related to energy savings, energy efficiency and renewable energies are sufficient to reach, in combination, a suitable target for nearly zero-energy buildings.

A real technology gap that would need to be bridged until 2021 is not perceived. However investment cost reductions, improved performance of components and systems or improved energy storage solutions can of course positively influence the viability and introduction of nearly zero-energy buildings.

Limitations may arise for renewable systems due to disparities in time or place, esp. if one technology would be significantly favoured by the market or by policies, see descriptions under tasks 4c and 4d (chapters 7.3 and 7.4).

7.1.2 Gap in life cycle costs

Currently, in various cases and of course depending on the exact definition of nearly zero-energy buildings at Member state level, nearly zero-energy buildings are placed beyond cost optimality, see virtual example in following graph.

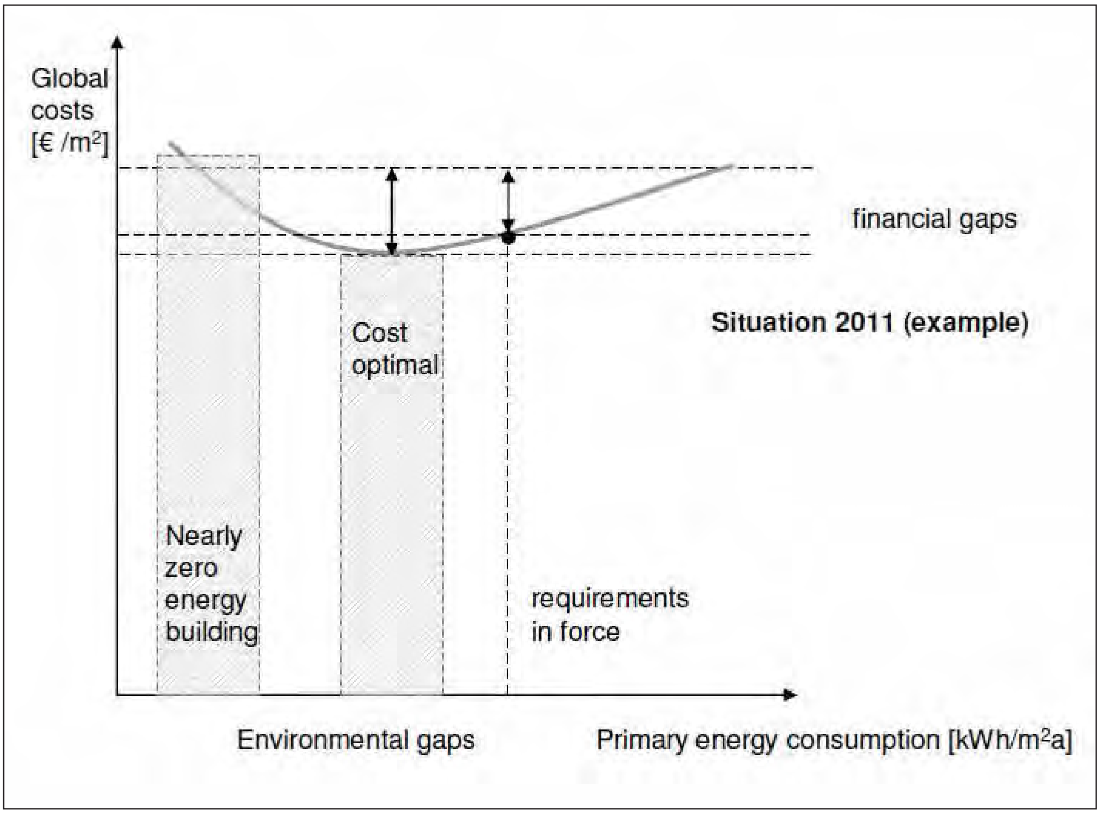

Figure 138: Financial and environmental gaps between nearly zero-energy building, cost optimality and current requirements in 2011 (example only)

Thereby it's important to keep in mind, that for the bulk of new buildings (except new public buildings) the nearly zero-energy buildings concept will apply as from 2021 on. This means that the actual gap that might need to be bridged will be defined by the framework conditions given in 2021. Factors that are likely to be subject to changes are e.g. technology costs (as reaction to more mature markets and larger volumes) the energy price (the average energy price for the period 2021 – 2051 might be assumed to be higher than the average for 2011-2041) and primary energy factor for electricity or district heating (in this case, the average primary energy factor for electricity but also for district heating/cooling for the period 2021 – 2051 might be assumed to be lower than the average for 2011-2041). This is currently assumed by many experts to lead to a reduction of the gap in relation to the situation in 2011, see graph below.

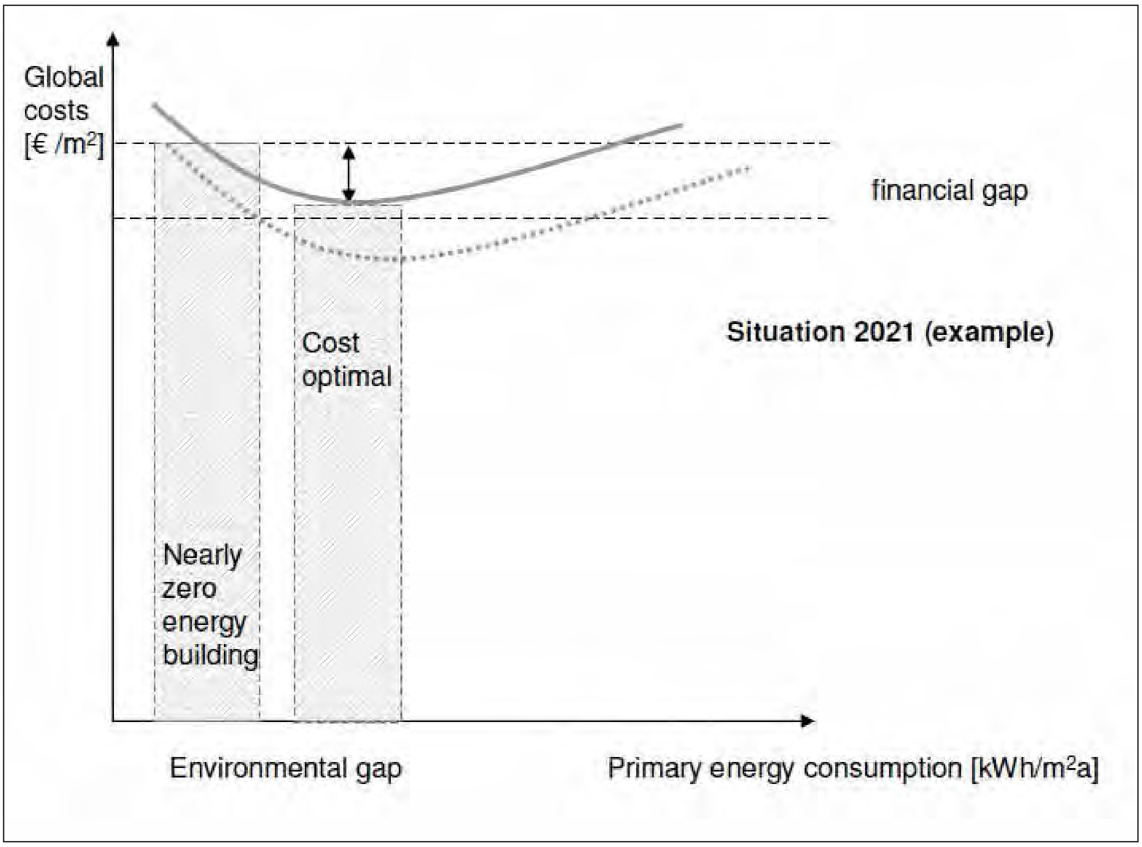

Figure 139: Financial and environmental gap between nearly zero-energy building and cost optimality in 2021 (example only)

Based on examples calculated in Task 3, possible changes regarding the input parameters on the way from today to 2021 have been assessed. This concerns 3 areas, being system costs, energy price and primary energy factor for electricity:

- The annual changes in costs for building envelope components and systems can be found in the appendix of task 4 (chapter 10.5.1).
- The average primary energy factor for electricity was reduced by 20% (fort he time frame 2021 – 2050 versus 2010-2039)

In a second step, the impact of these change on the position of the cost optimum and its relation to the "nearly zero-energy buildings area" has been calculated, see following examples:

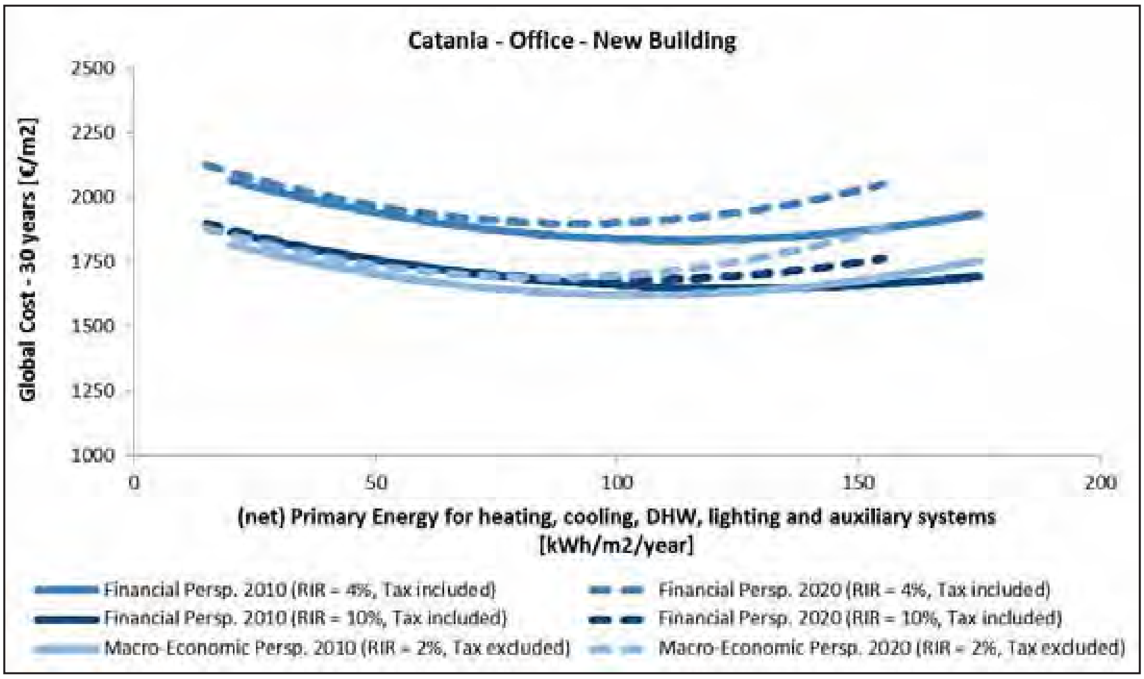

Figure 140: Impact of assumed changes between 2010 and 2020 on crucial input parameters – Catania – Office - New building

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 120 kWh/m²a, moving to around 80 kWh/m²a in the assumed situation in 2020.

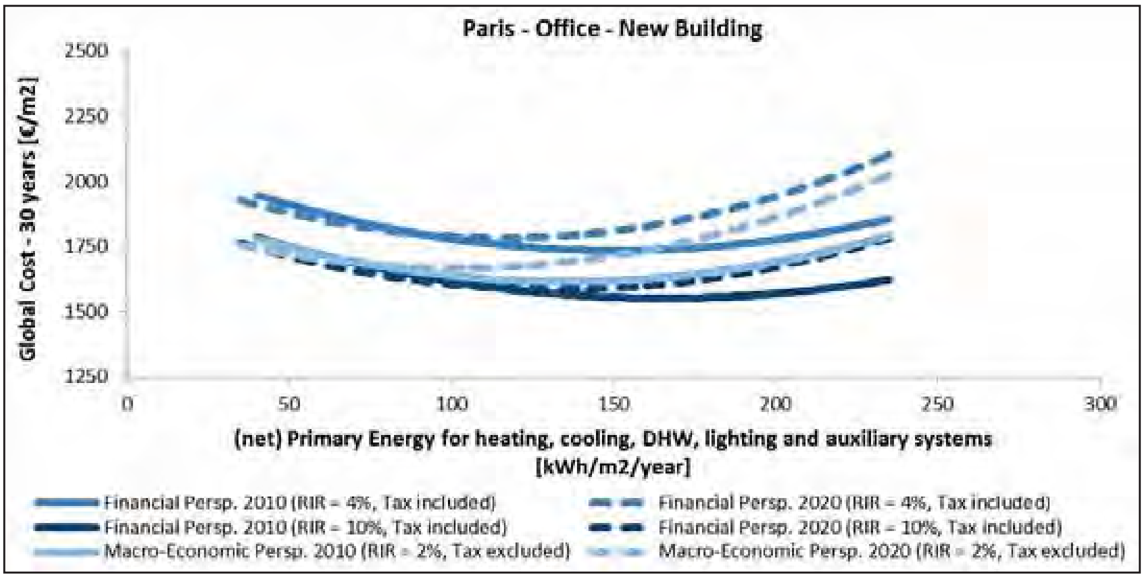

Figure 141: Impact of assumed changes between 2010 and 2020 on crucial input parameters – Paris – Office - New building

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 170 kWh/m²a, moving to around 100 kWh/m²a in the assumed situation in 2020.

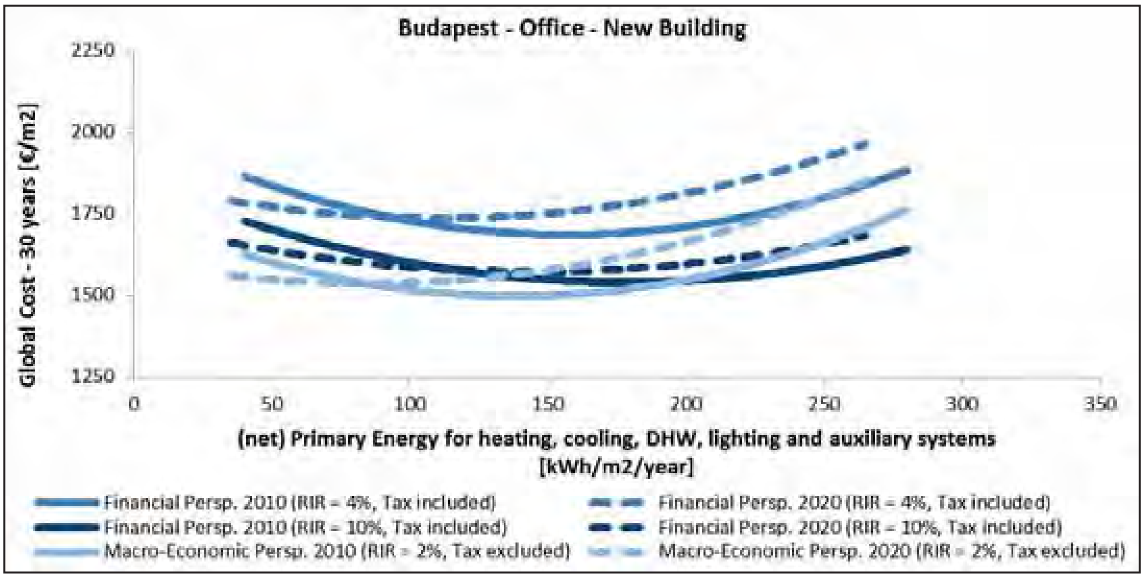

Figure 142: Impact of assumed changes between 2010 and 2020 on crucial input parameters – Budapest – Office - New building

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 160 kWh/m²a, moving to around 90 kWh/m²a in the assumed situation in 2020.

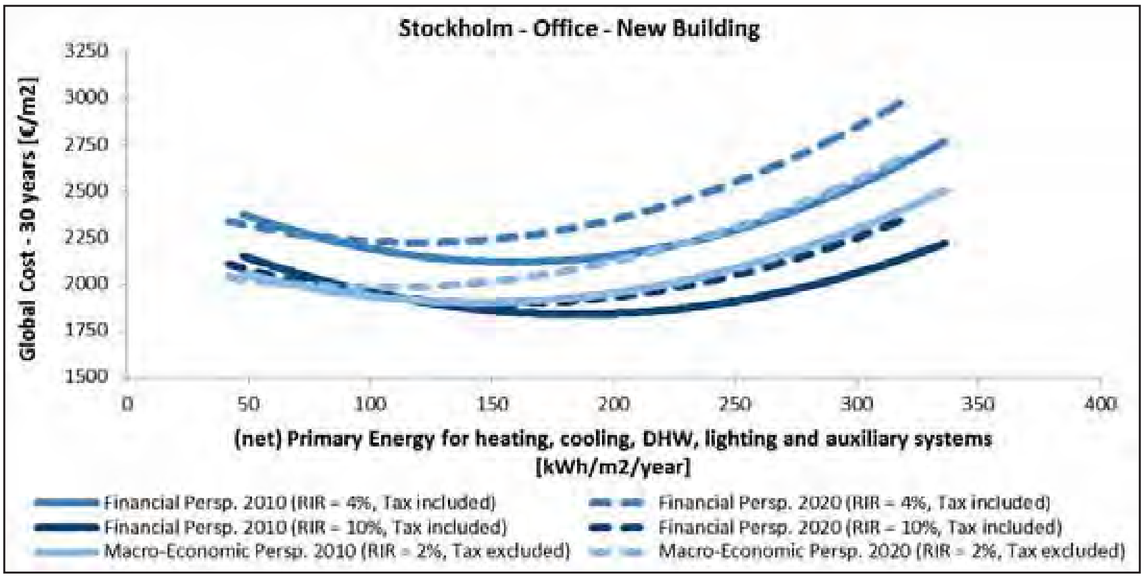

Figure 143: Impact of assumed changes between 2010 and 2020 on crucial input parameters – Stockholm – Office - New building

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 160 kWh/m²a, moving to around 100 kWh/m²a in the assumed situation in 2020.

While being subject to quite some uncertainties regarding the chosen scenarios on the input parameters, the results represent a significant change in the position of the optimum, supporting the view that a smooth transition between cost optimality and nearly zero-energy buildings is achievable.

7.2 Task 4b: Assessment of technological and cost gap (existing buildings)

While cost optimality is the current given framework regarding ambition level for both renovation and new buildings, Member states are also asked to develop plans regarding ambition level and introduction of existing buildings being refurbished to nearly zero-energy buildings.

In this chapter, the estimated gap for existing buildings between the principle of cost optimality and the principle of nearly zero-energy buildings is assessed in terms of:

- Availability and technical feasibility of technologies needed
- Differences in life cycle (global) costs

7.2.1 Technological gap

Also for refurbishing existing buildings into nearly zero-energy buildings, current technologies related to energy savings, energy efficiency and renewable energies are sufficient to reach, in combination, a suitable target for nearly zero-energy buildings. However more adaption to the specifics of the existing building is needed compared to new building situations. A real technology gap that would need to be bridged until 2021 is still not perceived.

Again investment cost reductions, improved performance of components and systems or improved energy storage solutions can of course positively influence the viability and introduction of nearly zero-energy buildings. Limitations may arise for renewable systems due to disparities in time or place, esp. if one technology would be significantly favoured by the market or by policies, see descriptions under tasks 4c and 4d.

7.2.2 Gap in life cycle costs

For the assessment of the financial gap in refurbishing existing buildings, the input parameters for the situation in 2010 versus 2020 have been changed in the same way as for new buildings, see chapter 7.1.2.

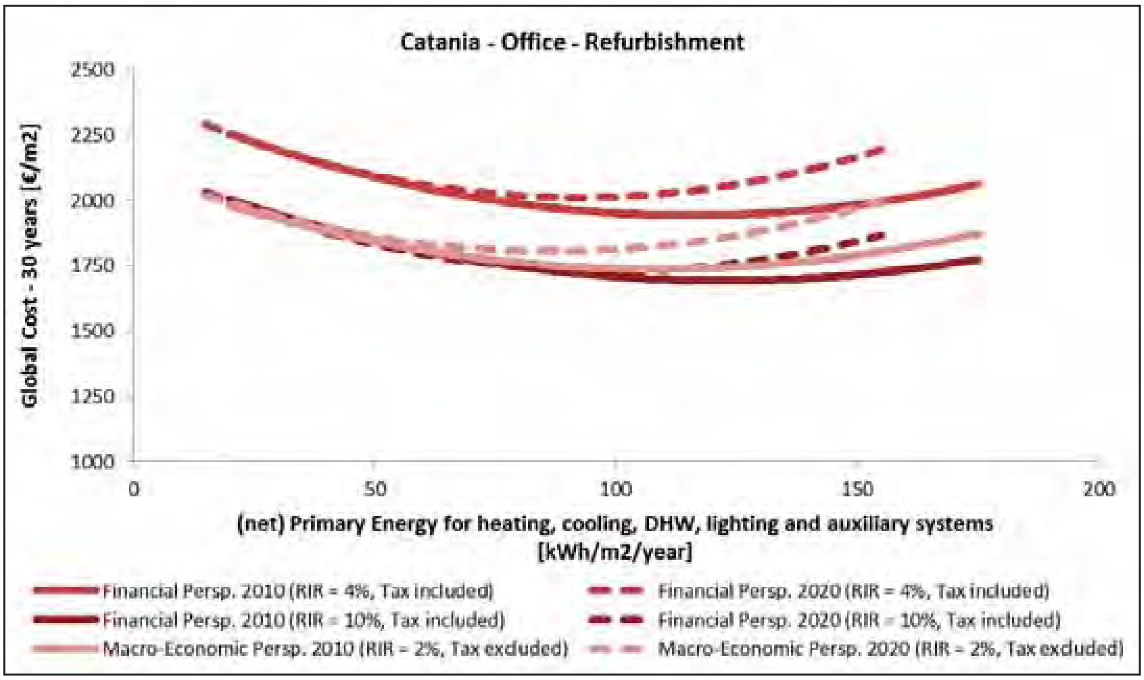

Figure 144. : Impact of assumed changes between 2010 and 2020 on crucial input parameters – Catania – Office - Refurbishment

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 120 kWh/m²a, moving to around 90 kWh/m²a in the assumed situation in 2020.

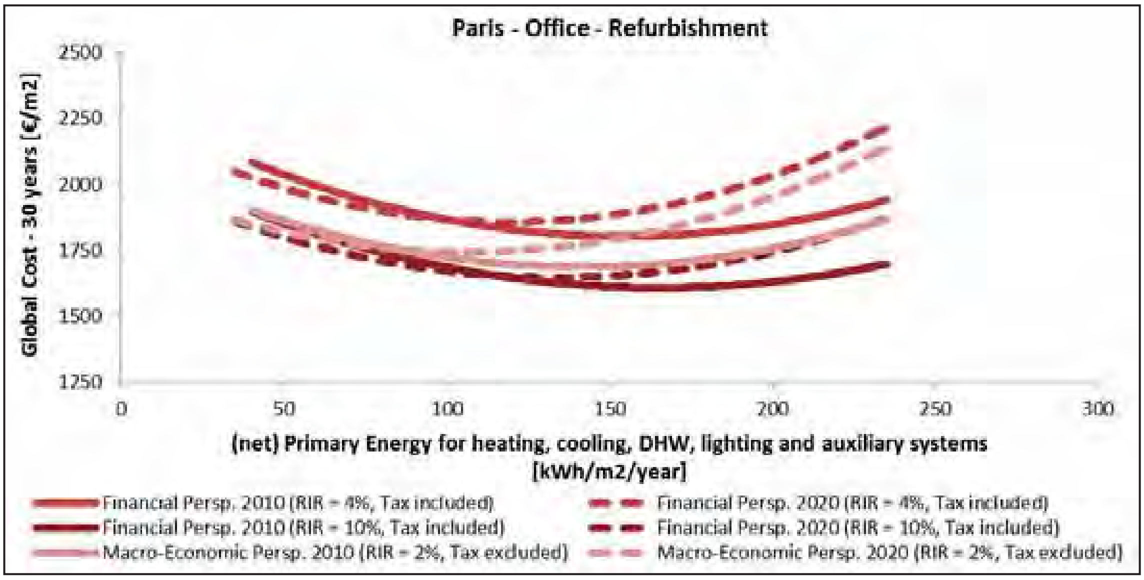

Figure 145. Impact of assumed changes between 2010 and 2020 on crucial input parameters – Paris – Office - Refurbishment

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 170 kWh/m²a, moving to around 100 kWh/m²a in the assumed situation in 2020.

0

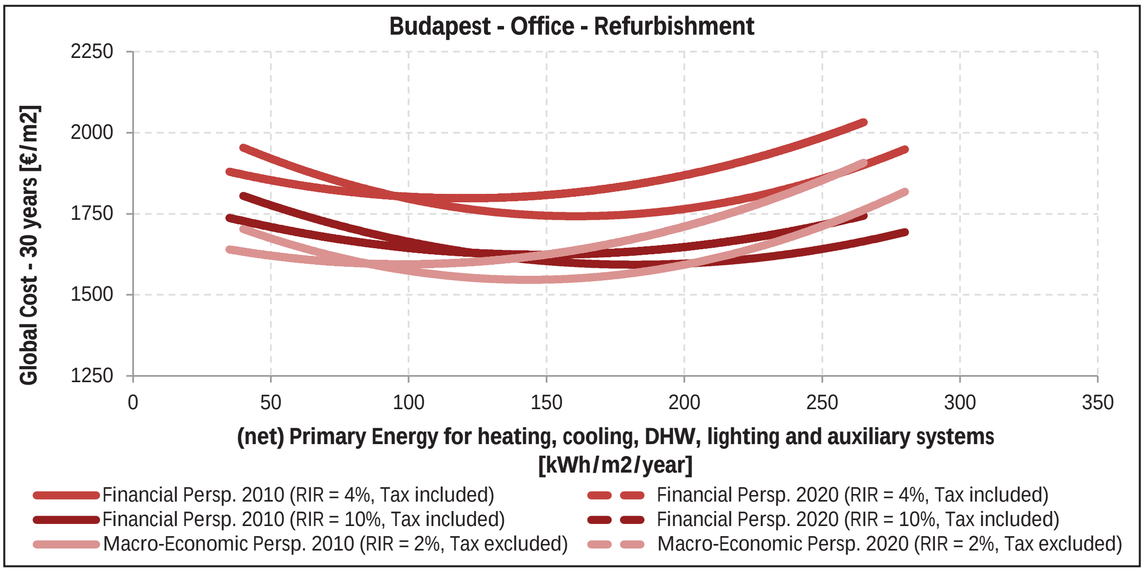

Figure 146. Impact of assumed changes between 2010 and 2020 on crucial input parameters – Budapest – Office - Refurbishment

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 160 kWh/m²a, moving to around 110 kWh/m²a in the assumed situation in 2020.

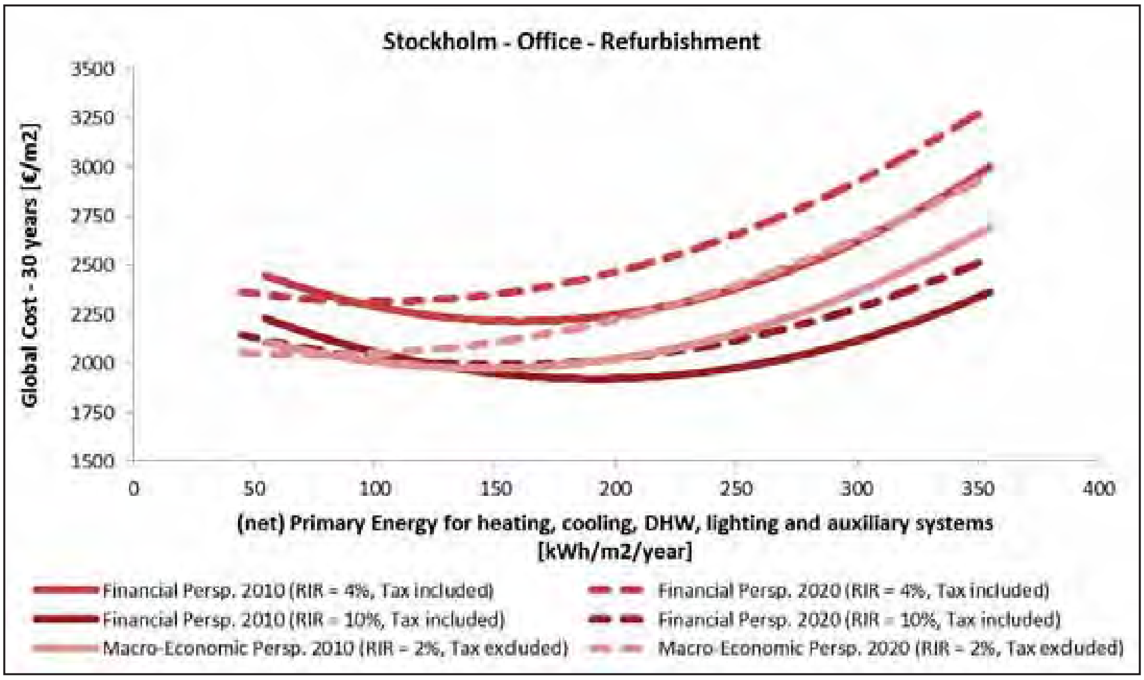

Figure 147. Impact of assumed changes between 2010 and 2020 on crucial input parameters – Stockholm – Office - Refurbishment

In this example, the cost optimum for the situation in 2010 (for RIR=4% Tax included) can be located around 170 kWh/m²a, moving to around 80 kWh/m²a in the assumed situation in 2020.

While being subject to quite some uncertainties regarding the chosen scenarios on the input parameters, the results represent a significant change in the position of the optimum, supporting the view that a smooth transition between cost optimality and nearly zero-energy buildings is achievable.

7.3 Task 4c: Identification of the particular role of renewable energy technologies

The following chapter contains an analysis regarding the role of renewable energy technologies in different European climate zones and tries to find out whether any kind of limitation exists. In this context, technical, environmental and financial aspects are considered. Although this analysis focuses especially on the role of certain renewable energy sources and applicable technologies within the buildings sector, also the combination with demand side measures is taken into account.

For the purpose of this analysis, we divided the European market into four different sub-regions in order to consider regional disparities in Europe regarding external preconditions as for example climatic and economic differences. The four regions have been analysed separately and are namely Northern Europe (Scandinavian countries, esp. Sweden), Western Europe (mainly Germany, France, UK), Southern Europe (mainly Spain, Italy) and Eastern Europe (mainly Poland, Hungary, Romania and Czech Rep).

Figure 148 shows the developed approach to identify the particular role of renewable technologies in the context of nearly zero-energy buildings:

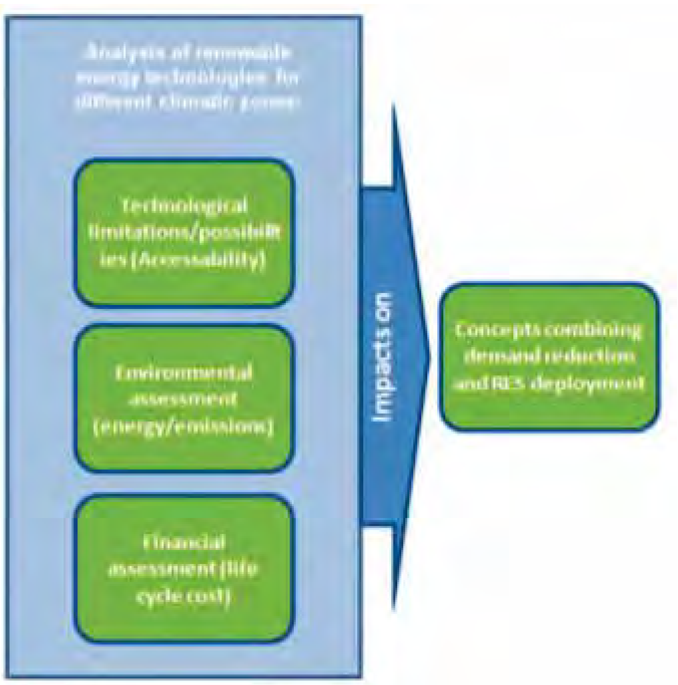

Figure 148. Methodological approach for tasks 4c and 4d: Identification of the particular role of renewable energy technologies

As Figure 148 illustrates, the analysis focuses on technological limitations / possibilities and considers an environmental and financial assessment within the above mentioned climate zones. In this context, three main aspects are analysed:

- Regional differences in life cycle costs for comparable renewable technologies. These life cycle costs are influenced by different investment costs, national strategies to settle disadvantages, as well as external (natural) circumstances.
- Looking at the production capacity and technical applicability, the goal is to estimate the accessibility of certain renewable energy techniques. The assumption is that accessibility raises proportional to the installed capability. Likewise, external preconditions in favour to certain techniques abet their accessibility.
- Possible savings in energy use and carbon emissions of specific technologies in different climate zones. This includes the analysis of prevalent regional emission factors for electricity as this is the main form of energy that is also important for renewable energy systems (e.g. heat pumps).

Taking the results of these aspects into account, emerging possible limitations for specific technologies can be identified. For this purpose, we structured the analysis into four subchapters, one for each European climate region. The results can be found in the following chapters 7.3.1 to 7.3.4 and the derived conclusions are presented in chapter 7.3.5.

7.3.1 Northern Europe

Active solar thermal systems need pumped (forced) circulation systems in cold climates. Those systems, which are more sophisticated, allow the separation of the collector and the storage tank and provide freeze protection, as well as a better protection against legionellae. Abatement costs can therefore be much higher in cold climates then in moderate climates (IEA 2010: 248). Combisystems providing heat for domestic hot water and space heating have become the standard in Northern Europe. Nevertheless, Northern Europe remains to be a rather small market for active solar thermal systems. The installed thermal capacity per 1000 capita in Sweden was in 2011 with 25.1 kW_{th} about half the European average level of about 51.7 kW_{th} and in Finland the total capacity was just 4.3 kW_{th} (ESTIF 2012: 10 f).

The efficiency of photovoltaic systems in northern Europe lies far behind regions with higher radiation levels. The average irradiation in Scandinavia is about 1,000 kWh/m² and relatively small in compared to Southern European regions with a radiation average of about 1,900 kWh/m² (EPIA 2011: 32).

Air Source Heat Pumps (ASHP), which are less expensive than Ground Source Heat Pumps (GSHP), still operate down to temperatures of around -25°C, but tend to be 10% to 30% less efficient in cold climates than GSHP (IEA 2010: 237).Nevertheless, Northern Europe represents a huge market for heat pumps. The interest in such technologies is high and the market penetration above the European average (EHPA 2010: 33).

The Northern pellet market has been developed into a mature market within recent years. Sweden and Denmark count as the main producers and consumers of wood pellets in Europe (WIP 2009: 27).

Sweden also plays a vanguard role concerning the standardisation of biomass products, which is a key to guarantee product quality, high efficiency and thus gain market confidence. Denmark and Finland, by contrast decided to wait for the completion of the European pellets standard (WIP 2009: 27).

7.3.2 Eastern Europe

Eastern Europe represents the smallest market concerning renewable energy sources in Europe. Accessibility can therefore be seen as rather low compared to other European regions. This impression fits with a rather low capacity of installed active solar thermal systems Eastern Europe. According to ESTIF (ESTIF, 2012), the installed capacity was significantly below the European average in a range between 3 and 25 kW_{th} per 1000 capita.

Although the market for air and water heat pumps in Eastern Europe is growing, heat pumps for domestic hot water preparation seem to be not present. A key problem might be the difficult license procedures (EHPA 2010: 65)

Only little improvement can also be seen at Eastern Europe’s pellet market as it just started to develop (WIP 2009: 27). Altogether, the renewable technology market has just begun to develop and all relevant technologies are available. However, due to missing experiences and education of most architects, installers and project developers, prices are comparatively expensive.

7.3.3 Western Europe

The Western European Market for Active Solar Thermal systems (AST) is well developed. Germany is the largest market in Europe and has an installed capacity of about 128 kW_{th} per 1000 capita. The highest specific capacity in Europe has Austria with about 332 kW_{th} (ESTIF 2012: 10 f). According to EPIA (2011c), “Given increased PV efficiency, economies of scale and the development of mature markets for PV, combined with the growth trend in the generation cost of electricity from all power sources, PV can be competitive [...] before 2020” in Germany, France and the UK.

The climate conditions in the Western region of Europe lead to the situation that by far the most heat pumps mainly operate in the heating mode, while air conditioning is rarely required. This climate circumstance has to be taken into account to avoid higher costs by installing unnecessary reversible systems (IEA 2010). Taking a closer look into the western market, it is noticeable that the market for heat pumps increased dramatically over the last years due to different subsidies and the market is expected to benefit even more from new building regulations (EHPA 2010: 55). The variety of geological settings in some parts of Western and Central European countries limits the direct utilization of geothermal energy to supply heat through district heating to a larger number of costumers but some countries may benefit widely when exploring their geological potential.

The Western Market for Biomass and Pellets has developed into a mature market. For example in Germany, the number of pellet heating systems has grown from about 3,000 systems in the year 2000 up to 180,000 systems in 2012 (DEPV, 2012) and Austria is the most developed market concerning residential pellet heating per capita (WIP, 2009). The wood pellet supply in Western Europe continues growing rapidly both in countries with developed supply structures and in countries with emerging wood pellet production. Therefore, the supply of the demand side is comparatively safe in the Western Market, especially due to the fact that Germany and Austria are the main consumers but also producers of pellet products in Europe and are able to supply their own market (WIP 2009: 27).

7.3.4 Southern Europe

The Southern region of Europe is the region with the highest radiation rates and the highest average temperatures. Thus, solar systems such as solar thermal and photovoltaics are already a quite good alternative to fossil energy systems and are expected to become even more efficient and cost-competitive in the future. Simple Active Solar Thermal systems without freeze protection and thermosiphon circulation systems can provide hot water at very competitive prices in specific frost-free regions (IEA 2010: 248). Thus, the Southern Region is especially suitable for less sophisticated Solar Domestic Hot Water preparation (SDHW) because of low space heating demands. Furthermore, it is the only region in which low-cost compact thermal storage systems are efficient, that enable larger solar systems to store the surplus heat collected during summer months until the shorter and warmer winter. In regions with high radiation rates, solar water heating can abate carbon emissions at very low or even negative costs as long as cheap and efficient solar systems are available and appropriate (IEA 2010: 248). The predominant system in the southern part of Europe is the thermosiphon collector. Italy and Spain are, after Germany, the most emerging solar thermal markets in Europe reaching high numbers of new system installations per year. Further tax rebates and the reduction of political obstacles and administrative burden could even enforce the increasing development (ESTIF 2012: 10).

The development of the PV market is promising as well. The energy payback time for thin film systems is already less than a year in Southern Europe (EPIA 2011: 1) and the produced residential electricity is expected to be cost competitive in Italy already by 2015 (EPIA, 2011c).

However, the biggest potential is expected for renewable combi-systems that generate heat for space heating purposes in winter times, cold through air-conditioning systems in summer and SDHW throughout the year (ESTIF.org). Reversible heat pumps are economically attractive in moderate climates, such as the southern region, as both heating and cooling applications are necessary throughout a year. The incremental cost of giving the possibility to reverse the cycle is very modest compared to the cost of installing a separate heating and cooling system (IEA 2010: 239). With the on-going heat pump market expansion in Southern Europe, the combined use for heating and cooling will become more important in the future. As an example, the Italian market is slightly growing and the general interest in heat pumps is considered to be high. Air Source Heat pumps (ASHP) are less efficient in other regions but obtain high efficiency rates under the Southern European climate (EHPA 2010: 70).

According to WIP (2009), “pellet market development in Southern Europe is generally hampered by limited availability of raw materials and a lower heat demand in households due to warm climates. The use of high-tech pellet central-heating appliances does not seem to be feasible in these countries. However, the market in Italy has shown the potential of pellet stove heating under these conditions [...].” Although external preconditions seem to be positive in order to increase the biomass market in Southern Europe, policy support lacks bigger intentions. Nevertheless, Italy belongs to the main producers of wood pellets in Europe.

7.3.5 Summary

Table 36 Summary of the distribution of different renewable energy technologies in Europe

Renewable Energy Technologies	Northern Europe	Eastern Europe	Western Europe	Southern Europe
Solar Thermal Systems	Need for more sophisticated systems. Higher abatement costs than in moderate climates. The market has a small size.	Installed systems present low capacity. The market is underdeveloped.	The installed systems present high capacity. The market is large and well developed.	Great potential due to high radiation levels; especially suitable for less sophisticated Solar Domestic Hot Water preparation (SDHW); and present a high efficiency of low-cost compact thermal storage systems. The market is large and still growing.
Photovoltaic Systems	Actually still low efficiency and high costs due to low radiation levels. The market has a small size.	The market is underdeveloped.	The systems have a high efficiency. The market is large and well developed.	Great potential due to high radiation levels and short payback times. The market has a medium size but is still growing.
Heat Pumps	Due to the cold climate, the efficiency of the systems is lower. However, the systems have a very good market penetration	The main challenge for increasing the use of those systems is the difficult license procedures. However it represents a growing market.	The systems mainly operate in heating mode, since air conditioning is just rarely required. The market is large and it is still growing.	Reversible systems are economically attractive in this climate. Combisystems have the biggest potential for market growth. The market has a medium size but is still growing.
Biomass and Pellets	Main producers and consumers in Europe. The market has a large size, has been well developed in recent years and is still growing	The market is in an initial development stage.	The market is large, well developed and it is still growing.	Raw materials are scarce and buildings just have a relatively low heat demand due to the warm climate. Thus, the market is still quite small but has considerable growing potential

7.3.6 Conclusions

Our analysis has shown that the distribution of the different renewable energy technologies differs significantly from region to region. In the Northern European market, especially heat pumps dominate but also the biomass technology is getting more and more important. In Southern Europe, especially solar thermal systems and reversible heat pump technologies, applicable for heating and cooling purposes promise the largest potentials. In Western Europe, for all kind of technologies a mature market has been developed while in Eastern Europe the renewable technology market is still underdeveloped.

Nevertheless, in all regions the different technologies are already used and thus, all technologies are available in each European region.

7.4 Task 4d: Specifics around maximum contribution of renewable energy

Renewable energy sources play a prominent role within the nearly zero energy concept. This directly follows from the EPBD's nearly zero-energy building definition given in Article 2.2:

1. *"'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;"*

Nevertheless it is also clear, that reducing energy needs comes first and only then RES come into play. This major EPBD approach results from the definition's "*should* be covered" and is explicitly mentioned in EPBD recital 15:

2. *"[…] alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs for heating and cooling are reduced to cost-optimal levels."*

This approach is also confirmed within the cost-optimal guidelines (EC 2010: 10):

3. *"Thus, the overall spirit of the EPBD (i.e. reduce energy use first) would not be compromised and the nearly zero-energy definition (i.e. a building with a very high energy performance and the nearly zero or very low amount of energy still needed to be covered to a large extent by renewables) is complied with."*

In those guidelines, MS are even encouraged to stress reducing energy needs first before running the "risk" of replacing measures for reducing energy needs by RES installations:

4. *"If a Member State would want to clearly avoid the risk that active RES installations replace energy demand reduction measures, the calculation of cost optimality could be done in steps gradually expanding the system boundary to the four levels […]: energy need, energy use, delivered energy and primary energy. […]"*

At the same time, using renewable energy to cover the nearly zero or very low amount of energy is a necessity in order to make nearly zero-energy buildings representative for the kind of buildings which is needed to achieve the EC's long term climate goals. Europe aims at bringing about drastic greenhouse gas emission reductions in the building sector of 88 to 91% compared to 1990 by 2050 [COM(2011) 112][22]. Considering the fact that existing buildings can just achieve the same low energy and carbon emissions level of new buildings with disproportionately more financial effort, new buildings have to have effectively close to zero emissions in order to compensate for what cannot reasonably be achieved with the existing building stock. But efficiency alone won't reach this target. Nearly zero emissions only will be achieved by interpreting the "very significant extent" as a number which should probably be closer to 100% than to 0%, i.e. a renewable share between 50% and 100% seems to be a realistic interpretation of the definition.

[22] A roadmap for moving to a competitive low carbon economy in 2050

Relative to the renewable share there are some specific questions that need to be solved until nearly zero-energy building have to be the common standard in Europe:

1. Which renewables are allowed?
2. To what extent should areal disparities between the building site and the renewable generation or source respectively be allowed?
3. To what extent should temporal disparities between energy need and renewable production be allowed?
4. How to calculate the share of renewables in a nearly zero-energy building?

1) **Which renewables?**

Article 2.5 of the EPBD explicitly defines "energy from renewable sources" as "*energy from renewable non-fossil sources, namely wind, solar, aero-thermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases*". In principle this is an exhaustive list of all kinds of renewables, which – as nearly zero-energy building are a subset of the buildings spoken of in the EPBD – are potential options for covering the share of renewables as requested in the nearly zero-energy building definition. Anyway this full set might be curtailed by other elements of the definition.

2) **Areal disparities**

There are different opinions among stakeholders, experts and policy makers on which renewable energy supply options may be included in the nearly zero-energy building definition. Taking the results from Task 1, there is a tendency to typically link onsite renewable production to the concept of buildings with a very high energy performance. Nevertheless Task 1 also identified a number of definitions for nearly zero-energy building which allow renewable generation and/or sources which go beyond "onsite", i.e. are considered to belong to "off-site" solutions. The cost-optimality guideline hints at what is "off-site" by giving examples for delivered energy: *"Delivered energy includes e.g. electric energy drawn from the grid, gas from the grid, oil or pellets (all with their respective primary energy conversion factors) transported to the building for feeding the buildings technical system."* This is in principle everything but energy from onsite sources, like PV and solar thermal energy. Obviously a limitation to onsite renewables would mean to deprive a nearly zero-energy building or its owner respectively of the bulk of sources and related technologies for achieving a significant share of renewables in the nearly zero-energy building's energy supply.

Such interpretation would cause significant inequality and different chances between building owners at different places (e.g. dense urban with lots of mutual shading of buildings vs. rural area with little mutual shading, MS with high solar irradiation vs. MS with very low solar irradiation) and it would hurt the principle of "technology openness". From a political point of view it seems to be very questionable if such interpretation could hold against the obvious unequal treatment.

Therefore BPIE (2011) state: *"There are different opinions among stakeholders, experts and policy makers whether off-site (=grid) renewables are or should be included in this definition. However the EPBD text appears to be clear in saying that "the nearly zero or very low amount of* *energy required should be covered to a very significant extent by energy from renewable sources,* ***including*** *[****but not*** *saying: "being" or* ***"limited to"****] energy from renewable sources produced on-site or nearby".* For the reasons mentioned above, this view is shared in this report. This also means that it is somewhat academic to further discuss the exact meaning of "nearby" as should be included in the nearly zero-energy building concept along with "onsite" and "offsite" solutions.

3) **Temporal disparities**

As pointed out in Task 1 "zero" within the nearly zero-energy building concept typically means *net* zero over a period of time as a result from balancing energy production that belongs to the building and its use. Hence, the balance period concerns the regulation of the time interval within which a (nearly) zero energy aim should be achieved. Recital (9) EPBD asks for a balance period of one year.

But having a balance period of one year does not necessarily forbid dividing the year into smaller sub-intervals and asking for a (nearly) zero energy balance for each of these sub-intervals. Several calculation procedures for the energy performance of buildings are based on monthly intervals which suggest applying a similar approach to the determination of a (nearly) zero energy balance. Obviously it is more ambitious to reach (nearly) zero energy balances for sub-intervals being arbitrarily shorter than one year. Usually shorter time spans such as a seasonal or monthly balance focus on a smaller stress of the (electricity) grid and call for higher energy efficiency, energy storage or more even energy production from renewable energy. This is easy to see in the case of PV on the buildings footprint (roof and/or façade) where high net surpluses in summer face high net deficits in winter. These time disparities of energy generation and use cannot be seen in an annual balance without sub-intervals but they get more and more pronounced with sub-intervals getting shorter. This relation can be seen in the "load match index". (Koch et. al 2011) as presented in the following chart with sub-intervals of one year, one monthly, one day and one hour for a net zero energy building.

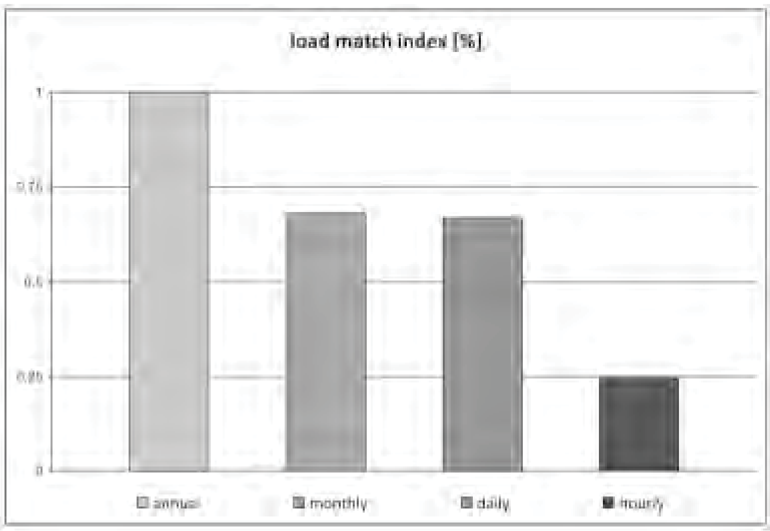

Figure 149 - Load match index for different sub-intervals (source: Koch et al. 2011)

The difference between the time of use and the time of generation of “on-site” or “nearby” electricity hinders the possibility to use electricity fully for self consumption. Grid connection is usually necessary to enable the true physical zero energy balance. Thus, it is assumed that excess electricity generated on-site is sent back to the grid, using the grid as an unlimited storage. However, due to rapid growth of distributed electricity generation the grid may not need this electricity or simply may not be able to receive it within its capacity limits.

Hourly or daily (on-site) balances) would mean almost no allowance for disparities. This would impose significant restrictions on the possibilities of utilising the grid as a buffer to offset energy consumption in case of excess production. Local storage technologies or cutting off local over production would be required in this case. Currently on-site storage technologies have limited capacity and low economic feasibility. Therefore such approach today would not support a “significant extent” of energy supply from renewable sources. On the other hand a yearly sub-interval would fully allow for such temporal disparities. The essential question is: “To what extent should renewable energy which is actually not used in the building be taken into account for an nearly zero-energy building?”. This is different from the question on areal disparities which is: “To what extent should renewable energy which is actually not produced on the building (plot) be taken into account for an nearly zero-energy building?” Finally all three previous items both questions lead to the final question:

4) **Share of renewables**
   All items mentioned previously obviously effect the share of renewables in a nearly zero-energy building. Therefore an indispensable prerequisite for filling the nearly zero-energy building concept with life and to make different approaches comparable is having clear rules for the calculation of the (very significant) extent to which energy from renewable sources covers the nearly zero or very low amount of energy required in a nearly zero-energy building.

Conclusion

Without doubt the real share of renewables in new nearly zero-energy building needs to be very significant, i.e. quite high, e.g. in the range 50% to 100%, in order to be consistent with long-term EU climate targets.

An approach on how to determine the share of energy from renewable sources in nearly zero-energy buildings is currently under development for prEN15603 (2013) by Technical Committee CEN/TC 371 “Energy performance of Buildings Project Group”. The draft is to be published by March 2013 for public feedback.

As soon as such procedure will be in place, another question will be to what extent renewable energy in nearly zero-energy building contributes to overarching EU renewable energy targets beyond 2020. This should be explicitly addressed and solved by aligning different sector targets (industry, transport, buildings etc.) with each other. The concept of having a renewable share in nearly zero-energy building will only fulfil its ultimate target of increasing the overall share of renewables in the EU and thus decreasing CO_2-emissions if it leads to real additional use of renewable sources and not just remains a bookkeeping exercise without really increasing the use of renewable energy.

8 Conclusion and Outlook

Member states have to report their national definition for nearly zero-energy buildings and their national plans for increasing the number of nearly zero-energy buildings.

The in-depth analysis that has been performed in this project revealed a wealth of definitions and schemes related to nearly zero-energy buildings in Europe and beyond. Most of them have in common the objective to achieve a more or less equalised annual energy balance. Nevertheless, calculation procedures differ significantly and are not necessarily in line with CEN standards underpinning the EPBD. Therefore, comparing the energy performance inherent to these schemes and standards turns out to be very difficult.

A similar problem arises when trying to compare *the ambition and measures taken for increasing the number of nearly zero-energy buildings* that should be reported in national plans by the Member States. So far the elements that should be part of such a report are spread over NEEAPs and NREAPs, and the depth and scope of actual reporting by the Member States differ significantly, making comparisons difficult.

It is understood that the definitions and reporting that were analysed in the context of this project can only give an indication of what could be expected in the actual reporting of Member States about their national definitions and plans for increasing the number of nearly zero-energy buildings. The reports that the Commission had received by the end of December 2012 were not included in the analysis for this project.

To facilitate the comparison of different national approaches for *defining* nearly zero-energy buildings, a comprehensive template was developed in this project. The template allows to systematically compare different aspects which are relevant for the scope and ambition for nearly zero-energy buildings' definitions. Another template was developed to facilitate a systematic *reporting on national plans* for increasing the number of nearly zero-energy buildings.

A first major conclusion and recommendation is:

- It should be in the interest of every Member State to follow a uniform, transparent approach for both reporting the national definition and national plans for increasing the number of nearly zero-energy buildings. Implementing nearly zero-energy buildings until 2019/2021 is a major challenge for the Member States. As all Member States face similar challenges and opportunities, only learning from each other by comparing definitions and strategies will create synergies, which do not only speed up the process but also increase the competitiveness of Europe in terms of nearly zero-energy building technology leadership.
- Such a harmonised reporting format should also allow the European Commission to act as a *facilitator* in the Member States' process of achieving nearly zero-energy buildings.

Having done the analysis of many definitions for (nearly) zero energy buildings, there is specific concern about the comparability of ambition target expressed as a *"numeric indicator of primary energy use"* as required by Annex 1 of the EPBD. As Member States are not obliged to use CEN standards for determining such a numeric indicator and even the application of CEN standard leaves quite some flexibility, for example as to the time step used in calculations - not to mention political considerations that may lead to different primary energy factors - the second major conclusion is:

- It seems to be inappropriate to take primary energy as the only basis for creating benchmarks for nearly zero-energy buildings. We strongly recommend always adding the energy need for heating, cooling and hot water as well as the energy use for lighting. Later other performance indicators, e.g. for ventilation, auxiliaries and plug loads, may be added as 'bring to life' the energy performance indicator required by Annex I of the EPBD.
- The energy need is the starting point for calculating primary energy via the additional steps of energy use and delivered energy. In each step additional parameters are included which make the result of the calculation less transparent. This means that the calculation of the energy need of a building is most transparent, while the primary energy is least transparent. Therefore the energy need seems to be well-suited as a (supplementary) benchmark for the energy performance of nearly zero-energy buildings.

Using *2010* prices and technologies and other assumptions we made, the multitude of calculations that were performed for every climate and every new building type, returned a number of building variants *with similarly low minimum global cost* but much less energy need and primary energy than the bulk of analysed variants (having used quite conservative assumptions). Specifically, these *energy needs (being the sum of heating and cooling (sensible & latent))* turned out to be in the following ranges for the different climate zones (new buildings, financial perspective):

- Zone 1: Catania (others: Athens, Larnaca, Luga, Seville, Palermo): 15-45 kWh/m^{2}a (new office), 15-30 kWh/m^{2}a (new SFH)
- Zone 3: Budapest (others: Bratislava, Ljubjana, Milan, Vienna): 15-45 kWh/m^{2}a (new office), <15 kWh/m^{2}a (new SFH)
- Zone 4: Paris (others: Amsterdam, Berlin, Brussels, Copenhagen, Dublin, London, Macon, Nancy, Prague, Warszawa): 30-45 kWh/m^{2}a (new office), here variants having the same *average* global cost were found in the classes <15 kWh/m^{2}a and 15-30 kWh/m^{2}a as well; <15 kWh/m^{2}a (new SFH)
- Zone 5: Stockholm (Helsinki, Riga, Stockholm, Gdansk, Tovarene): 15-30 kWh/m^{2}a (office), <25 kWh/m^{2}a (SFH)

- *Domestic Hot Water* (DHW): DHW is very much influenced by occupant density, thus a *per capita* benchmark would make sense. Nevertheless this may be unpractical, since many other indices are normalised to the floor area and since the number of occupant in a building unit fluctuates significantly. As a proxy Member States could chose to set maximum values for energy *need* for DHW relative to the treated floor area. For example, the German Energy Saving Ordinance assumes a value of 12.5 kWh/m^{2}a, which we deem to be a realistic benchmark for single family homes. For multi-family homes literature shows that maximum values of 15-20 kWh/m^{2}a seem to be realistic considering the usually higher occupant density. Here we are neglecting heat recovery which might reduce these values by up to 50%. In office buildings only DHW should be close to 0 kWh/m^{2}a. A practical general upper limit might be set at 20% of the multi-family homes value, i.e. approximately 4 kWh/m^{2}a.

- *Lighting, non-residential*: This is strongly influenced by daylight availability at a certain latitude. The Norwegian standard NS 3071:2012 “Criteria for passive houses and low energy buildings. Non residential buildings” sets a maximum value of 12.5 kWh/m^{2}a as energy *use* for lighting. A range between 6 and 10 kWh/m^{2}a may be adequate for zones with higher daylight availability.
- From 2020 onward all chosen target values need periodic adjustment to reflect the actual technology progress.

The final question is if cost optimal buildings and nearly zero-energy buildings will already have converged by 2021. To answer this question we assessed the estimated gap between the principle of cost optimality and the principle of nearly zero-energy buildings in terms of a) Availability and technical feasibility of technologies needed and b) Differences in life cycle (global) costs.

The analysis of a) did not reveal a real technology gap until 2021. In general, even current technologies are already sufficient to reach a suitable level for nearly zero-energy buildings.

As cost optimality is focused on primary energy we applied the transparent approach described above using the common "net zero energy limited" variant to assess the convergence. Let’s recall here that in this exercise we thus assumed to include energy for heating, cooling, ventilation and auxiliaries, hot water, lighting; weighting of energy exported to the grid or delivered to the building is assumed to be symmetric; the time interval is assumed to be the entire year. The calculated parameter is hence net primary energy consumption over a year (which does not include in itself information on mismatch between time of generation and time of use).

The conservative assumptions that were applied did not get net primary energy close to zero in the year 2010 for most combinations of climates and building types. The buildings being closest to zero primary energy usually were beyond the cost optimal area. One reason for that is the restriction of energy from renewable sources to photovoltaic or solar thermal systems located on a reasonable area on the roof of the exemplary buildings – these were the systems considered in this study, obviously there are more renewable options, which may be more or less favourable than using PV depending on the situation. Nevertheless, it became very clear that in many cases on-site renewable energy will not be sufficient to reach a primary energy level close to zero without further energy efficiency measures and/or a significant decrease of primary energy *factors* of *off-site* energy carriers *supplementary* to a very low energy need of the building.

The same calculations were performed at 2020 prices. Here we made very cautious assumptions as to decreased real prices for 2010 performance levels. We also assumed only modest energy price increases. Nevertheless, the typical result of these calculations was the relative improvement of low energy *need* variants compared to high energy need variants as to global cost. Taking these assumptions, a “natural”, economically driven development towards buildings with lower energy needs than today can be predicted for the years until 2021. The most attractive energy need class may move to even lower levels than shown for some of the above analysed reference buildings.

From our point of view the class “energy need for heating and cooling“ < 30 kWh/m^{2}a may probably and the energy class < 15 kWh/m^{2}a will almost certainly suffice to be called “nearly zero-energy building” by 2021. A very low level of energy need for heating and cooling is a vital pre-condition for nearly zero primary energy buildings. We also regard this to be a vital precondition to achieve a significant share of energy from renewable sources in nearly zero-energy buildings on a large scale and thus to widely achieve nearly zero primary energy. Anyway without an additional real decrease of primary energy factors and accelerated innovation even this "natural" movement towards zero will neither bring most of the new buildings in Europe really close to zero primary energy nor to zero CO_2 emissions *at the same time*.

Therefore the final major conclusions are:

- The future development of primary energy factors and the interaction of energy export from, and energy import to, nearly zero-energy buildings combined with time-dependent primary energy factors should get much more attention in future analyses and research of a building's energy performance.
- The cost optimal methodology uses a complex approach for finding building variants with least life-cycle cost. This includes sophisticated assumptions on future cost. Less focus seems to be on the adequate inclusion of future primary energy consumption. Typically a *constant* primary energy factor and energy mix is taken for the whole period of 30 years. We suggest to explicitly ask for the *sum* of primary energy that will be used by a building variant during the calculation period in order to have an analogy to how cost are treated.This reinforces our proposal to add energy needs as an indicator which is much less by uncertainty on future developments.
- Primary energy as the EPBD's main numeric indicator of energy performance does not directly reflect one of the main targets of European energy policy which is reduction of greenhouse gas emissions. Still greenhouse gas emissions reflect "just" one relevant impact category. Ideally, with a view to long-term climate targets, primary energy should be supplemented by a comprehensive "total emissions" indicator including greenhouse gas emissions, acidification, ozone depletion, particulate matter, nuclear waste etc.
- A real life-cycle balance for nearly zero-energy buildings should take into consideration appliances and plug-loads as well as energy and various pollutant emissions related to the construction and disposal of the building. Otherwise there is a high risk of sub-optimising the total life-cycle impact. This should seriously be taken into consideration for national applications of the EPBD's nearly zero-energy building definition and for updates of the EPBD.
- A numeric value index illustrating the real share of energy from renewable sources should be linked to nearly zero-energy buildings. Such an index should reflect the real additionality of energy from renewable sources in nearly zero-energy buidings. To achieve this, the main issues to be solved are clear definitions of temporal and spatial boundaries and avoidance of double counting especially for electricity from renewable sources.
- Comparisons of the energy performance of different buildings should make very explicit which comfort category is used and how it is defined (e.g. assumptions on clothing); this is requested by the cost optimality methodology as well. The choice of the level of temperature set points (fixed or variable in summer) can have a significant impact on the energy consumption of nearly zero-energy buildings.

All those necessary changes for seeing nearly zero-energy buildings as the standard by 2021 seem to be manageable, especially when Member States exploit the synergies of a joint effort.

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10 Appendix

10.1 Appendix to Introduction

Review on most recent nearly zero-energy building studies and principles

10.1.1 BPIE: Principles for nearly zero-energy buildings - Paving the way for effective implementation of policy

Nearly Zero-energy buildings: main challenges and implications
The study analyses ten challenges and their implications for setting a sustainable and practical nearly zero-energy building definition and proposes principles to be considered when setting up a practical definition. The challenges identified are presented as questions that have to be addressed for the transposition of a nearly zero-energy buildings requirement into a practical, consistent and sustainable definition. The analysis of these challenges has led to several important implications for the nearly zero-energy building definition

Challenge no 1:
How and to what extent do current sectoral and overall targets of the EU regarding CO2 emissions, energy efficiency, renewable energies and other indicators affect the ambition level and set-up of a nearly zero-energy building definition?

Implication for the nearly zero-energy building definition
If EU countries want to meet the 2050 targets for CO2 reduction, then the nearly zero-energy building requirements for new buildings also have to include nearly zero carbon emissions below approx. 3kgCO2/m^2yr. A weaker ambition for new buildings between 2021 and 2050 would necessarily lead to an even higher and almost unrealistic savings requirement of "90% plus" for the renovation of today's building stock.

Challenge no 2:
How different are the solutions between nearly zero CO2 and nearly zero (primary) energy solutions for individual buildings and what are the implications for a suitable definition of nearly zero-energy buildings?

Implication for the nearly zero-energy building definition
The first nearly zero-energy building implication identified is the need for a consistent definition, which should contribute at the same time to both energy and CO2 emission reductions. Hence, the minimum requirements for the energy performance of the building should use an energy indicator that can properly reflect both energy and CO2 emissions of the building as the reduced energy consumption should lead to a proportional reduction of CO2 emissions. In general, the primary energy use of a building accurately reflects the depletion of fossil fuels and is sufficiently proportional to CO2 emissions. Proportions are only distorted when nuclear electricity is involved. Nevertheless, if a single indicator is to be adopted, then the energy performance of the building should be indicated in terms of primary energy, as in line with current EPBD. However, to reflect the climate relevance of a building's operation, CO2 emissions should be added as supplementary information.

It should be noted that there are additional requirements for ensuring a match between nearly zero-energy buildings and climate targets. In particular, it is very important that the conversion factors from final to primary energy are based on reality and not influenced by political considerations or by an inaccurate approximation. Moreover the conversion factors should be adapted continuously to the real situation of the energy system.

Challenge no 3:
Which choices should be made within a definition regarding time disparities (e.g. daily vs. annual balance) and local disparities (e.g. on-site vs. off-site production) between produced and consumed energy?

Implication for the nearly zero-energy building definition
The nearly zero-energy building definition should properly deal with local and temporal disparities of renewable energy production. This is necessary in order to, on one hand, maximise the renewable energy share and the emission reductions and, on other hand, ensure a sustainable development of the local heating and cooling systems. Therefore the nearly zero-energy building definition should address the following:

- As to local disparities, the most obvious and practical solution is to accept and count all on-site, nearby and off-site production from renewable energy sources when calculating the primary energy use of the building. Allowing for only on-site and nearby renewable energy production could be a considerable barrier in implementing nearly zero-energy buildings. Thus the nearly zero-energy building definition should be flexible and adaptable to changes in local plans and strategies. For instance, a district heating connection should be mandatory for nearly zero-energy buildings when there are plans for a renewable powered district heating plant that offers supply at a reasonable price. Off-site renewable energy should be allowed as well because this offers more opportunities for 'green' energy production, opening and not restricting the future progress towards energy-positive buildings. However, off-site renewable energy has to be properly controlled and certified for avoiding fraud and double counting.
- Temporal disparities in renewable energy supply may influence the associated GHG emissions of the building when off-site energy is used to compensate for periods with a lower renewable energy supply than the building's actual energy demand. Therefore, the period over which the energy balance of the building is calculated is important. The practical solution, offering at the same time a reasonable compromise, is to accept either monthly or annual balances. If annual balances are allowed, it will be necessary to introduce an additional verification methodology to take into account the associated GHG emissions of the energy supply over the period. The monthly energy balances are short enough to offer a reasonable guarantee for the emissions associated with the energy supplied to the building. In order to keep the concept as simple as possible it seems preferable and sufficient to use for the time being an annual balance, but to leave the option open for a more accurate yet demanding monthly energy balance in the future.

Challenge no 4:
How to ensure that a definition of nearly zero-energy buildings avoids lock-in effects and allows the concept to be expanded later towards energy-positive buildings?

Implication for the nearly zero-energy building definition

In order to ensure maximum flexibility and to minimise the risk of lock-in situations the nearly zero-energy building definition should take into account the following:

- The evaluation of the buildings energy performance should be based on an annual balance but move towards a more accurate monthly balance in the future.
- The system boundaries should not be too tight, e.g. inclusion of renewable energy from the grid should be possible in specific cases when on-site/nearby capacities cannot be installed due to spatial and building geometry constrictions and/or weather conditions.
- The energy balance must take into account the quality of the energy and be assessed separately for electricity and heating. Hence, the quality of the energy production should be considered as being an important condition for avoiding a misleading nearly zero-energy building concept with ineffective or counter-productive achievements.

Challenge no 5:

How can a definition be shaped to be applicable or transferable to different climates, building types, building traditions and the existing builcing stock etc. in a way that reflects such differing circumstance s and allows flexibility without leading to (too) complex rules?

Implication for the nearly zero-energy building definition

A proper nearly zero-energy building definition should take into account the climate, building geometry and usage conditions as follows:

- Climate: Two options are suggested for taking into account climate conditions in the nearly zero-energy building definition:
    - A first option is to calculate the energy requirement for an average European building located in an average European climate on the basis of the EU's 2050 climate target. This average energy requirement may then be corrected and adapted at national/regional level, e.g. by using the relation of national/regional vs. European cooling degree days (CDD)+ heating degree days (HDD), grid infrastructure
    - A second option is to calculate and impose a fixed value, being zero or very close to zero, and the same for each country and all over Europe. Such option would be chosen in the event that the first option appears to be too complicated or it will be necessary to have an absolute zero-energy balance for all new European buildings in order to reach the climate targets.
- Geometry: It appears unfair for buildings with an "easy" shape to have to compensate for the unfavourable geometries of other buildings. Hence, for new buildings differences in geometry do not seem to be a striking argument for differences in energy requirements (e.g. in kWh/m^{2}yr) and the requirements should therefore be independent of geometry. On the other hand, for the existing building stock this might be seen differently and the geometry aspects should be further analysed in order to avoid additional unfair burdening of the building owners.
- Usage: All residential buildings should meet the same requirements as they typically have the same usage patterns. In addition, non-residential buildings with a similar usage pattern as residential buildings may still have the same requirements as residential buildings.

The other non-residential buildings should be classified in as few categories as possible (following the main criteria of indoor temperature, internal heat gains, required ventilation etc.) and should have particular energy performance requirements.

Challenge no 6:
Should a definition of nearly zero-energy buildings and related thresholds include or exclude household electricity (plug load) and in which way could this be done?

Implication for the nearly zero-energy building definition
For providing convincing guidance on a nearly zero-energy buildings definition, it may well be questioned if the EPBD lists all the relevant energy uses that are actually related to the ultimate goal of minimising building related CO2 emissions. Based on an extensive analysis, the following is proposed:

- According to the EPBD only the energy use of equipment providing some selected "building services" which are heating, cooling, ventilation and lighting is to be considered in an nearly zero-energy building definition. Nevertheless there is some further integrated equipment providing building services, which may be even mandatory by law in most of the Member States, but which is missing in the EPBD and thus should be a part of it. For example lifts and fire protection systems are not within the scope of the nearly zero-energy building definition from the EPBD, but are part of the default 'building services'.
- At this point in time, including electricity for appliances in the definition of nearly zero-energy building is not recommended, because it is not in the current scope of the EPBD. However, in the long run, it is advisable to complement the energy uses currently mentioned in the EPBD by all other energy uses in the buildings. Household electricity or electricity for appliances should be included in a future version of the EPBD, e.g. via a given value per person or m^2 (similar to the approach regarding the need for domestic hot water in current regulations) and consequently in the nearly zero-energy building definition.
- A feasible interim solution for avoiding sub-optimisation might be to systemize all energy uses and clearly show the subset of uses currently included in the EPBD. The energy uses outside the scope of the EPBD do not necessarily need to be integrated in the same energy performance indicator, but they might be mentioned using the same unit along with the EPBD indicator in order to get the whole picture.
- To achieve a sustainable nearly zero-energy building definition it may be important to take into account all the energy uses of a building for two main reasons:
    - In today's very low-energy or passive houses the amount of household electricity or electricity for appliances respectively has the same order of magnitude as that needed for space heating/cooling and domestic hot water. The same is true for the technical systems providing building services.
    - In Europe, on average, electricity consumption represents comparatively high amounts of primary energy consumption and related carbon dioxide emissions. The same goes for energy use in the construction of the building and its supply systems as well as for disposal of the building.

Challenge no 7:
Should a definition of nearly zero-energy buildings and related thresholds include or exclude the production and disposal stage of building elements, components and systems and in which way could this be done?

Implication for the nearly zero-energy building definition
A life-cycle assessment (LCA) approach for nearly zero-energy building is definitely far beyond the current intention of the EPBD, but might be in a future recast. There are some practical recommendations to be considered for the time being:

- Energy consumption during the construction and disposal phases of a building becomes more important the more the energy consumption during the use phase decreases.
- Due to insufficient consistency of results from different LCA tools it may be too early to require LCA information as part of a threshold value. Nevertheless, in principle, it would make sense to include LCA information in the evaluation of a building's energy performance.
- A practical solution for the near future would be to estimate the energy need for production and disposal and require an informative mention of this value in addition to the indicator(s) reflecting the energy performance of the building. Including the information regarding energy consumption during the phases of construction and disposal of a building will underline the importance of each life cycle phase's energy consumption. However, for the time being it is not suggested that life cycle energy consumption should be included within the scope of the EPBD.

Challenge no 8:
Should it be possible within the definition of nearly zero-energy buildings (regarding demand side and supply side) to look at groups of buildings rather than at a single building?

Implication for the nearly zero-energy building definition
The EPBD clearly focuses on the energy performance of individual buildings. However, there may be good reasons to address a group of buildings and to have a common energy balance for them. For assessing the opportunity of considering groups of buildings instead of a single building, the energy demand and the energy supply need to be analysed separately.

- As to the energy demand side, it may be a solution to compensate specific disadvantageous circumstances affecting one or a few selected buildings within a group of buildings (e.g. shading from landscape and thereby reduced solar gains) that do not allow each of these selected buildings to achieve a required very low energy demand with an acceptable level of effort. However, this would mean that the owner of a building which is part of such a pool would depend on what is actually built and maintained by other owners. Apparently the situation is easier when having one owner for the whole new settlement, e.g. a building complex owned and rented by a real-estate company. However, especially in the case of new buildings, there seems to be little evidence to explain why a certain required threshold should not be reached at the level of the individual building; the energy related or financial synergies from pooling buildings are not obvious. Consequently, there are no sufficiently strong reasons for clustering buildings.

- As to the energy supply side, it is clearly within the EPBD scope to use nearby/on-site central systems as an alternative to individual systems per building. Such central supply can yield benefits e.g. in terms of investment savings, better efficiency and better possibilities for seasonal storage.

Challenge no 9:
What guidance can/needs to be given regarding the balance of energy efficiency and renewable energy within the nearly zero-energy buildings definition?

Implication for the nearly zero-energy building definition
It is necessary and also in line with the EPBD's nearly zero-energy building definition to have a threshold for maximum energy demand as well as a requirement for the minimum percentage of renewables. For this reason, the renewable energy share should take into account only active supply systems such as solar systems, pellet boilers etc. The passive use of renewable energy, e.g. passive solar gains, is an important design element of nearly zero-energy buildings, but it seems logical - and also in line with EPBD-related CEN standards - to take these into account for the reduction of gross energy needs.
A threshold for energy demand could be set for each country in a given corridor, defined top-down at EU level according to the needs imposed by longer term climate targets and climate adjusted at country/regional level, e.g. based on HDD/ CDD.
The minimum share of renewables to cover the remaining nearly zero or very low energy demand of the building might be chosen in the range of 50%-90% in order to be consistent with EU energy and climate targets. Moreover, there are two more reasons for choosing a compulsory range of 50%-90%:

- The proposed range is in line with the nearly zero-energy building definition from EPBD which is asking that the energy demand of the building be covered from renewable sources to a "very significant extent".
- The proposed range is likely to satisfy all the potential requirements for achieving the overarching targets for energy or GHG respectively.

The requirement proposed above for the renewable energy share would contribute to a paradigm change moving from renewable energy being a minor substitute or complement of a fossil fuel based energy system towards an energy system where renewable energy is dominant, while fossil systems exist only to a certain extent, e.g. to secure the supply during peak loads or as a backup source.
Whereas the bandwidth of the necessary share of renewable energy supply can be derived from technical and financial boundary conditions, the exact share to be achieved at EU or country levels is likely to remain subject to political considerations. A possible practical solution is to start with a minimum requirement for the renewable energy share as part of the nearly zero-energy building definition and to stimulate a further increase of the share.

Challenge no 10:

Is there a necessary or optional link between the principle of cost-optimality and the concept of nearly zero-energy buildings within the EPBD recast and what could be the implications?

Implication for the nearly zero-energy building definition

The recast EPBD stipulates that the EU Member States shall ensure minimum energy performance requirements for buildings to be set 'with a view to achieving cost-optimal levels'. Whereas the Commission is to provide the comparative framework cost-optimal methodology, each EU Member State has to do the calculations at country level, to compare the results with its energy performance requirements in force and to improve those requirements accordingly if necessary.

Beyond delivering information for the update of current requirements over the coming years, the cost-optimal methodology is suitable for gradually steering cost-optimal levels towards nearly zero-energy building levels by 2021.

Indeed, the cost-optimal methodology may be used, for instance, to calculate the needed financial support (soft loans, subsidies etc.) and market developments (cost reduction for certain technology etc.) for facilitating a smooth and logical transition from today's energy performance requirements towards nearly zero-energy building levels in 2021. Consequently, when fixing a threshold for the primary energy demand of a nearly zero-energy building, it is recommended to leave some freedom for placing this threshold within a certain corridor, which could be defined as follows:

- The upper – least ambitious - limit, defined by the energy demand of different building types, would result from applying the cost-optimal levels according to Article 5 of the EPBD recast.
- The lower – most ambitious - limit of the corridor, would be set by the best available technology that is freely available and well introduced on the market, e.g. as, currently, triple glazing for windows.

The EU Member States may determine their national requirement for the buildings' energy demand within the limits of the above corridor, according to the specific national context. Imposing a corridor and not a fixed threshold, will allow specific country solutions for achieving an overarching target (primary energy / CO2-emissions), based on the most convenient and affordable balance between minimum requirements for energy demand and renewable energy share. Today we assume that, on the one hand, there may still be a gap to be bridged between cost-optimal levels and nearly zero-energy building levels by 2021, at least in some EU Member States. On the other hand, in several Member States it is also possible to reach convergence between cost-optimal and nearly zero-energy building levels by 2021, mainly due
to the estimated increase in energy prices and expected decrease in technology costs.

Principles for nearly zero-energy buildings

To achieve a suitable definition, related facts and findings need to be seen in a broader societal context and need to be transferred into a practical standard, taking into account financial, legal, technical and environmental aspects. Analysing the implications identified above, it becomes obvious that most of them interact or require the consideration of one or several societal aspects. Consequently, the principles for an nearly zero-energy building definition should be built on the same broad perspective, should take into account all financial, legal, technical and environmental aspects and should meet the present and future challenges and benefits. Hence, a proper and feasible nearly zero-energy building definition should have the following characteristics:

- To be clear in its aims and terms, to avoid misunderstandings and implementation failures.

- To be technically and financially feasible.
- To be sufficiently flexible and adaptable to local climate conditions, building traditions etc., without compromising the overall aim.
- To build on the existing low-energy standards and practices.
- To allow and even foster open competition between different technologies.
- To be ambitious in terms of environmental impact and to be elaborated as an open concept, able to keep pace with the technology development.
- To be elaborated based on a wide agreement of the main stakeholders (politicians, designers, industry, investors, users etc.).
- To be inspiring and to stimulate the appetite for faster adoption.
- To allow for application in existing buildings

Consequently, there are three basic principles, each one with a corollary for setting up a proper nearly zero-energy building definition, addressing the three main reasons and aims for regulating the building sector: reduced energy demand, the use of renewable energy and reduced associated GHG emissions. The suggested principles and approaches for implementing them are described in the following table.

First nZEB Principle: Energy demand	Second nZEB Principle: Renewable energy share	Third nZEB Principle: Primary energy and CO_2 emissions
There should be a clearly defined boundary in the energy flow related to the operation of the building that defines the energy quality of the energy demand with clear guidance on how to assess corresponding values.	There should be a clearly defined boundary in the energy flow related to the operation of the building where the share of renewable energy is calculated or measured with clear guidance on how to assess this share.	There should be a clearly defined boundary in the energy flow related to the operation of the building where the overarching primary energy demand and CO_2 emissions are calculated with clear guidance on how to assess these values.
Implementation approach: This boundary should be the energy need of the building, i.e. the sum of useful heat, cold and electricity needed for space cooling, space heating, domestic hot water and lighting (the latter only for non-residential buildings). It should also include the distribution and storage losses within the building. **Addendum:** The electricity (energy) consumption of appliances (plug load) and of the other building technical systems (i.e. lifts, fire security lighting etc.) may also be included in the nZEB definition as an additional indicative fixed value (similar to the approach on domestic hot water demand in most of the MSs building regulations).	**Implementation approach:** This could be the sum of energy needs and system losses, i.e. the total energy delivered into the building from active supply systems incl. auxiliary energy for pumps, fans etc. The eligible share of renewable energy is all energy produced from renewable sources on site (including the renewable share of heat pumps), nearby and offsite being delivered to the building. Double counting must be avoided.	**Implementation approach:** This is the primary energy demand and CO_2 emissions related to the total energy delivered into the building from active supply systems. If more renewable energy should be produced than energy used during a balance period, clear national rules should be available on how to account for the net export.

Corollary of First nZEB Principle: **Threshold on energy demand**	Corollary of Second nZEB Principle: **Threshold on renewable energy share**	Corollary of Third nZEB Principle: **Threshold on CO_2 emissions in primary energy**
A threshold for the maximum allowable energy need should be defined.	A threshold for the minimum share of renewable energy demand should be defined.	A threshold for the overarching primary energy demand and CO_2 emissions should be defined.
Implementation approach: For the definition of such a threshold, it could be recommended to give the Member States the freedom to move in a certain corridor, which could be defined in the following way: • The upper limit (least ambitious, maximum allowed energy demand) can be defined by the energy demand that develops for different building types from applying the principle of cost optimality according to Article 5 of the EPBD recast. • The lower limit (most ambitious) of the corridor is set by the best available technology that is freely available and well introduced on the market. Member States might determine their individual position within that corridor based on specific relevant national conditions.	**Implementation approach:** The share of energy from renewable sources which is considered to be "very significant" should be increased step-by-step between 2021 and 2050. The starting point should be determined based on best practice, nearly Zero-Energy Buildings serving as a benchmark as to what can be achieved at reasonable life-cycle cost. A reasonable corridor seems to be between 50% and 90% (or 100%).	**Implementation approach:** For meeting the EU long term climate targets, the buildings CO_2 emissions related to the energy demand is recommended to be below 3 kg CO_2/(m^2 yr). The EPBD clearly promotes primary energy as indicator for the energy performance of buildings. However, the buildings should follow also the EU's long-term goals by 2050 and definitively the CO_2 reduction is in close relation to the reduction of energy consumption and energy decarbonisation. Consequently, introducing an indicator on the CO_2 emissions of buildings (linked to the primary energy indicator for the energy demand) is the single way to ensure coherence and consistence between the long-term energy and environmental goals of the EU.

Validation of nearly zero-energy building principles: simulation of reference buildings in different climate zones

To verify and evaluate the proposed nearly zero-energy building principles and implementation approaches, indicative simulations on reference buildings were performed. The general findings of simulating the application of the proposed nearly zero-energy building principles may be summarised as follows:

Impact of different options	
Renewable energy share between 50% and 90%	**CO_2 emissions below 3 $kgCO_2/m^2yr$**
Fossil fired solutions are already struggling to achieve a renewable share of 50%. The fossil fired systems are not an option in the case of including the energy consumption of appliances in the energy demand and imposing a requirement for a very high share of renewables (90%). A 90% renewable share may be reached by using additional off-site green electricity or, only in regions with very good solar irradiation, by installing additional on-site renewables. District heating impact depends largely on its renewable share: a 50% renewable DH system is not enough in some locations. In single family buildings, heat pump solutions easily achieve a 50% renewable share. By using additional off-site green electricity or on-site renewables, the heat pump option can secure even a 100% renewable energy share. In office buildings, biomass and heat pump solutions reach a 50% share of renewables.	For the single family building, at the basic variants (excluding appliances, green electricity and PV) all fossil fired solutions (gas boiler, micro CHP and district heating with a small renewable share) generally are clearly above the limit of 3 $kgCO_2/(m^2yr)$. Heat pump solutions come close and bio solutions (biomass boiler, bio micro CHP) clearly stay below the threshold. For office buildings, only the biomass micro CHP is below the threshold. Using green off-site electricity significantly decreases CO_2 emissions. For the single family building, the fossil fired solutions generally fail to meet the target (with or without the consideration of appliances), except at locations with very little heating and hot-water demand (in warm climate zones). In office buildings, because of the relatively high share of electricity all related variants stay below the threshold. The consideration of the electricity demand for the appliances and office equipment does not generally change this result.
For single family homes with high heat consumption, it is possible to achieve a 90% share of renewables only by using a 100% heat supply from biomass fired systems (boiler, CHP). Office buildings have a higher relative share of electricity than residential buildings. Therefore green electricity is required by all considered options (expect the fossil fuels options) in order to reach a 90% share, usually even including office equipment (appliances). Due to space restrictions, additional PV systems are less effective than in the case of the single family building.	For the single family building, additional on-site renewables (i.e. PV in this simulation) improve the situation. The fossil solutions are still above the threshold even with the considered additional PV system (which is however quite small, but enough to reach a high renewable energy share). For office buildings, additional on-site renewables (such as the 2 kW_p PV system) is much less effective. The CO_2 threshold is fulfilled only without appliances and assuming additional on-site PV power. Fossil fuel options in moderate and cold climate zone cannot fulfil the condition even with additional on-site PV power.

10.1.2 IEA Task SHCP Task 40 / ECBCS Annex 52 "Towards Net Zero Energy Solar Buildings"

Two consortium members, Wuppertal University as well as Politecnico di Milano are members and experts within the current IEA Task SHCP Task 40 / ECBCS Annex 52 "Towards Net Zero Energy Solar Buildings"(www.iea-shc.org/task40/). An international literature review on definitions and calculations methodologies was undertaken in 2009/2010 and published early 2011[23]. The emphasis of most publications found was more on the goals. Many ZEB definitions and methodologies remain generic and far from standardized. In addition to the literature review, a comprehensive data base with about 300 nearly ZEB projects of all typologies and climates was developed by Wuppertal University, allowing cross analysis of the experiences and data from realized Net ZEBs[24]. The data base also covers some renovation projects aiming towards the Net ZEB level. Based on this background a book on Net ZEBs was recently published in English and German language and sold about 2000 copies until end of 2011[25].

Net or nearly zero-energy building indicates a building connected to the energy infrastructure; therefore a Net ZEB is conceptually understood within the task as an energy efficient building that balances its energy demand on an annual basis by generating energy on-site. It is recognized that the annual balance is not sufficient to fully characterize Net ZEBs. In particular, Net ZEBs should be designed to work in synergy with the grids and not to put additional stress on their functioning. It is also recognized that different definitions are possible, in accordance with a country's political targets and specific conditions. Therefore a series of criteria is foreseen to characterize the most important features A critical discussion has underlined the importance of the choices on the boundaries, the metrics and associated weighting system, the requirements on energy efficiency and the hierarchy of energy supply. The balance concept is central in the definition framework and two major types of balance are identified, namely the import/export balance and the load/generation balance, and the respective pros and cons are discussed. Concerning the temporal energy match, a Net ZEB's ability to match its own load by on-site generation and to work beneficially with respect to the needs of the local grid infrastructure have to be considered within suitable indicators.
A consistent monitoring and verification process for Net ZEBs has to complete the analysis. Initial research points out that for an easily verifiable definition it seems preferable to consider all operational energy uses in a building (incl. plug loads,..), in order to avoid the need for sub-metering, so paving the way to the establishment of measured building energy performance ratings for Net ZEBs.
Implications of comfort definition on the concept and design process of nearly zero-energy buildings are also analysed within this task, e.g in

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[24] Musall, Weiss, Voss, Lenoir, Donn, Cory, Garde: Net Zero Energy Solar Buildings: An Overview and Analysis on Worldwide Building Projects, Proceedings of the EuroSun Conference, Graz, 2010

[25] Voss, Musall (ed.): Net Zero Energy Buildings, book, DETAIL, ISBN 978-3-0346-0780-3, 2011

I.Sartori, J. Candanedo, S.Geier, R.Lollini, F.Garde, A. Athienitis, L. Pagliano, Comfort and Energy Efficiency Recommendations for Net Zero Energy Buildings, Eurosun conference 2010, Graz, Austria.

10.1.3 Description of projects under the IEE programme and main conclusions

CommonCense Project under IEE programme

The European standard EN15251 was adopted to define acceptable indoor temperatures and light levels as the basis for energy calculation. The provision of comfort is a key concern for building designers. Mechanical cooling is energy intensive. Naturally ventilated (NV) buildings with fewer energy costs cannot control indoor conditions closely. Formally standards have used comfort models which favour close environmental control so NV buildings have been looked on as second-rate. EN15251 allows NV buildings more freedom for environmental variation in line with the findings of comfort theory. This project seeks to use existing information from field surveys to test the limits set by EN15251 for temperature and lighting and to validate its recommendations using existing data and building simulations.

CENSE Project under IEE programme

Name: Leading the CEN Standards on Energy performance of buildings to practice
Duration: 10/2007–3/2010
Responsible: TNO Built Environment and Geosciences, Netherlands
Objective
The European Committee for Standardisation (CEN) contributes to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement. Under mandate from the European Commission, CEN has produced a set of standards in support of the introduction of the energy performance of buildings directive of the European Parliament and the Council. The CENSE project aims to improve the knowledge across the Member States on the role, content and status of these standards and provide guidance on their implementation. Feedback will be collected for the fine tuning of the standards and recommendations will be drafted and put forward.
Results

- A snapshot has been prepared, in early 2008, of the utilisation of the CEN standards in national building regulations across Europe.
- Guidance documents on the standards and regulations/methodologies in Member States are to be published on the website.
- A report on common trends, barriers, possible solutions and good practice examples on the use of the standards will be published.
- Recommendations will be made for further harmonisation to the Member States and European Commission.

Budget: €1 814 037 (EU contribution: 50 %)

KeepCool Project under IEE programme

Name: Service buildings Keep Cool: promotion of 'sustainable cooling' in the service building sector KeepCool

Duration: 1/2005–2/2007

Responsible: Austrian Energy Agency, Austria

Objective

Demand for cooling energy is expected to rise dramatically in Europe in the coming years, despite better understanding of passive cooling technologies. The aim of this project was to propose intelligent of getting passive cooling to penetrate the market and to establish a new definition of sustainable summer comfort.

Results

- A tool-kit explaining the ten steps to achieve sustainable summer comfort was produced. This online tool includes technology profiles, best practice examples in English and national languages, supplier and expert lists, and an analysis of comfort legislation in participating countries.
- An awareness-raising campaign on summer energy consumption took place and included articles in the daily and technical press, international conferences and technical workshops, two online encyclopaedias, radio and TV broadcasts.
- The sustainable summer comfort message was conveyed to 500 owners of individual buildings, as well as many others with large property portfolios.
- KeepCool succeeded in including the Adaptive Comfort Model into the European StandEN 15251 and in removing further barriers towards the use of passive cooling solutions.
- This action now continues towards the Keep Cool II project which aims at providing analysis and technical tools, as well as addressing existing networks and policymakers regarding sustainable summer comfort.

Budget: €722 086 (EU contribution: 50%)

Main conclusions

These studies among others have shown the importance of assessing/influencing the boundary conditions, in defining and designing low and zero-energy buildings:

- outdoor conditions (microclimate) according to EPBD recital 25,
- indoor conditions (explicit and sensible choice of comfort conditions, according to eg EN 15251 and related studies)
- level of electric plug loads (many ongoing studies on ways to reduce energy use by ICT equipment – e.g. PrimeEnergy, office and domestic appliances
- square meters per person

EPBD recast, recital 25

"...Priority should be given to strategies which enhance the thermal performance of buildings during the summer period. To that end, there should be focus on measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques, primarily those that improve indoor climatic conditions and the micro- climate around buildings."

Example on Comfort criteria:
Recent revisions of international standards have updated the definitions of comfort and ways to use them in designing and evaluating buildings. ASHRAE Standard 55:2004 [6] and EN 15251:2007 [7] have introduced the Adaptive model to be used in naturally ventilated buildings and ISO 7730:2005 [8] and EN 15251 have introduced the concept of comfort categories based on different ranges of Predicted Mean Vote (PMV) or operative temperature around the neutral conditions. There are differences in the approach taken by those standards that have relevant implications on the design of low energy buildings and Net ZEBs.
ASHRAE Standard 55 and EN 15251 both propose that acceptable temperature ranges actually depend on the type of system used to provide summer comfort. EN 15251 distinguishes two types of buildings, those with mechanical cooling and those without it, and for the analysis of the latter in summer both Fanger and adaptive models are allowed. In the definition section, "buildings without mechanical cooling" are defined in the standard as "buildings that do not have any mechanical cooling and rely on other techniques to reduce high indoor temperature during the warm season like moderately-sized windows, adequate sun shielding, use of building mass, natural ventilation, night time ventilation etc. for preventing overheating".
This has direct implications on design procedures particularly for low energy and Net ZEBs. The standard EN 15251 states that: "The temperature limits presented in A.2 [author note: adaptive comfort range] should be used for the dimensioning of passive means to prevent overheating in summer conditions e.g. dimensions and the orientation of windows, dimensions of solar shading and the thermal capacity of the building's construction. Where the adaptive temperature limits presented in A.2 (upper limits) cannot be guaranteed by passive means mechanical cooling is unavoidable. In such cases the design criteria for buildings WITH mechanical cooling should be used."
Therefore, a procedure could be devised to vary building envelope parameters in order to minimise an "adaptive discomfort index". If the adaptive temperature limits cannot be guaranteed, a "Fanger discomfort index" can be used instead as the target to be minimised. These indexes can be selected among the ones proposed in EN 15251 [Annex F (Informative): Long term evaluation of the general comfort conditions]. Reducing the discomfort indexes by choice of passive means also implies a reduction of the energy needed for heating and/or cooling of the building and hence of the energy consumed by active means used to reduce the discomfort (if still needed).

- Pagliano, L. and Zangheri, P. (2010), Comfort models and cooling of buildings in the Mediterranean zone, Advances in Building Energy Research, Volume 4, pages 167-200. ISSN: 1751-2549 E-ISSN: 1756-220, Earthscan UK

- P. Zangheri and L. Pagliano (2010), Methodology for design and evaluation of zero energy buildings in Mediterranean climate. Application to a Passivhaus with Earth to Air Heat Exchanger. Palenc conference 2010, Rode Island, Greece

- F. Nicol, L. Pagliano. Allowing for thermal comfort in free-running buildings in the new standard EN15251, In Proceedings of the International Conference Improving Energy Efficiency in Commercial Buildings (IEECB'08), Frankfurt, Germany, 10-11 April 2008

10.1.4 Studies to support the development of cost-optimal methodology framework

Among others, the part developed by eERG-PoliMi on guidelines for calculation of the energy flows and introduced in the final text, was used in the present report.

The need to clearly identify and address the energy needs is explicitly addressed in EPBD recast, e.g. in recital 15

. As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs for heating and cooling are reduced to cost- optimal levels.

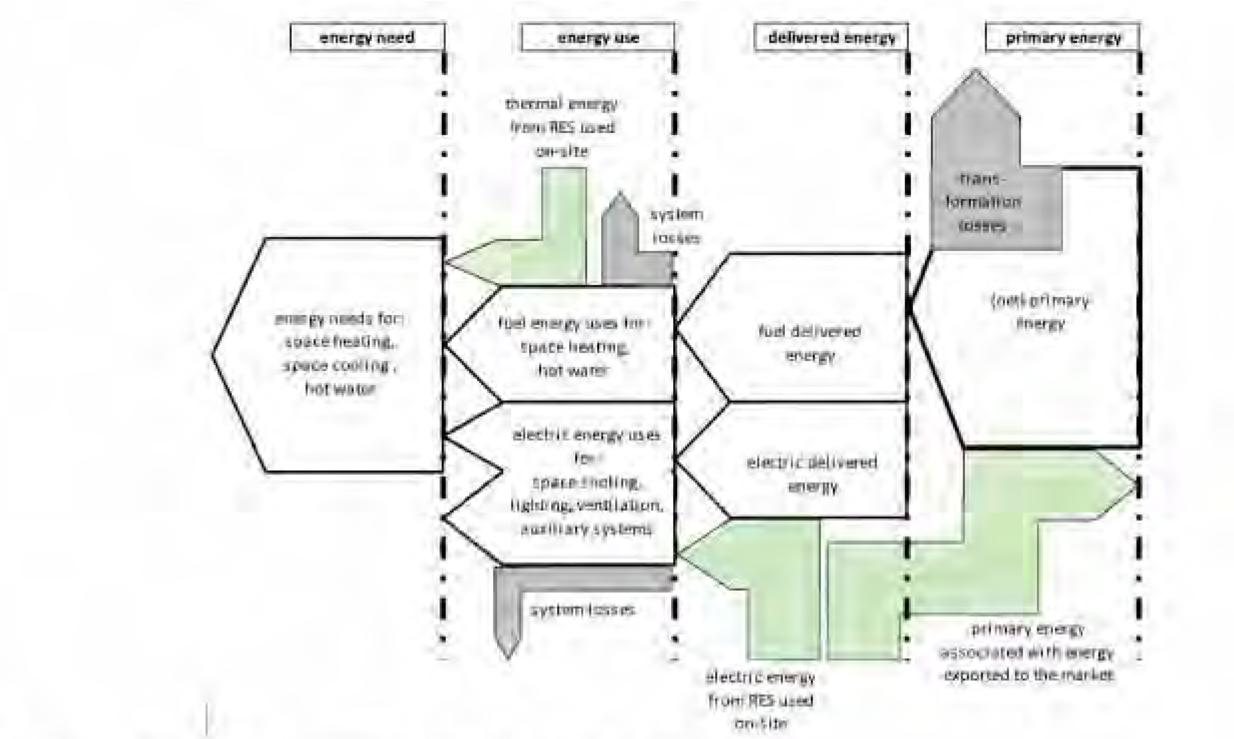

Figure 1 - Schematic illustration of the calculation scheme.

Under paragraph 1 of Annex I(3) to the Regulation, the calculation of energy performance involves first the calculation of final energy needs for heating and cooling, then the final energy needs for all energy uses, and thirdly the primary energy use. That means that the 'direction' of the calculation is from the needs to the source (i.e. from the building's energy needs to the primary energy). Electrical systems (such as lighting, ventilation, auxiliary) and thermal systems (heating, cooling, domestic hot water) are considered separately inside the building's boundaries.

If a Member State would want to clearly avoid the risk that active RES installations replace energy demand reduction measures, the calculation of cost optimality could be done in steps gradually expanding the system boundary to the four levels given in Figure 1 below: energy need, energy use, delivered energy and primary energy. With this, it will become clear how each measure/package of measures contributes to the buildings energy supply in terms of costs and energy.
Delivered energy includes e.g. electric energy drawn from the grid, gas from the grid, oil or pellets (all with their respective primary energy conversion factors) transported to the building for feeding the buildings technical system.

It is recommended that the energy performance calculation be done as follows:

Calculation of energy performance from net energy needs to primary energy use:

2. Calculation of the building's net thermal energy needs to fulfil the user's requirements. The energy need in winter is calculated as energy losses via the envelope and ventilation minus the internal gains (from appliances, lighting systems and occupancy) as well as 'natural' energy gains (passive solar heating, passive cooling, natural ventilation, etc.);
3. Subtraction from (1) of the thermal energy from RES generated and used on-site (e.g. from solar collectors);
4. Calculation of the energy uses for each end-use (space heating and cooling, hot water, lighting, ventilation) and for each energy carrier (electricity, fuel) taking into account the characteristics (seasonal efficiencies) of generation, distribution, emission and control systems;
5. Subtraction from electricity use of the electricity from RES, generated and used on-site (e.g. from PV panels);
6. Calculation of the delivered energy for each energy carrier as sum of energy uses (not covered by RES);
7. Calculation of the primary energy associated with the delivered energy, using national conversion factors;
8. Calculation of primary energy associated with energy exported to the market (e.g. generated by RES or co-generators on-site);
9. Calculation of primary energy as the difference between the two previous calculated amounts: (6) - (7).

10.2 Appendix task 1

10.2.1 Additional list of relevant publications

Table 37. Additional literature for known definitions, calculation methodologies and labels for nearly zero-energy buildings. (please find 25 most relevant publications in in task 1a)

Nr.	Country	Publication	Specific content, definition
26	**EU**	ECEEE (2011): Steering through the maze #2 - nearly zero-energy building: achieving the EU 2020 target. European Council for Energy Efficient Economy. Brussels	Overview
27	**INT**	Bayer MaterialScience AG: EcoCommercial Building Program. Online available under www.katalog.ecocommercialbuilding.de/bms/bms-eco.nsf/id/DE_Home?open, last reviewed 30.03.2012.	Exemplification to "EcoCommercial Building Program"
28	**INT**	Marszal, Anna Joanna; Bourrelle', Julien S.; Nieminen, Jyri; Berggren, Björn; Gustavsen, Arild; Heiselberg, Per; Wall, Maria (2010): North European Understanding of Zero Energy/Emission Buildings. Published during proceedings of Renewable Energy Conference 2010. Trondheim	Overview
29	**INT**	Marszal, Anna; Heiselberg, Per (2012): Zero Energy Building definition – a literature review. A technical report of subtask A of the IEA SHC Task40 / Annex 52 "Towards Net Zero Energy Solar Buildings", Aalborg University. Aalborg	Summary, Overview
30	**INT**	Voss, Karsten; Sartori, Igor; Napolitano, Assunta; Geier, Sonja; Goncalves, Helder; Hall, Monika et al. (2010): Load Matching and Grid Interaction of Net Zero Energy Buildings. Published by EuroSun Conference 2010, Graz	methodological Explanation
31	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2011): Kriterienkatalog Bürogebäude Neubau, Wien	Exemplification to "klima:aktiv"
32	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2011): Kriterienkatalog Bürogebäude Sanierung, Wien	Exemplification to "klima:aktiv"
33	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2011): Kriterienkatalog Wohngebäude Sanierung, Wien	Exemplification to "klima:aktiv"
34	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2012): Kriterienkatalog Bildungseinrichtungen Neubau, Wien	Exemplification to "klima:aktiv"
35	**AT**	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW): klima:aktiv Bauen und Sanieren (2012): Kriterienkatalog Wohngebäude Neubau, Wien	Exemplification to "klima:aktiv"
36	**AT**	Bundesministerium für Verkehr, Innovation und Technologie (BMVIT): Forschungs- und Technologieprogramm „Haus der Zukunft", Wien. Online available under www.hausderzukunft.at, last reviewed 21.05.2012	Exemplification to "Haus der Zukunft"
37	**AT**	Klima- und Energiefonds (2012): Leitfaden Mustersanierung 2012, Wien	Exemplification to "Mustersanierung"
38	**BE**	Attia, Shady; Mlecnik, Erwin; van Loon, Stefan (2011): Principles for nearly zero-energy buildingsin Belgium. Louvain-la-Neuve	methodological Explanation
39	**BE**	Mlecnik, Erwin (2011): Defining nearly zero-energy housing in Belgium and the Netherlands. In: Energy Efficiency	methodological Explanation
40	**BE**	Mlecnik, Erwin; Attia, Shady; van Loon, Stefan (2011): Net zero energy building: A review of current definitions and definition development in Belgium. Published by Passiefhuis-Platform. Berchem	Overview
41	**CA**	Athienitis, Andreas (2007): Canadian Market, Regulations and Technologies applied to Low-Energy Buildings (houses): A State-of-the-Art. Published by Solar Buildings Research Network. Montreal	Exemplification to "EQuilibriumTM"
42	**CA**	Green, Thomas C. (2009): EQuilibriumTM. Demonstrating a Vision for Sustainable Housing in Canada, EQuilibriumTM Housing - Canada Mortgage and Housing Corporation. IEA Task 40 / Annex 52 Net Zero Energy Solar Buildings. Montreal, 06.05.2009	Exemplification to "R-2000 Standard"

43	**CH**	Leibundgut, Hansjürg (2011): LowEx building design. For a ZeroEmissionArchitecture, published by Vdf Hochschulverlag AG. Zürich	Exemplification to "LowEx building"
44	**CH**	MINERGIE® (2011): MINERGIE-A®/A-ECO®. Online available under http://www.minergie.ch/minergie-aa-eco.html, last reviewed 11.01.2012	Exemplification to "Minergie©-A"
45	**CH**	Zimmermann, Mark; Althaus, Hans-Jörg; Haas, Anne: Benchmarks for sustainable construction. A contribution to develop a standard. In: Energy and Buildings 37/2005, S. 1147–1157	Overview
46	**CZ**	Ministry of Industry and Trade; Czech Technical University Prague; Chamber of Commerce of Czech Republic; Czech Green building Council and Czech Passive house Centre (in the approval process): The Amendment of the Act on Energy Management 406/2000 Coll., Prague	Exemplification to "nearly zero-energy building"
47	**DE**	Bundesministerium für Verkehr, Bau und Stadtentwicklung (2012): Effizienzhaus Plus mit Elektromobilität. Technische Informationen und Details. Online available under www.bmvbs.de/DE/EffizienzhausPlus/Projekt/effizienzhaus-plus-projekt_node.html, last reviewed 18.04.2012.	Exemplification to "EffizienzhausPlus"
48	**DE**	Fraunhofer Institut für Bauphysik (2011): Wege zum Effizienzhaus-Plus. Published by Bundesministerium für Verkehr, Bau und Stadtentwicklung. Berlin	Exemplification to "EffizienzhausPlus"
49	**DE**	Heinze, Mira; Voss, Karsten (2009): Goal: Zero Eenergy Building - Exemplary Experience Based on the Solar Estate Solarsiedlung Freiburg am Schlierberg, Germany. In: Journal of Green Building 4 (4), S. 1-8.	Exemplification to "Plusenergiehaus©"
50	**DE**	Schirmer, Stefan (2011): dena-Modellvorhaben „Auf dem Weg zum EffizienzhausPlus". Energetische Anforderungen des Modellvorhabens. Published by Deutsche Energieagentur dena. Berlin	Exemplification to "EffizienzhausPlus"
51	**DE**	Sobek, Werner (2009): Triple Zero®. Published by Werner Sobek, Greentech. Stuttgart. Online available under www.wernersobek.com, last reviewed 21.05.2012.	Exemplification to "TripleZero©"
52	**DE**	solares bauen (2005): Das zeroHaus. Online available under http://www.zero-haus.de/zertifizierung.html, last reviewed 09.02.2005	Exemplification to "zeroHaus"
53	**DE**	Sonnenhaus-Institut e.V. (2008): Das Sonnenhaus. …unabhängig und umweltbewusst: Wohnen mit der Sonne. Straubing	Exemplification to "Sonnenhaus"
54	**DE**	Stockinger, Volker; Grunewald, John; Jensch, Werner (2012): Plus-Energie. Begriffsdefinition, Umsetzung, Bilanzierung und Klassifizierung. In: HLH (3), page 20–32	methodological Explanation
55	**DE**	Voss, Karsten (2008): Was ist eigentlich ein Nullenergiehaus. Passivhaustagung 2008, Nurnberg	methodological Explanation
56	**DE**	Voss, Karsten; Musall, Eike (2011): Null- und Plusenergiegebäude: Allgemeine Bilanzierungsverfahren und Schnittstellen zur normativen Praxis in Deutschland. In: EnEVaktuell (IV), page 3–5.	methodological Explanation
57	**DE**	Voss, Karsten; Musall, Eike; Lichtmeß, Markus (2010): Vom Niedrigenergie- zum Nullenergiehaus: Standortbestimmung und Entwicklungsperspektiven. In: Bauphysik 32 (12), page 424–434.	methodological Explanation
58	**DK**	Lund, Henrik; Marszal, Anna Joann; Heiselberg, Per (2011): Zero energy buildings and mismatch compensation factors. In: Energy and Buildings 43 (7), page 1646–1654	methodological Explanation
59	**DK**	Marszal, Anna Joanna; Heiselberg, Per; Lund Jensen, Rasmus; Nørgaard, Jesper (2012): On-site or off-site renewable energy supply options? Life cycle cost analysis of a Net Zero Energy Building in Denmark. In: Renewable Energy 44, page 154–165	Overview
60	**DK**	Velux (2011): Velux Modelhome 2020. Published by Velux. Hørsholm. Online available under www.velux.de/privatkunden/wohnqualitaet_energieeffizienz_nachhaltigkeit/modelhome2020?cache=0, last reviewed 29.05.2012	methodological Explanation
61	**GR**	Santamouris; Sfakianaki (2011): Zero Energy Green Neighbourhood. Report Prepared by CRES on the zero energy project of Green Neighbourhood, CRES, Pikermi Athens, 2011	Exemplification to "Green Neighbourhood"
62	**NL**	Agentschap NL (2010): Energieneutraal Bouwen, hoe doe je dat?. Online available under www.agentschapnl.nl/sites/default/files/bijlagen/Infoblad_Energieneutraal_Bouwen.pdf, last reviewed 21.05.2012	methodological Explanation
63	**NL**	Platform energietransitie Gebouwde Omgeving (2009): Stevige ambities, Klare taal!, definiëring van doelstellingen en middelen bij energieneutrale, CO2-neutrale of Klimaatneutrale projecten in de	methodological Explanation

		gebouwde omgeving. Utrecht. Online available under www.agentschapnl.nl/sites/default/files/bijlagen/Rapport%20-%20Stevige%20ambities%20klare%20taal,%20definitiestudie%20-%20november%202009.pdf, last reviewed 30.05.2012	
64	**NL**	Agentschap NL (2010): Uitgerekend Nul, Taal, Rekenmethode en Waarde voor CO2 cq. energieneutrale utiliteitsgebouwen. Online available under http://www.agentschapnl.nl/sites/default/files/bijlagen/Rapportage%20Uitgerekend%20Nul.pdf, last reviewed 30.05.2012	methodological Explanation
65	**NL**	W/E adviseurs (2009): Stevige ambities, Klare taal!, definiëring van doelstellingen en middelen bij energieneutrale, CO2-neutrale of Klimaatneutrale projecten in de gebouwde omgeving. Online available under www.agentschapnl.nl/sites/default/files/bijlagen/Rapport%20-%20Stevige%20ambities%20klare%20taal,%20definitiestudie%20-%20november%202009.pdf, last reviewed 21.05.2012	Overview
66	**NO**	Norwegian University of Science and Technology NTU: The Research Centre on Zero Emission Building. Online available under www.sintef.no/Projectweb/ZEB/About-ZEB, last reviewed 21.05.2012	methodological Explanation
67	**SE**	Elmroth, Arne (2012): Energihushållning och värmeisolering – Byggvägledning 8 En handbook I anslutning till Boverkets byggregler (engl.: A guide to the energy requiremenst in the building regulations), Svensk Byggtjänst, Stockholm. Online available under www.byggtjanst.se, last reviewed 25.05.2012	methodological Explanation
68	**SE**	Sandberg, Eje (2012): Kravspecifikation för nollenergihus, passivhus och minienergihus. Published by Sveriges Centrum för Nollenergihus. Styrelsen	Exemplification to “nollenergihus”
69	**SP**	González Álvarez, Marcos (2011): Nearly zero-energy buildings, from research to real construction. International Conference within Construmat 2011 fair. Barcelona	Overview
70	**UK**	CIBSE (2010), Down to Zero, CIBSE Journal, February 2010, pp. 36-40.	Overview
71	**UK**	Department of Energy and Climate Change (DECC) (2012): 2012 consultation on changes to the Building Regulations in England Section two Part L (Conservation of fuel and power), in Communities and Local Government (CLG), London. Online available under http://www.communities.gov.uk/documents/planningandbuilding/pdf/2077834.pdf, last reviewed 30.05.2012	methodological Explanation
72	**UK**	Department of Finance and Personnel (Ireland): The Energy Performance of Buildings in Northern Ireland. Online available under http://www.dfpni.gov.uk/index/buildings-energy-efficiency-buildings/energy-performance-of-buildings.htm, last reviewed 30.05.2012	methodological Explanation
73	**UK**	Building Standards Division (BSD): Sustainability labelling in Scottish Building Standards. Online available under http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/about/bsdsustain, last reviewed 30.05.2012	methodological Explanation
74	**UK**	Building Standards Division (BSD): Introduction to Energy Performance. Online available under http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/profinfo/epcintro, last reviewed 30.05.2012	methodological Explanation
75	**US**	Crawley, Dru; Pless, Shanti; Torcellini, Paul: Getting to Net Zero. ASHRAE Journal 51, 2009, S. 18 –25	methodological Explanation
76	**US**	Griffith, Brend et al.: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector. Technical Report NREL/TP-550-41957, 2007	Overview

10.2.2 List of contacts with stakeholders and MS experts in the context of Task 1a

Country	Stakeholders and MS experts	Partner organizations
Austria	Klemens Leutgöb	E7
	Sonja Geier	Aee Intec - Institute for Sustainable Technologies
Canada	Andreas Athienitis	NSERC Smart Net-zero Energy Buildings Strategic Research Network
	Josef Ayoub	Natural Resources Canada
Czech Republic	Jan Pejter, Lucie Kochová	Enviros
Denmark	Per Heiselberg, Anna Marszal	Aalborg University
	Søren Østergaard Jensen	Danish Technological Institute
	Kim B. Wittchen	Danish Building Research Institute, Aalborg University
Finland	Jyri Nieminen	VTT Technical Research Centre of Finland
France	François Garde	Universitét de La Reunion, ADEME
Germany	Karsten Voss, Eike Musall	University of Wuppertal
	Thomas Boermans, Andreas Hermelink, Sven Schimschar	Ecofys International
	Anton Maas	University of Kassel, Fachgebiet Bauphysik
Greece	Mattheos Santamouris, Katerina Sfakianaki	IASA – NKUA
Hungary	András Zöld	András Zöld
Italy	Lorenzo Pagliano, Paolo Zangheri	Politecnico di Milano
	Assunta Napolitano, Roberto Lollini	Institute for Renewable Energy, EURAC Research
Luxemburg	Markus Lichtmess	Boblet Lavandier & Associes S.A.
Netherlands	Thomas Boermans, Andreas Hermelink, Sven Schimschar, Martin Mooij	Ecofys International
	Erwin Mlecnik	OTB TU Delft
Norway	Igor Sartori	SINTEF
Spain	Jordi Cipriano	CIMNE
	Jaume Salom	Institut de Recera en Energia de Catalunya (IREC)
Sweden	Arne Elmroth	Arne Elmroth, Byggteknik AB
Switzerland	Armin Binz, Monika Hall	Hochschule für Architektur, Bau und Geomatik - Institut Energie am Bau
	Mark Zimmermann	Empa - Swiss Federal Laboratories for Materials Science and

Country	Stakeholders and MS experts	Partner organizations
		Technology
United Kingdom	Thomas Boermans, Andreas Hermelink, Sven Schimschar	Ecofys International
	Roger Higgins	Ecofys International
United States of America	Danny Parker	Florida Solar Energy Centre
	Paul Torcellini, Adam Hirsch	National Renewable Energy Laboratory (NREL) - High Performance Buildings
International associations	Karsten Voss, Eike Musall	University of Wuppertal

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10.2.3 Filled in reporting template (intermediate version) with current (2012) Danish directive "Danish Building Regulation 2010 (BR10)"

1. General information				
Country			Denmark	
Name of certification scheme, definition, directive, or label			**Danish Building Regulation 2010 (BR10)**	
Author, institution			Kim Wittchen & Kirsten Engelund Thomsen, SBI	
Year of introduction			2011	
Refernce of existing document(s)			BR10	
Energy benchmark			Nearly zero energy buildings	
Integration and consideration in national directive			integrated	BR10
2. Energy Balance	**EPBD requirement**	**EPBD/RED reference/source**	**Defined content in Member states national planning**	**Explanation, comment, source**
2.1 balance type	load vs. generation – the amount of energy required should be covered to a very significant extent by energy from renewable sources (wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases).	EPBD article 2.2 and 2.6	load vs. generation	DK hasn't any fixed RES share of the of the total primary building energy load. Residential nZEB buildings must have a primary energy consumption less than 20 kWh/m^2K and in non-residential buildings 25 kWh/m^2K.
2.2 physical boundary	single building – the EPBD lays down requirements for the common general framework for a methodology for calculating the integrated energy performance of buildings and building units.	EPBD article 1.2a	building site	The buildings at the same land register can be calculated as one building
2.3 balance boundary load				
• **space heating, domestic hot water**	The energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting.	EPBD article 2.4	considered	
• **ventilation, cooling, air conditioning**			considered	
• **auxiliary energy**			considered	
• **lighting**			considered	Only in non-residential buildings
• **plud loads, appliances, IT**			not considered	
• **central services**			not considered	
• **electric vehicles**			not considered	
• **embodied energy**			not considered	
2.4 balanre boundary generation				
• **generation on-site**	The amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. 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. Minimum levels of energy from renewable sources shall be required, inter alia, through district heating and cooling.	EPBD article 2.2, 2.6, and 13.4	considered	
• **generation near by**			considered	If the RES ownership is registered on the building or cluster of buildings then RES is considered
• **generation external**			not considered	
• **crediting**			not considered	
2.5 balance period	yearly – the methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance of a building	EPBD preamble recital 9	yearly	Calculation is based on a quasi-stationary monthly calculation

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3. Accounting System				
3.1 normalization	floor area - use of primary energy should be expressed in kWh/m²y	EPBD article 9.3a	gross floor area	Heated gross floor area
3.2 primary metric	Energy from renewables & non-renewable sources which has not undergo any conversion or transformation process. Primary energy factors used for the determination may be based on national or regional yearly average values.	EPBD article 2.5 and 9.3a possible source: EN 15603 or national and regional codes	other	The conversion factors used in DK definiton of nearly zero energy buildings are mentioned in BR10 (district heating = 0.6; electricity =1.8; other = 1.0)
3.3 secondary metric	nothing defined but used in some known methodologies		no second metric choosen	
3.4 symmetric or asymmetric weighting	nothing defined but current international discussion		symmetrical weighting	
3.5 time dependent weighting	nothing defined but current international discussion		static conversion factors	
3.6 monthly accounting limitation	no requirements but current international discussion within IEA SHCP Task 40/ECBCS Annex 52 and EPBD Concerted Action		nothing defined	Same conversion factors used all year
4. Further requirements				
4.1 fraction of renewables	Building regulations and codes or by other means with equivalent effect should require the use of minimum levels of energy from renewable sources in new and existing buildings that are subject to major renovation. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources.	RED article 13.4 and EPBD article 2.2	not defined	
4.2 temporal performance				
• **load match**	nothing defined but current international discussion within IEA SHCP Task 40/ECBCS Annex 52		not defined	
• **grid interaction**	nothing defined but current international discussion within IEA SHCP Task 40/ECBCS Annex 52		not defined	
4.3 performance requirements	The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources.	EPBD article 2.2	not defined	
4.4 prescriptive requirements	The introduction of intelligent metering systems shall be encouraged whenever a building is constructed or undergoes major renovations	EPBD article 8.2	defined	Requirements for heat recovery, installations, maximum U-values, energy-balance for windows, air-tightness etc. are given in BR10.
4.5 comfort & IAQ requirements beside usual national directives	The performance calculation of buildings should take into account indoor climate requirements. It includes, in addition to thermal characteristics such as air-conditioning installations, inter alia, applications of energy from renewable sources, passive heating and cooling elements, shading, indoor air-quality, and adequate natural light.	EPBD article 1.1 and preamble recital 9	defined	Requirements for indoor temperature levels and daylight levels are given in BR10.
4.6 monitoring procedure	The energy performance of a building means the calculated or measured amount of energy	EPBD article 2.4	defined	
5. Field of application				
5.1 building type	residential/non-residential - Member States shall ensure that all new buildings are nearly zero- energy buildings by 31 December 2020 resprecively after 31 December 2018 (occupied and owned by public authorities).	EPBD article 9.1a/b	residential/non-residential	
5.2 new/retrofit buildings	New, and existing buildings that are subject to major renovation, should meet minimum energy performance requirements adapted to the local climate.	EPBD preamble recital 15, and article 9.1a/b	new	Nearly zero is only a requirement for new buildings.
5.3 private/public buildings	private/public - Member States shall ensure that by 31 December 2020, all new buildings are nearly zero- energy buildings and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.	EPBD article 9.1a/b	private/public	

10.2.4 Pictures of seven used case studies in Task 1c

Figure 150 Plus-energy primary school in Hohen Neuendorf, Germany. Source IBUS Architekten und Ingenieure

Figure 151 Nursery “Die Sprösslinge” in Monheim, Germany. Source Bayer Material Science

Figure 152 Kleehäuser in Freiburg, Germany. Source Jörg Lange

Figure 153 EnergyFlexHouse in Taastrup, Denmark. Source Danish Technological Institute

Figure 154 Circe office and laboratory in Zaragoza, Spain. Source Circe

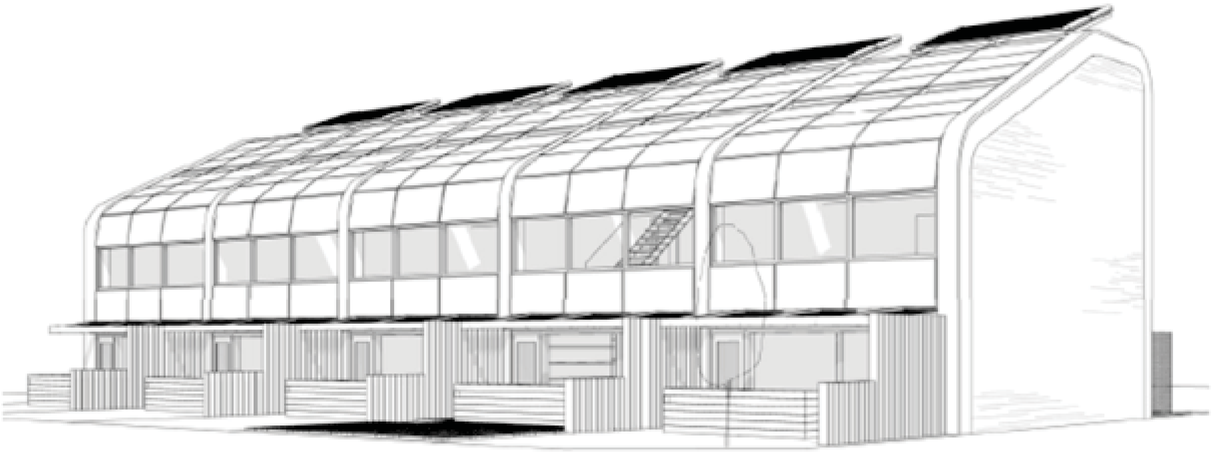

Figure 155 Sketch of Glasbruket dwelling house. Source Lund University

Figure 156 Rendering of Vala Gard in Helsingborg, Sweden. Source Lund University

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10.2.5 Output spreadsheets of the Net ZEB evaluator tool with results of the seven investigated building projects

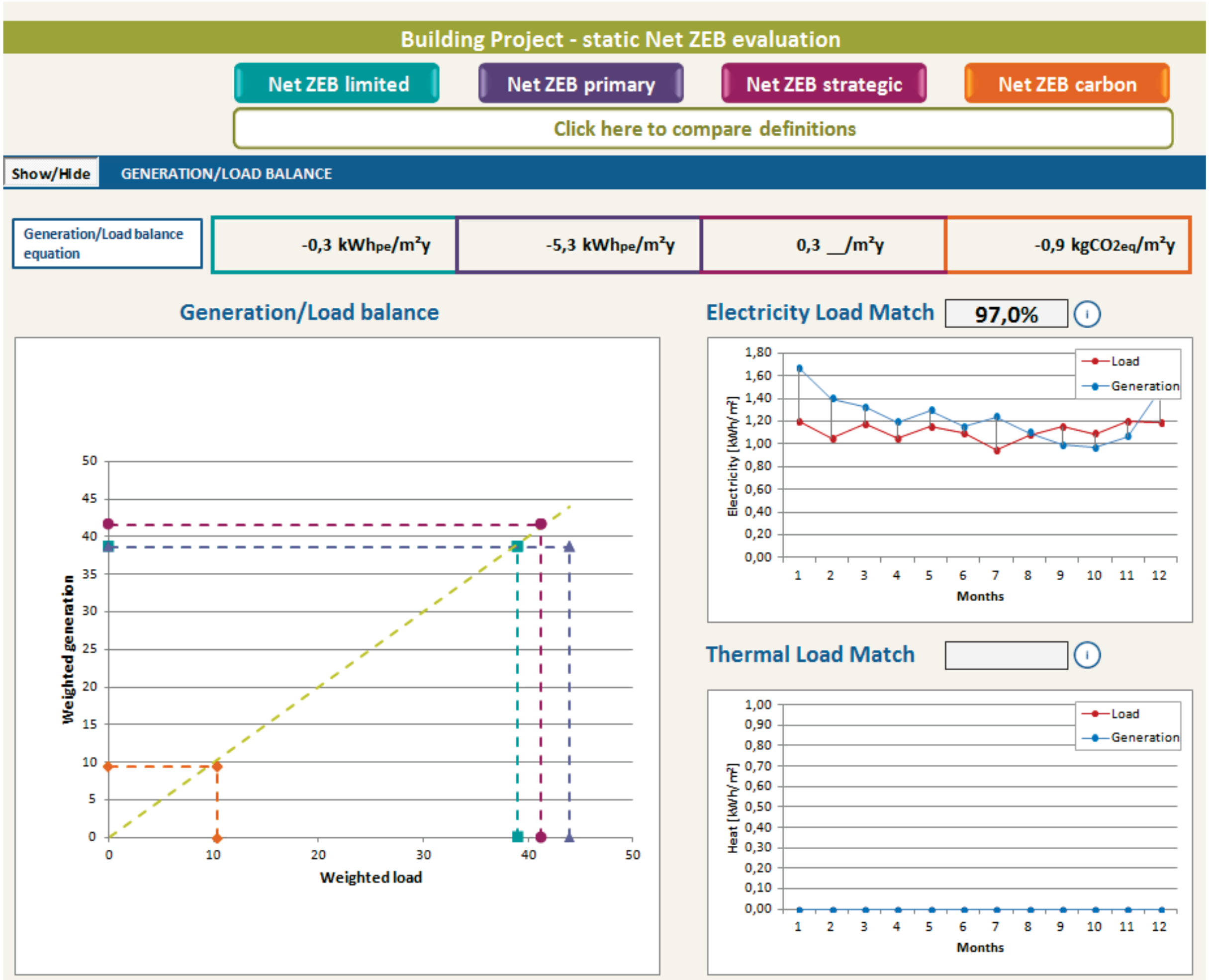

Figure 157 Balance results of the four different balance types in the “Net ZEB evaluator tool” for the Primary School in Hohen Neuendorf, Germany.
All four balances are very close to a zero balance (due to very low demands), the electricity load match on a virtual monthly level is very high due to the use of a combined heat and power plant and a PV array. There is no thermal load match as no district heating grid is connected to the building / no heat is fed into a grid. Source University of Wuppertal

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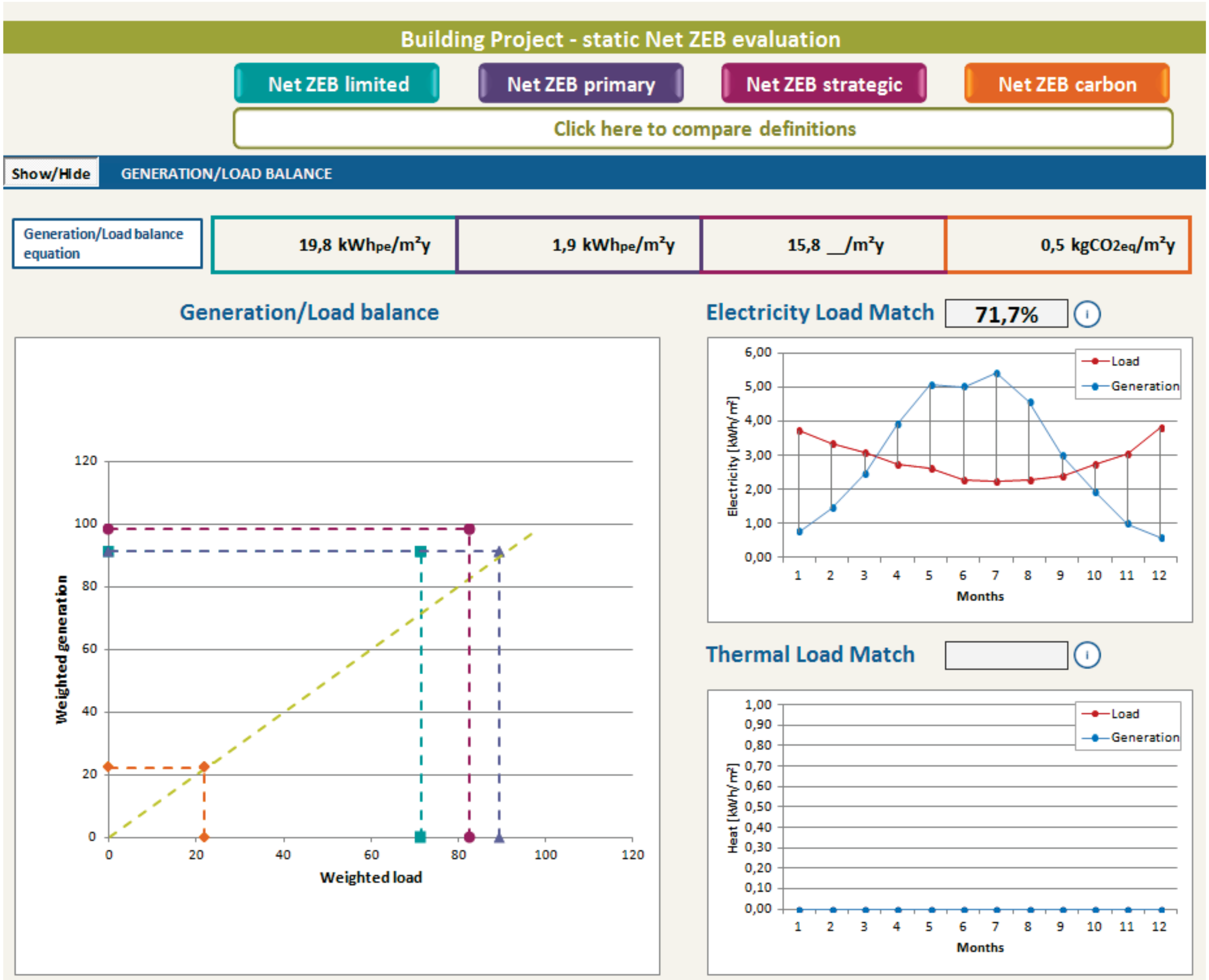

Figure 158 Balance results of the four different balance types in the "Net ZEB evaluator tool" for the Nursery "Die Sprösslinge" in Monheim, Germany.
The zero primary energy / CO2 aim is achieved in all four balance types. The curve of the electricity load match indicates the solely use of PV (generation peaks in summer times, demand peaks in winter times). Source University of Wuppertal

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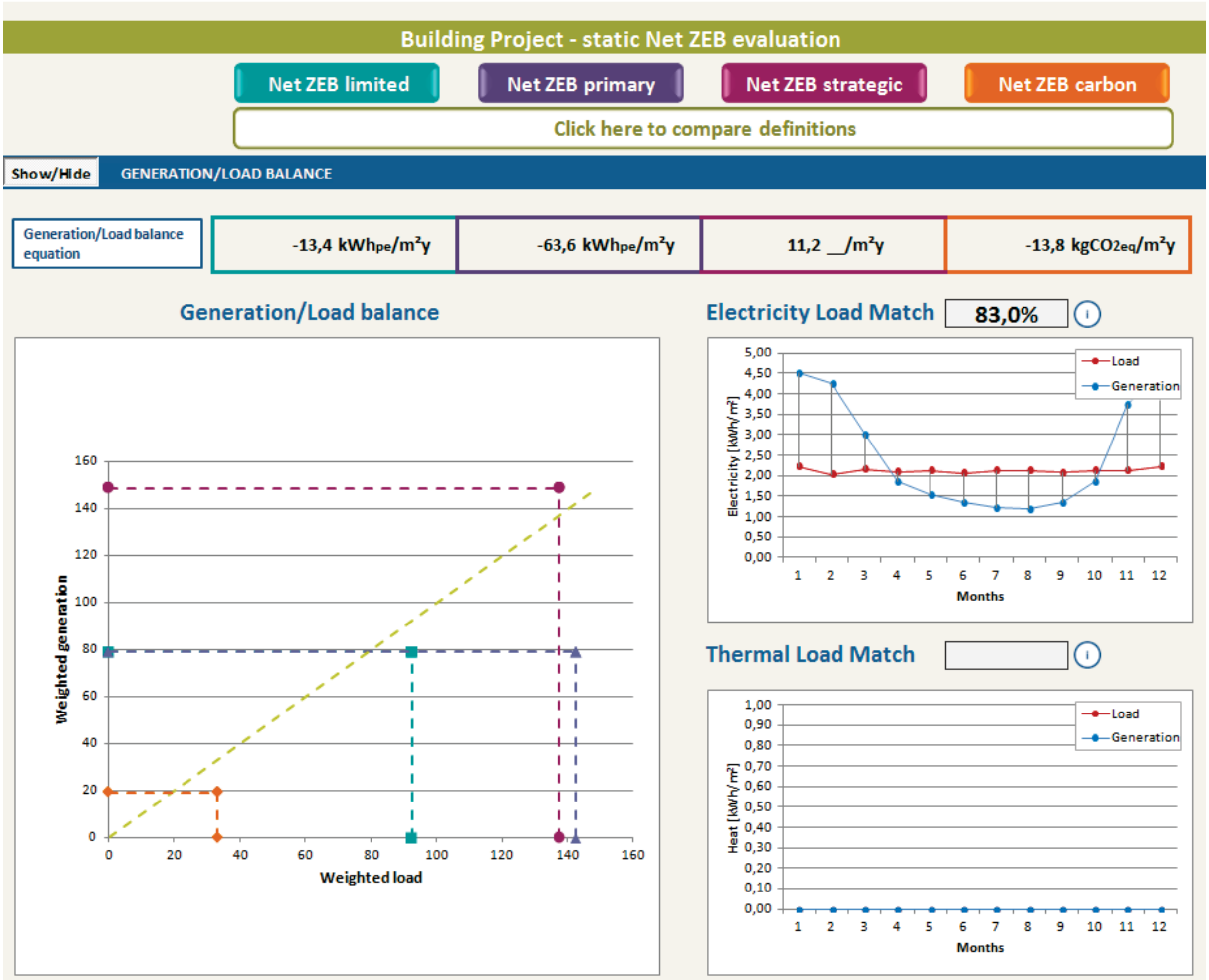

Figure 159 Balance results of the four different balance types in the "Net ZEB evaluator tool" for the Kleehäuser in Freiburg, Germany.

The zero primary energy/CO2 aim is only achieved for the Net ZEB strategic calculation as this includes the planned and actually used share of external wind turbines (off-site generation systems are not included in all other three balance procedures, see(Figure 14 and Figure 15). The electricity load match curve shows a very constant demand due to very efficient appliances and a non electric, gas based space heat coverage (CHP) and represents generation maxima in winter times where less electricity is generated by the small PV system but more by the CHP unit (off-site generated wind energy is not included, see above). Source University of Wuppertal

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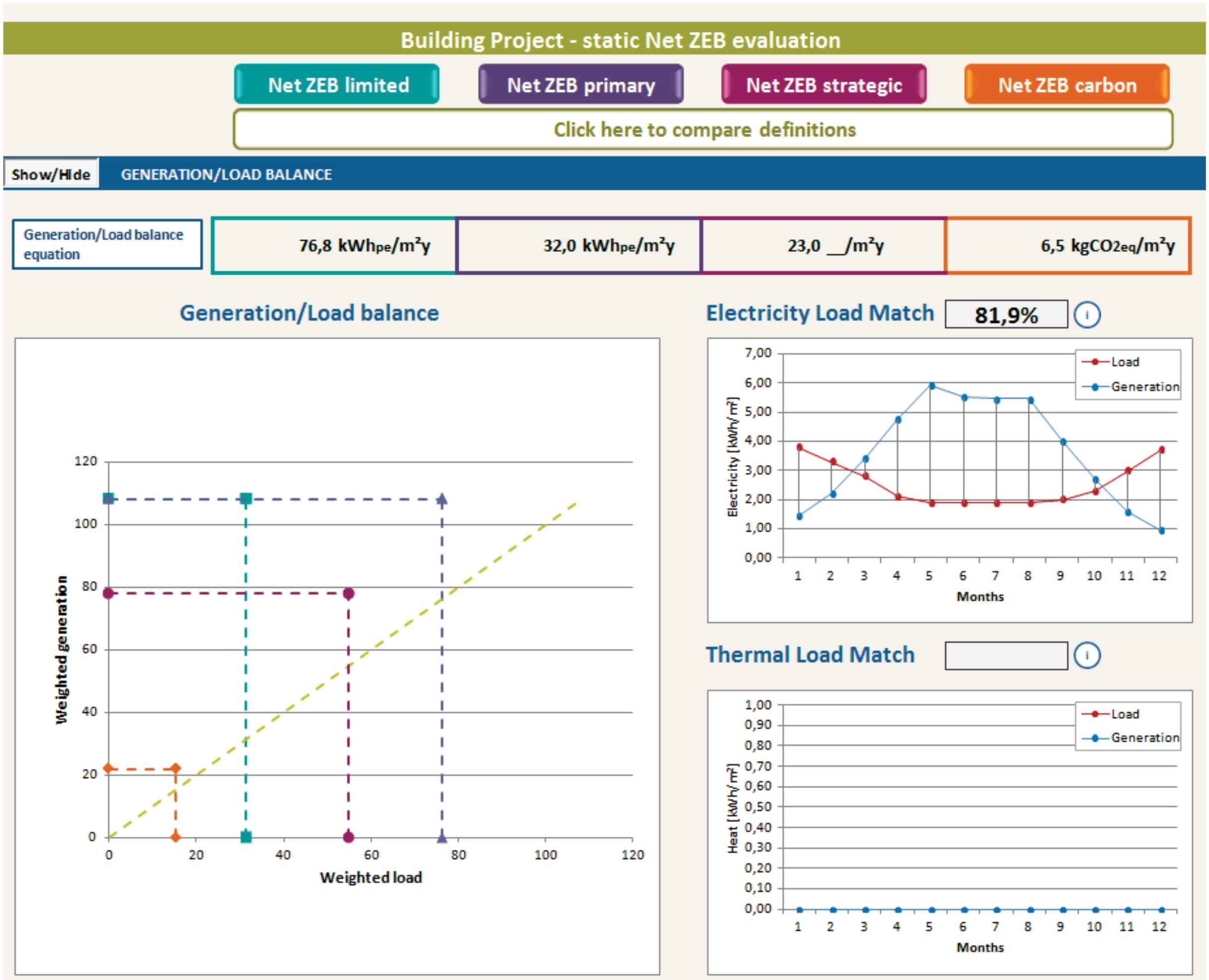

Figure 160 Balance results of the four different balance types for EnergyFlexHouse in Taastrup, Denmark.

The zero primary energy/CO2 aim is achieved in all four balance types. The electricity load match is very high due to a large PV system which was planned to cover beside the building and user related energy also the demand of electric vehicles which are not included in any of the four balance calculations of the Net ZEB evaluator tool. The curve is very typical for all-electric buildings with PV and heat pump (electricity generation high during summer times, low in winter times parallel to higher demands). Source Danish Technological Institute/University of Wuppertal

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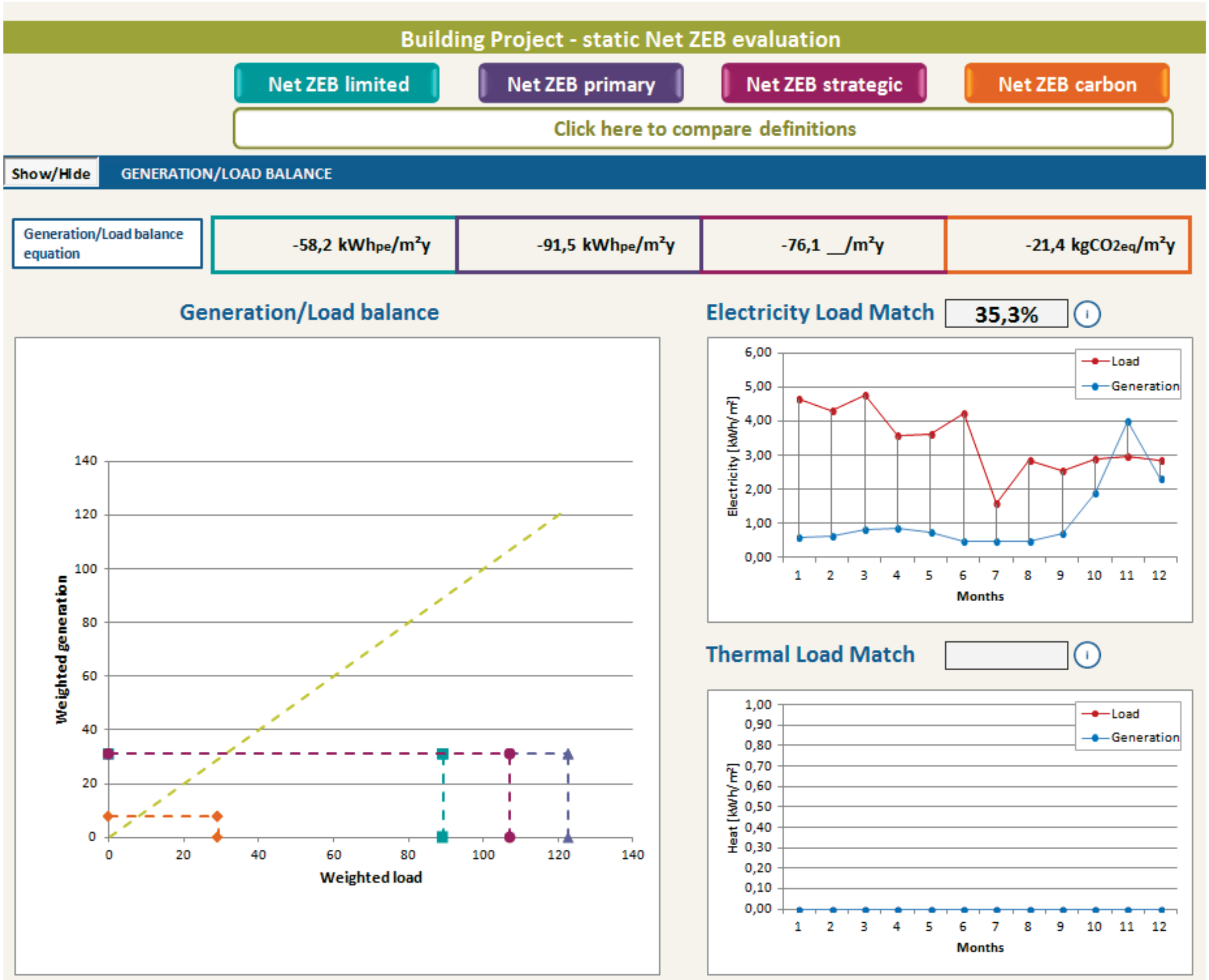

Figure 161 Balance results of the four different balance types in the “Net ZEB evaluator tool” for the CIRCE office building in Zaragoza, Spain.
The zero primary energy/CO2 aim is not achieved in any of the Net ZEB calculations because the generation systems (PV and on-site wind turbine) do not have enough capacity to cover all loads. The virtual electricity load match curve indicates the effect of changing wind energy generation due to the local wind regime. In the strategic balance only the demand has changed/lower weighting factors.
Source IREC - Catalonia Institute for Energy/University of Wuppertal

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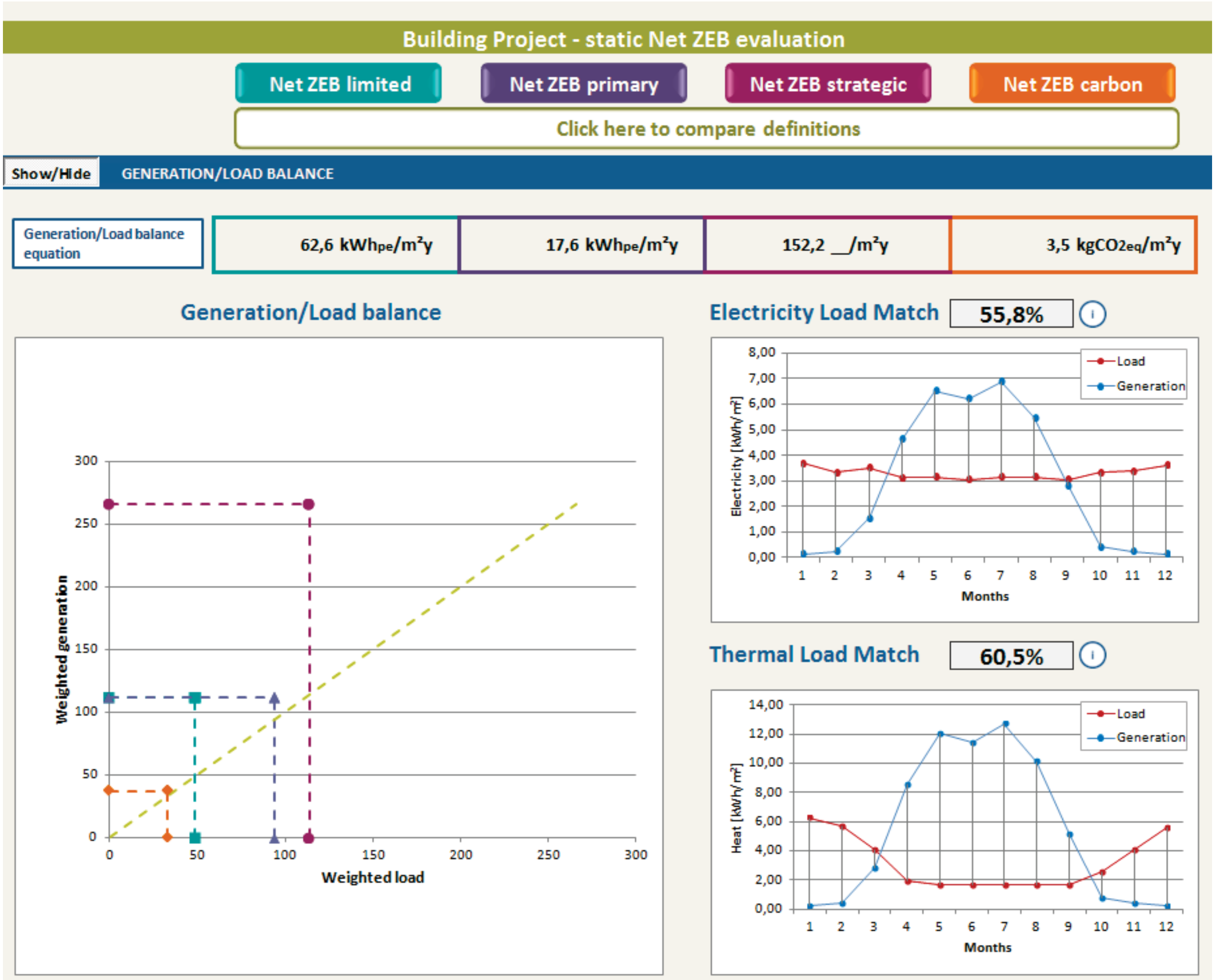

Figure 162 Balance results of the four different balance types in the "Net ZEB evaluator tool" for the Glasbruket building in Malmo, Sweden.
All four balances are positive what reflects low demands and high generation and fed-in credits. Both electricity and heat is generated (mostly during summer times) and fed into grids. The thermal load match indicates the connection to a heating grid and large solar thermal collectors. The electricity demand is very constant (no heating via electricity) whereas the heating load follows the temperature trend of a year in northern Europe. Source Lund University / University of Wuppertal

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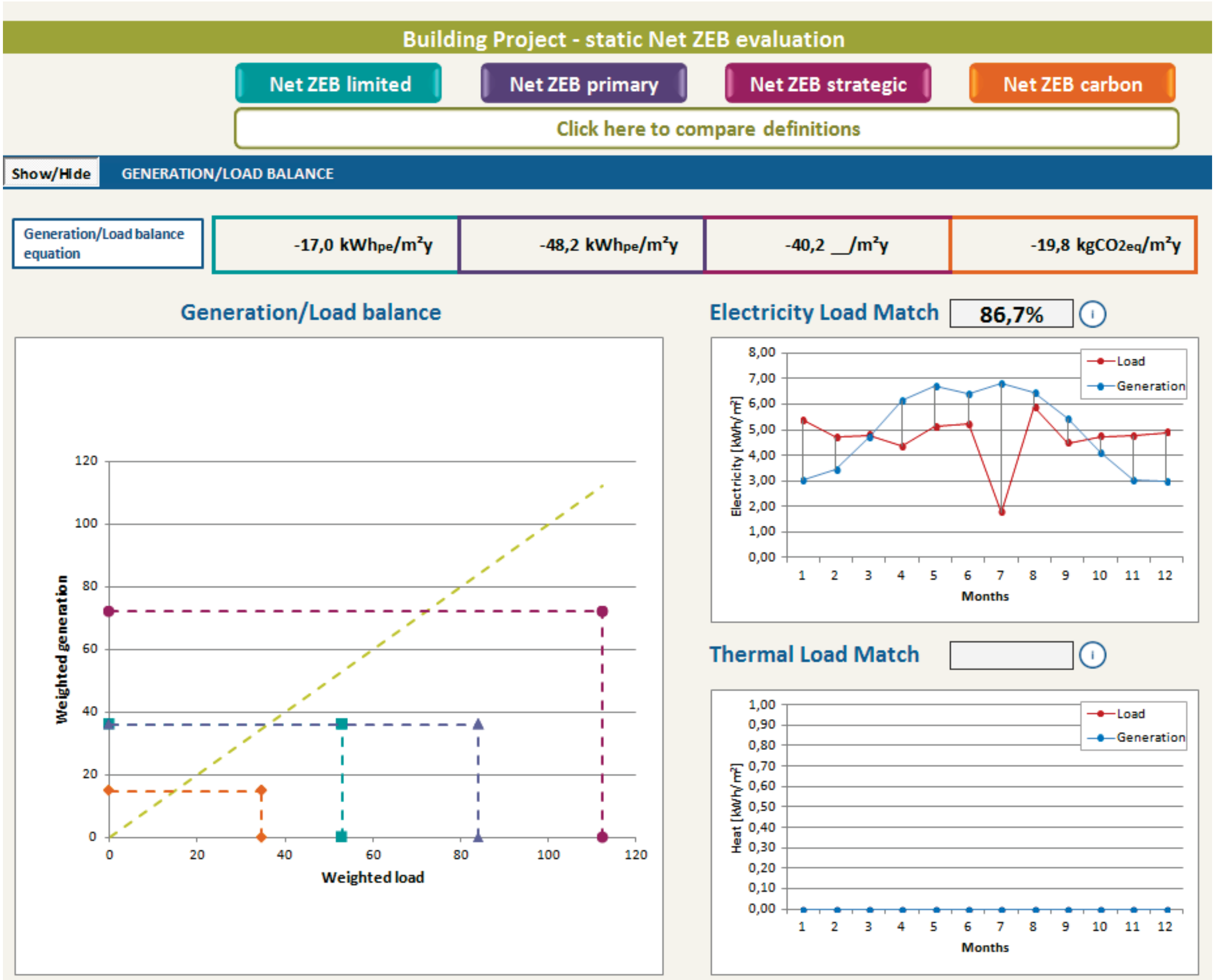

Figure 163 Balance results of the four different balance types in the “Net ZEB evaluator tool” for the planned Vala Gard building in Helsingborg, Sweden.
All four balances are not equalized. The on-site generation systems are too small, off-site generation is again not considered (see above). Very low electricity demands in July indicate the official summer break. During this time the most electricity is generated. Source Lund University / University of Wuppertal

10.2.6 Additional information about the "Net ZEB evaluator" tool

The Net ZEB evaluator is an Excel-based tool that consists of four sheets (see Figure 164). The first three sheets have to be filled in with input data (Building information and energy data, Weighting factors, Project finance) whereas the last one reports calculation results (Net ZEB evaluation). Input data cells are highlighted in yellow and some of them are locked to prevent the filling of input data where not appropriate. Information on how to complete the tables is available in the question mark boxes. Definitions and terminology are available in info boxes. Nevertheless, the content of the spreadsheet is relevant with [Sartori 2012].

The spreadsheet is not meant to substitute any tool for calculating building loads. For this reason, it does not need any envelope features or any efficiency conversion of energy systems as input. The balance calculation is performed if yearly data about energy demand and supply are entered in the first sheet and weighting factors related to the considered energy carriers are entered in the second sheet. Calculation macros are run by clicking arrow-buttons at the bottom of the sheets (Figure 165).

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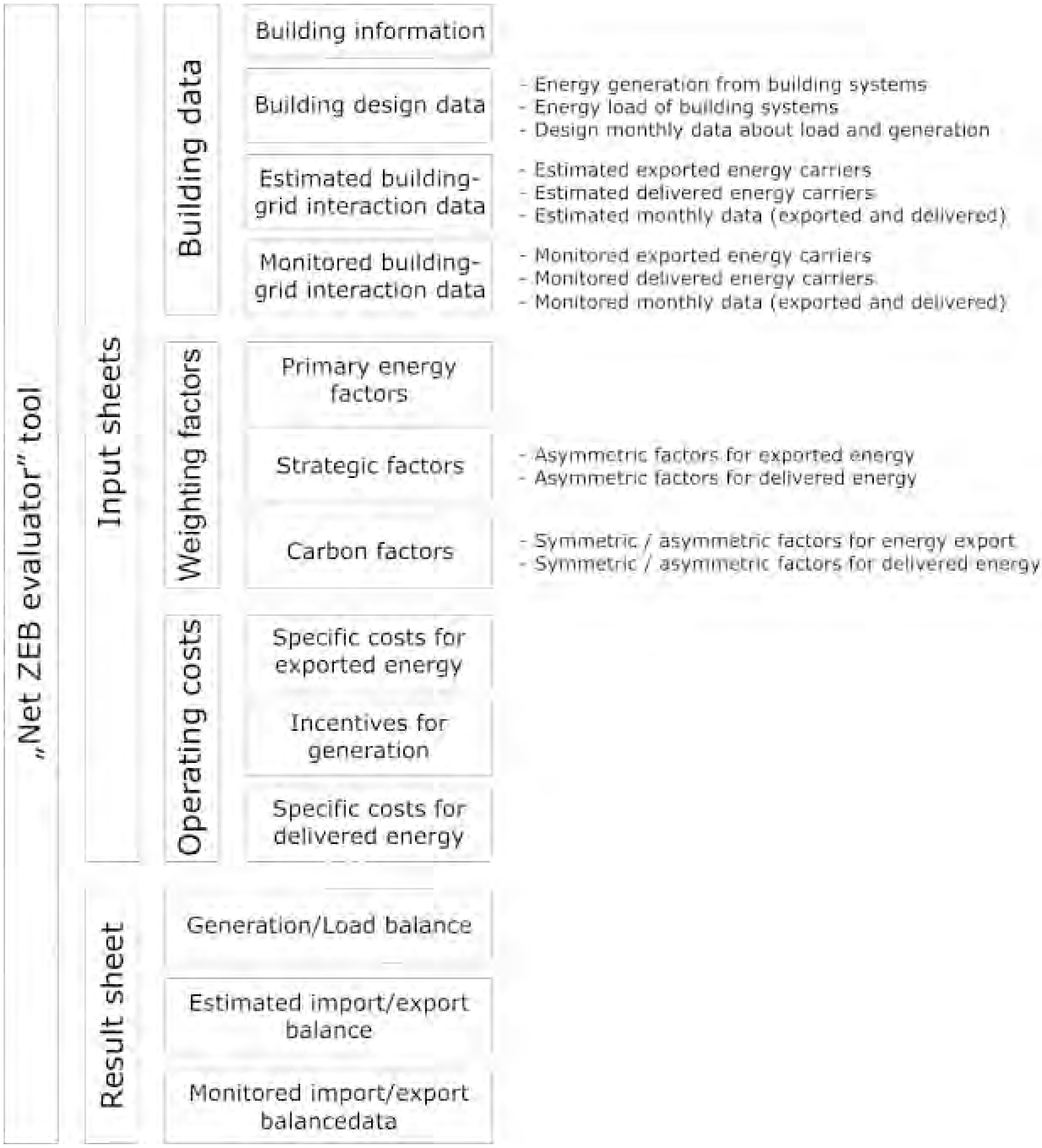

Figure 164. Diagrammatic plan of the different sheets, sections and tables of the Net ZEB evaluator tool. Source University of Wuppertal.

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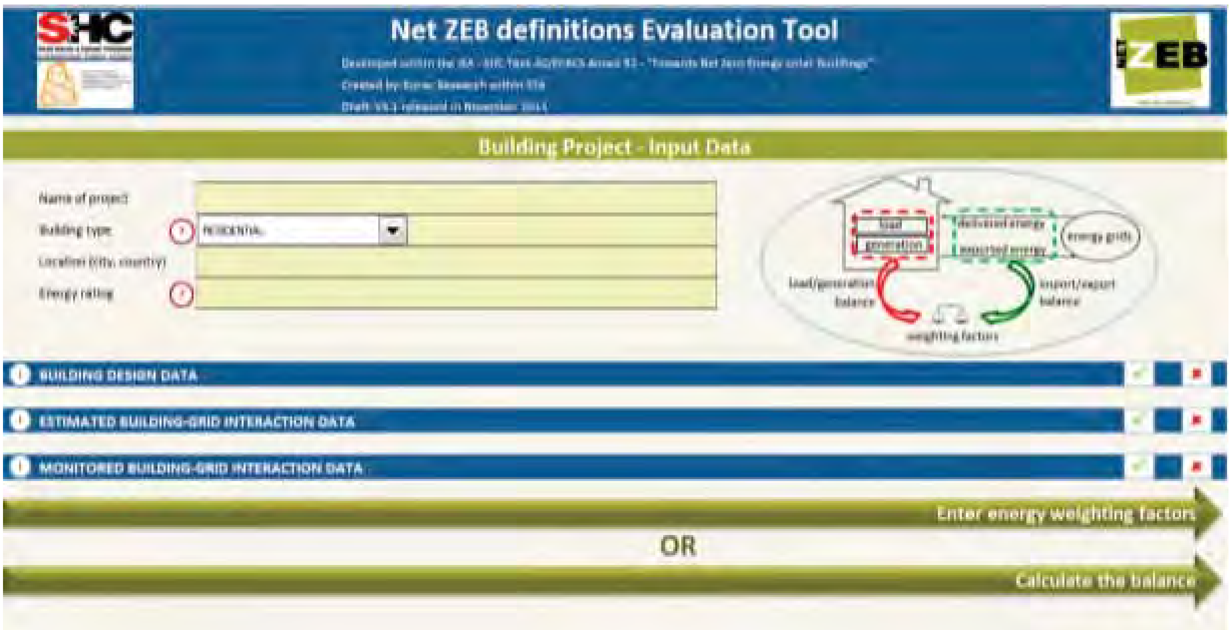

Figure 165.The Net ZEB evaluator tool. Macros are run by clicking the green arrows-button at the bottom of teach sheet. Source [Belleri 2012].

In the first sheet (building data) general building information and data about the buildings energy demand and supply have to be entered. The building type has to be selected from a dropdown list. It implements different calculations with respect to the first definition (called Net ZEB limited). In order to allow checking the balance with different kind of input data, this sheet is divided into three sections (figure 1):

1. Building design data
2. Estimated building - grid interaction data
3. Monitored building - grid interaction data

Each section can be easily opened or closed by clicking on checkmark buttons on the right (figure 1). The tool enables to enter yearly values of delivered and exported energy or energy load and generation, but requires monthly values for the load match factor calculation.

1. The building design data (building load and generation) have to be filled in to check the generation/load balance. This section again is divided into three tables:

- The first table asks for data according to energy generation from building systems. It requires the data for renewable energy generated from different building systems. The most recurrent technologies have been considered and there are blank cells where other technologies and other generated energy carriers can be added. Each value per energy carrier is always linked to other entries of the same energy carrier by a univocal number. The overall generation of the each energy carrier can be accounted in different cases. If the energy carrier is generated by a system connected to an energy grid with the possibility to export, it is recommended to write the entire amount of generation and in a table called "Energy load of building systems" (assumed absence of any generation and self-consumption). But if the energy carrier is generated by a system which is not connected to any energy grid, two options are available:

- consider the generation as totally self-consumed (thereby any value in this table should be entered in a table called "Energy load of building systems" - load should be written as it is, that already reflects the effect of generation)

- consider it as generation, thereby a correspondent "virtual" energy system load should be entered in the table called "energy load of building systems" for the selected substituting carrier.

If the self-consumption can be estimated, using import/export balance should be considered (if possible also for the other energy carriers).

- The second table deals with energy load of building systems. Here energy loads for different final uses and different energy carriers are required. If some loads are aggregated, for instance gas loads for DHW and heating, the tool user can fill just one cell and add comments on the value entered. The itemization of final uses on one hand is to have an immediate link to the building codes; on the other hand it is necessary because “Nearly Net ZEB” definition does not include all the final uses. If the total energy demand is entered, the balance calculation relies on that value and a message warns that the balances relevant to the Nearly Net ZEB and the Net ZEB primary definitions will output the same result, as the tool does not recognize the inclusion or exclusion of appliances.

- The third table gives the possibility to estimate the Load Match index for electricity and thermal energy. The input data for this estimation are required in the third table. Here the Load Match Index will be calculated as the ratio between monthly values of the carrier generated by the building systems connected to any energy infrastructure, and the monthly values of the overall load of the same energy carrier.

2. In the second section it is possible to estimate the balance between delivered and exported energy as well in the case that dynamic simulations (that account for the simultaneousness of the energy supply from renewable sources and the loads) are available specific assumptions are set about this. This section could also be used to calculate the so called “monthly net balance” by filling the yearly values as the sum of the monthly net values. The simulation time step should be entered and estimated appliances consumption as well. The estimated import/export balance relevant to the Nearly Net ZEB definition cannot be evaluated unless assumed data about appliances are entered in the proper cell. Similarly to the previous section, this one is divided into three tables:

- In the first table yearly exported energy carriers, derived from detailed simulations on the specified time steps or assumptions on self-consumption are to be entered if a “monthly net balance” should be calculated.

- The second table “estimated delivered energy carriers” requires yearly delivered energy carriers, derived from detailed simulations on the specified time step or assumptions on self-consumption if a “monthly net balance” has to be calculated.

- The third table requires monthly data for an estimated Load Match Index. It will be calculated as the ratio between the amounts of the several energy carrier generated by the building systems connected to any energy infrastructure and self-consumed for any final use, and the overall load of the same energy carrier for all the final uses. Hence Monthly data of delivered, exported and generated energy (electricity and thermal energy) are required.

3. In the third section the monitored import/export balance in the building operation mode can be calculated by entering monitoring data about delivered and exported energy to test Net ZEB definitions. To calculate the monitored balance relevant to the Nearly Net ZEB definition the (monitored) consumption of appliances should be entered in the proper cell as well. The time resolution of monitored data should be entered in a specific cell. Similarly to the previous sections, even this one is divided into three different tables:

- The first table requires monitored yearly exported energy carriers.

- In the second table yearly data of delivered energy divided by energy carriers are to be entered, derived from monitoring.

- In the third table monitored monthly data of delivered, exported and generated energy (electricity and thermal energy) are required. The Load Match Index will be calculated as the ratio between the amount of the energy carriers generated by the building systems connected to any energy infrastructure and self-consumed for any final use, and the overall load of the same energy carrier for all the final uses.

The second sheet includes the weighting factors. They are necessary to convert the final energy into the metrics considered in the selected definitions (primary energy, CO2 emissions and possibly a user defined metric) which allow the different balance calculations.
This sheet allows entering only static weighting factors, as including dynamic accounting in the Net ZEB balance would considerably increase the complexity of calculations and the assumptions on future time dependent patterns. It is rather preferable to calculate the Net ZEB balance with static or quasi-static values and then use, in addition, dynamic values to address the temporal energy match characteristics (e.g. load match index) [Sartori 2012].
The entered factors can be symmetric or asymmetric, depending on the energy carrier, technologies used as energy supply systems or their location [Sartori 2012]. The strategic factors can be used to promote or discourage the adoption of certain technologies and energy carriers as well as include the conversion of primary sources into energy carriers. To assess Nearly Net ZEB and Net ZEB primary definitions, symmetric primary energy factors have to be entered whereas the strategic Net ZEB definition asks for asymmetric strategic weighting factors. The Net ZEB emission definition is assessed by entering symmetric or asymmetric emission weighting factors.
Generally in a note cell the primary and emission weighting factor source should be cited and a reason for the strategic factor choice should be given.

The third sheet contains the project finance data. In three different tables the specific cost data for exported and delivered energy and incentives for renewable energy generation, if any, for each energy carrier can be entered. It allows estimating operating cost for every selected definition and for every kind of data entered in the tool.

The fourth sheet contains the balance results. It is explained in the main part of the report, see chapter 4, Task 1c.

All explanations on the tool are based on an internal user guide written in the course of the mentioned research program “Towards Net Zero Energy Solar Buildings” by the main developer Annamaria Belleri, EURAC research Italy [Belleri 2012].
A new version of the tool is under development. It will probably be used for the final calculations during this research progress.

10.3 Appendix task 2

10.3.1 Detailed country fact sheets of the political framework for increasing the number of nearly zero-energy buildings

Based on the survey, that has been conducted for Task 2a and including inputs from the National Energy Efficiency Action Plans (NEEAP), the National Renewable Action Plans (NREAP), the Concerted Action (CA) reports and additional, complemental inputs by our international pool of experts (see chapter 5.1), the following detailed national fact sheets have been developed.

10.3.1.1 Austria

Austria

1) National targets

- Of final energy savings effective in 2016, approximately 80% would result from energy efficiency measures regarding building shells (63.8%) and heat provision (16.2%)
- RES-energy and shares 2020
  - o Estimated share of RES in building sector:

	2005	. 2010	. 2015	. 2020
Residential	24%	25%	26%	26%
Commercial	8%	9%	10%	10%
Public/Industrial	1%	1%	2%	2%
All buildings	33%	35%	. 38%	. 38%

  - o RES-shares: initial value, target 2020
    - RES-share 2005: 24,4%
    - Target 2020: 34%
    - Expected amount : 107174 GWh
  - o RES-share 2020 by NREAPs
    - Heating and Cooling: 48 593 GWh
    - Electricity: 52378 GWh
    - Electricity: 4505 ktoe
  - o Shares RES-Heat by technology 2020
    - Geothermal: 1.0%
    - Solar: 6.4%
    - Biomass: 86.3%
    - Heat pumps: 6.3%
  - o Shares RES-Electricity 2020
    - Hydro: 80,4%
    - Geothermal: 0%
    - Solar: 0,6%
    - Tide, wave, ocean: 0%
    - Wind: 9,2%
    - Biomass: 9,8%
  - o RES-share 2020 by NREAPs
    - Electricity: 70,6%
    - Heating and Cooling: 32,6%
    - Overall RES-share (with Transport): 34,2%

- a) national energy efficiency targets are included in the NEEAP
- b) there are no explicit policy targets concerning the intended increase of numbers of nearly zero-energy buildingat the federal level.
- The Energy Strategy (Energiestrategie Österreich, März 2010) mentions nearly zero-energy building (Netto-Nullenergie-Gebäude) as focus area in energy-related R&D, but not as explicit goal in the building-related policy instruments.

- c) In some of the regional energy and climate change strategies (see quotation column) nearly zero-energy building (Niedrigstenergiegebäude, Passivhäuser) are mentioned as point of orientation in new construction, which is supported by different policy instruments (mainly subsidy schemes), but explicit targets on shares of nearly zero-energy buildingin new construction are missing

2) Regulations

(NREAP)

- mandatory use of 'innovative climate-relevant systems' for the construction of residential houses and public buildings
- Building Code: For the construction of new buildings with a total useful floor area greater than 1 000 m² alternative systems must be used provided it is advantageous technically, environmentally and economically
- Measures for the increased use of solar heat, heat pumps and biomass heating installations in buildings are also planned.
- Progress Report:
  - o Technical rules in the building code of state governments: existing and continuously updated; Goal: Promotion of renewable energy systems in the building sector (Table 2)

(Concerted Action – EPBD)

- In 2009, every of the 9 States had his own building code, which mainly defined the quality of buildings by U-values.
- In 2008 the harmonization of the different codes resulted in a national implementation of the EPBD.
- Process of Harmonization and implementation is managed by the OIB (Austrian Institute of Construction Engineering) and an official working group representing the nine States.
- The resulting legislation framework sets the minimum thermal heating demand of new or major renovated residential and non-residential buildings.
- - differs depending of the surface/volume factor, the use of the building (residential, non-residential), renovations and new buildings. (III-12)
- For non-residential major renovation without ventilation or air-conditioning additional requirements for the cooling demand are set (from 1st of January of 2010: 4.0 kWh/m2a;)
- For other buildings only the U-values according to Directive 6 of the OIB apply for summer cooling. (III-3; III-12 - III-14)

(Additional Information)

- a) Definition of nearly zero-energy building-Standard: The building code for new construction refers to something like a nearly zero-energy building-standard (Niedrigenergiestandard lt. ÖNORM 8118), but this standard refers only to the quality of the building envelope and thus does not fulfil the definition in the EPBD; the building code for major renovation is about 30-40% looser that for new construction.
- b) Roadmap: The following information is strictly confidential! Roadmap is under development engaging the representatives of the regions in the OIB committee. The actual (still secret draft) foresees a stepwise tightening of the building codes (for new construction as well as for major renovation) - there are however serious political fights an the following topics: Leading energy performance indicator (final energy consumption; primary energy consumption; CO2-

indicator); primary energy factors for district heating and electricity; allowance of PV.

- c) There is no other regulation that refers to nearly zero-energy building.

3) Economic incentives

(NEEAP)

- Private Sector
  - o New and renovated buildings
  - o Residential building subsidy — building shell (Start: 1982)
  - o Residential building subsidy — efficient heating systems (Start: 1982)
  - o Tightening construction law requirements (Start: 1991)
- Renovated buildings
  - o National recovery plan/Renovation voucher (2009-2011)
  - o Investment subsidy
  - o Improve thermal insulation (building shell as well as windows and doors) and to improve the weather generation systems of residential and commercially used buildings that were erected before 1 January 1999 or which are at least 20 years old
  - o Household: The maximum subsidy level amounts to 20% of the (thermal) renovation costs and/or a maximum amount of EUR 5 000 plus EUR 1 500 in the case of conversion from heat generation systems to systems based on renewable energy sources
  - o Companies: Subsidy of 30% at most for small and medium-sized enterprises, for at most 40 % of the investment costs.
- Public Sector
  - o renovation programmes for public buildings (since 1999)
  - o External service providers are used to create overall concepts for the highest possible energy savings
  - o 80 % of the calculated savings go towards the financing of the construction measures. The remaining 20 % are returned to the user of the building

(Additional Information)

- a) Residential construction subsidies (Wohnbauförderung): Is the most powerful instrument with about 1 bil. € p.a. and administered by the regions. There are different subsidy schemes in the regions; some of them (e.g. Vorarlberg, Salzburg, Steiermark) have "progressive" schemes, meaning increasing funding rates with increasing energy performance. Furthermore, due to increasing minimum standards in the building code, also the requirements in the subsidy schemes need to get more demanding.
  In summary: There is already a strong tendency to foster nearly zero-energy buildingby this subsidy instrument. This is valid for new construction as well as for major renovation.

- b) funding for R&D: There exisits the specific R&D programme Haus der Zukunft plus aiming top nearly zero-energy building ("Plusenergiegebäude"). This programme also includes a rough definition of the term "Plusenergiegebäude" (see my inputs to task 1)

- c) Subsidies for refurbishment of non-residential buildings: For the refurbishment of non-residential buildings there exists a subsidy scheme at the federal level ("Umweltförderung").

This subsidy schemes also includes "progressive" elements, meaning that the funding rate increases with increasing thermal performance and by combination of thermal improvement with RES measures. nearly zero-energy building, however, are not explicitly mentioned.

4) Financing instruments

(NREAP)

- 'Environmental Assistance in Austria' (UFI) (since 1993)
  - Companies
  - Support for investments to increase RES share through investment grant
  - Standard reimbursement rate: 30 % of environment-related investment costs;
  - Bonus of 5 % for accompanying building measures to reduce the cooling demand
- Climate and Energy Fund Law (since 2007) - should be expanded by 2011.
- 'Buildings as Power Plants' framework programme of the KLI.EN Fonds
  - Mustersanierungsoffensive campaign especially directed to support best practice renovation in hotel and hospitality buildings
  - Tourist, commercial and office buildings; schools; homes; hospitals and such
  - Investment grants: max. 40 % of environment relevant investment costs , 5 % award for thermal solar installations or individual biomass units
- Several Regional housing support programmes available(detailed listing see p.111)
  - For Construction, Remediation, Other
  - Targeted: all
  - Depending on region, includes various financing aid such as direct loans and subsidies, Investment grants etc.

(Progress report)

- Planned:
  - Further development of eligibility criteria and tools in the building (enter into force 2013)
  - Stronger focus of housing support on thermal remediation and he use of renewable energy for heating systems (Table2)
- Subsidy scheme wood heating 2011 (total of EUR 3 m is available) - (500 € per boiler) for the implementation of pellet and wood-chip central heating systems and pellet stoves.
- Sample remediation
  - Extensive remediation projects for commercial and public buildings can be subsidized
  - Improvement of heat insulation, measures for the use of renewable energy sources and for the increase of energy efficiency fall within the remit of extensive remediation projects

- Subsidy for solar PV plants up to 5 kW - promoting individual, private solar PV plants through an investment cost subsidy
- Solar thermal – Large-scale solar plants - innovative, large-scale solar thermal plants with a collector surface of 100 to 2 000 m2 supported (PR p.18)

(Concerted Action – EPBD)

- Comprehensive system of subsidies.
- National level
  - Investment subsidies by National Climate and Energy Fund ("Klima- und Energiefonds") for the thermal retrofitting of residential and non-residential buildings (100 M€/a until

2014)
  - Grant of up to 30%
- Province level
  - Various subsidies exist.
  - Especially concerning thermal insulation, use of biomass for heating and solar energy for heating and domestic hot water.
  - Also for: energy consulting and the issue of EPCs.
- Subsidies for the retrofitting
  - Either as investment grants (between 10 and 25%) or loans (with 1%to 4% interest for a period of 10 to 20 years, depending on the regional system and the quality of supported measures).
  - Normally the issuing of an energy certificate before and after construction is included.
- Wohnbauförderung
  - Implemented 1968, are changed and now based on the heat demand.
  - Low energy buildings and passive buildings have been supported for many years in Austria
  - Most of the new buildings have a heat demand of less than 50 kWh/m²a (to get subsidies) and share of "passive" buildings is relatively high.
  - Although there are no minimum values for the use of Renewable Energy sources in buildings there are many possibilities to get subsidies for renewable energies installations.

5) Energy performance certificates' use and layout in relation to nearly zero-energy buildingstandard

(Concerted Action – EPBD)

- "Energieausweis -Vorlage Gesetz (EAV-G)" implemented 2008 as basis for a national harmonized certification of buildings.
  - Energy certificate rates buildings by the heat energy demand in kWh/m²a
  - Can only be issued by qualified experts
  - Comprehensive, containing the description of the building geometry and of every single part of the building (30-40 pages)
  - Its validity is 10 years.
  - Building need to be certified when undergoing a renovation for which a building permit is needed or when sold or rented
  - No sanctions if a certificate is wrong or not issued.
  - Costs of a certificate start at 450€ for a new small building to over 15000€ for a existing complex building like a hospital
  - Certificates for major renovation have to contain a recommendations (including description of the measure, costs, savings, payback and impact of all measures on the energy rating)
  - Calculation methodology includes the existing CEN-standards, it describes the whole building envelope as well as the heating, cooling, ventilation and air conditioning, ect
  - For non-residential buildings lightning is also included
  - Results and details of the calculation have to be uploaded to the central register of Statistics Austria.
  - Public buildings larger than 1000 m² are required to display an energy certificate at the

main entrance.
    - Energy performance certificates are randomly checked when uploaded to one of the data bases. There is no national mandatory Quality assurance scheme. (III-3 - III-7)
- No specific focus on nearly zero-energy buildingplanned related to EPC. The labelling, however, in general underlines (differences in) energy performance.

6) Supervision (energy advice and audits)

(NEEAP)

- Energy advice for private households (p.32)
    - Federal states offer advice with regard to energy for households
    - Quality of the energy advice is ensured by means of a standardised training, consisting of a standard course (A level) and an advanced training course (F level).
    - Scope of the advice services vary according to federal state and can range from providing information by telephone to comprehensive advice before undertaking construction or renovation measures
- Advice for local authorities (since 2009)
    - Establishment of energy platforms in regions
    - Advice for local authorities in regard to planning and calls for tenders as well as in regard to the erection and renovation of municipal buildings
- Advisory services for energy efficient newly constructed buildings (since 200) (p. 109)
    - Extension of advice centres for citizens
- Energy check of service buildings (Advice for renovation works)
- Energy report on buildings
    - single-family homes, apartment blocks and municipal buildings
    - Analysis, resolution of weak points and calculation of energy consumption as well as savings potentials
- Energy advice for office buildings (since 2004)
- Renovation advice (since 2009)
    - Generation of an overall renovation concept, including energy pass.

(Concerted Action – EPBD)

- Inspection obligations for boilers exist for more than 15 years.

  The frequency of inspection depends on the energy source and the size of the heating system. The reports include up to now little information but comprehensive inspection reports will be introduced when implementing the recast of the EPBD in 2012. And by then the inspection reports will be collected to a central database.
- Inspection of air-conditioning systems is still at an early stage, since these have so far not been regularly inspected and the calculation methodology as well as the training of experts has to be developed. A/C systems with an output of 12 kW and higher are to be inspected. (III-7 - III-8)

(Additional Information)

- a) Federal programme klima:aktiv bauen: The climate protection programme for the building sector klima:aktiv bauen includes a part with energy advice and audits, with specific focus on nearly zero-energy building (buildings fulfilling the quality criteria of klima:aktiv, see my description under task 1)

• b) Energy advice at the regional level: Each regions runs energy advice programmes which are usually strongly connected with the residential construction schemes. (Wohnbauförderung). Usually the availment of energy advice is a precondition for getting subsidies. There is, however, no specific focus on nearly zero-energy buildingbeyond the quality criteria fixed in the different subsidy schemes.
7) Information (tools) *(NEEAP)* • Individual federal states and energy utilities offer individual advice services or individualised internet services on ways to save energy from electricity and heat for households and small trade businesses. (p. 85) • Municipal construction works (Oct 2008) (p. 107) o Information event on more professional planning and implementation of municipal construction projects. o Taking into account energy consumption, responsibility of the public sector for building culture and its exemplary role. This event served to raise awareness. • Quality of spaces in school buildings (May 2010) o Provision of information: Acoustics, lighting, ventilation. This event served to raise awareness in regard to the construction of school buildings. • Expansion of range of information services (since 2009) o Media campaigns: Lifestyle: better living with less energy. o Modernisation of buildings as a joint action programme of the federal state in conjunction with commerce and banks. • Information, advice and calls for tenders for municipal buildings o Support in drawing up the project, drafting of the contract, calls for tenders, etc. • Energy accounting in local authorities (since 2000) o More than 50 local authorities have implemented energy accounting; the aim is to also provide this service online; more than 500 buildings in the benchmarking database. *(Concerted Action – EPBD)* • The government started many actions to promote EPCs on regional level, mainly using brochures, folders and information campaigns linked to the training of experts. Seminars, events and workshops were held to promote awareness among citizens regarding information on the thermal quality performance of buildings. Different websites provide detailed information. (III-9) *(Additional Information)* • a) Information tools on the federal level: o “Klima:aktiv bauen” implements a wide range of information activities on nearly zero-energy building (i.e. buildings fulfilling the criteria of “Klima:aktiv”) • b) In addition, there are numerous information activities at the regional levels on the topic of very low energy buildings (passive houses etc.). These activities are often implemented by the regional energy agencies, which are responsible for energy advice in general and advice related to subsidy schemes in particular.
8) Demonstration • a) R&D demonstration: A large part of the programme Haus der Zukunft plus refers to

demonstration (new construction as well as major renovation). The demonstration projects are widely disseminated. • b) "klima:aktiv haus": All buildings which are labelled according to klima:aktiv criteria (which can be seen as a specific definition of nearly zero-energy building) are made publicly available on the web • c) Mustersanierung: This additional, smaller demonstration programme is specifically related to high energy performance refurbishment of non-residential building. The project results are monitored in detail and made available via a web-portal
9) Education and training *(NEEAP)* • Renovation advisers for residential buildings and service buildings, advanced training for energy advisers and sellers of prefab houses in respect of building standards under the 'klima:aktiv' climate protection initiative. U(p. 87) • Educational programme (since 2000) o Broad programme on advanced training in energy related matters with a focus on renewables, facility management and energy efficient buildings. *(NREAP)* • The Climate and Energy Fund (KLI.EN Fonds) provides a contribution to the research and development of sustainable energy technologies (p. 36) *(Concerted Action – EPBD)* • Courses and seminars for experts issuing EPCs are offered but not mandatory. • Training for inspectors of air-conditioning systems is still necessary and is organized by the government and energy agencies together with Chambers of Commerce and of Civil Engineers. (III-6 - III-8) *(Additional Information)* • a) Trainings on the federal level: The programme klima:aktiv runs a specific sub-programme oriented at further education related to high energy performance buildings (mainly for master builders and executing construction companies) close cooperation with professional further education institutions • b) Training activities at the regional level: Some regions (e.g. Vorarlberg put a strong focus on training of planners related to nearly zero-energy building (passive houses) and offer several courses through different channels. In addition in some regions so-called company clusters have been developed, which also put a strong focus on training of the participating companies (e.g. Ökobaucluster in Niederösterreich)

10.3.1.2 Czech Republic

Czech Republic

1) National targets

(NEEAP)

- No target for nearly zero-energy building for 2013, 2016, 2020 set

(NREAP)

- RES-energy and shares 2020:
  - o Estimated share of renewable energy in the building sector (%), 2010, 2015, 2020 - Total 3.8, 4.3, 4.7
  - o RES-shares:
    - initial value 2005: 0,06%,
    - Target 2020: 13%
    - Expected amount : 50953 GWh
  - o RES-share 2020 by NREAPs
    - Electricity: 11679 GWh
    - Electricity: 1004 ktoe
    - Heating and Cooling: 30895 GWh
  - o RES-share 2020 by NREAPs (data source: Table 3)
    - Electricity: 14,3%
    - Heating and Cooling: 14,1%
    - Overall RES-share (with Transport): 13,5%
  - o Share RES-Electricity 2020
    - Hydro: 19,5%
    - Geothermal: 0,2%
    - Solar: 14,8%
    - Tide, wave, ocean: 0%
    - Wind: 12,8%
    - Biomass: 52,8%
  - o Share RES-Heat 2020
    - Geothermal: 0,6%
    - Solar: 0,8%
    - Biomass: 94,2%
    - Heat pumps: 4,4%

(Additional Information)

- Since 2020 all new building as nearly zero-energy buildings (since 2020 expected annual increase in the number of buildings of about 1,000 of new non-residential buildings and about 14.000-22.000 of new residential buildings)
- According the Amendment of the Energy Management Act 406/2000 Coll. the new buildings with floor area larger than 1500 m2 has to meet the energy demand of nearly zero-energy building since 2018 (buildings owned by public authorities since 2016), the new buildings with floor area larger than 350 m2 has to be nearly zero energy since 2019 (buildings owned by public authorities since 2017), other the new buildings has to be nearly zero energy since

2020 (buildings owned by public authorities since 2018). The buildings will prove that they meet the energy demand when applying for building permit.

2) Regulations

(NEEAP)

- In January 2011 work on a draft amendment to Act No 406/2000, which will implement the new Directive 2010/31/EU started.

- Planned (p.51)
  - o Benchmarks on energy performance indicators will be set for the year 2013, when new legislation enters into effect
  - o These requirements will gradually (over time) be tightened up to 2020
  - o Establish primary energy factors at the level of individual technologies and their respective values used to calculate total annual primary energy
  - o Establishment of the use of renewable energy sources is currently proposed using primary energy with the relevant primary energy factors

(NREAP)

- Each new building and any building over 1,000 m2 undergoing a major refurbishment has to undergo a renewable energy use assessment (p. 31)

- Amendment of Act No. 406/2000 Coll. envisages that if renewable energy sources are technically, economically and environmentally feasible, they will have to be incorporated in all new or refurbished buildings - starting from 2012 this will apply to all public buildings and starting from 2015 to all other buildings.

(Concerted Action – EPBD)

- The EPBD has been implemented in the Czech Republic and the implementation of the recast of the EPBD in the legislation is planned. (III-78)
- EPC implementing regulation (published in 2007) sets the minimum requirements for the energy performance of new buildings and existing buildings under major renovation. The EP requirements for new and existing buildings are the same. New requirements directly connected with the EPBD implementation:
  - o Global minimum requirements on consumption for all types of buildings expressed in kWh/m2 per year of delivered energy; RES and D-H feasibility studies for new buildings over 1,000 m2;
  - o Energy Performance Certificate
- Main regulations:
  - o Regulation No. 14812007 Colt. of the Ministry of Industry and Trade, specifying the details of the energy performance of buildings.
  - o Level of heat energy demand, according to the Czech standard CSN 73 05 O4O-2/71:2005 - standard set two levels of insulation: required and recommended
- In the Czech Republic, no impact of the EPBD is evident regarding the strengthening of the thermal characteristics of the building envelope (III-77)
- Planned
  - o In 2011 - The new legislation will be prepared and published. The amendment of the Energy Management Act will be submitted to the Parliament for approval.
  - o In 2012 - The new legislation will become mandatory.

	(Additional Information) • Definition of the nearly zero-energy building is under approval process. The amendment of Energy Management Act 406/2000 Coll. defines the nearly zero-energy building as building with very low energy demand which should be covered to a very significant extent by energy from renewable sources. The detailed definition will be explained in the Decree of the energy performance of buildings and there will be fixed percentage of energy demand which should be coved by RES. The percentage will be probably different for different types of buildings - residential, non residential etc. • Roadmap - the introduction of energy performance requirements is defined in the amendment of Energy Management Act 406/2000 Coll. As mentioned above, requirements for new nearly zero building will be introduced gradually according to the size (floor area) of buildings since 2016 for building owned by public authorities (2018 other buildings). • The requirements for energy performance of nearly zero-energy buildings will be defined in the Decree of the energy performance of buildings which is under construction. The Czech technical standard Thermal protection of the buildings (CSN 73 05 40-2) was already updated in November 2011. This standard defines the recommended U-values of constructions for very energy efficient buildings. The Construction Act already requires meeting the energy performance requirements, so it won't be updated.
3)	Economic incentives *(Additional Information)* • The Green Savings programme which supported quality insulation of residential builings, the replacement of environment unfriendly heating system for low-emission biomass boilers and efficient heat pumps, installations of these sources in new low-energy buildings, as well as construction of new houses in the passive energy standard ended in 2011. Nowadays, there are negotiations whether a new program to support the construction and reconstruction of buildings will be launched. • R & D of energy efficient buildings is granted by Ministry of Industry and Trade in programmes EFEKT and TIP. No tax reduction is considered in connection to nearly zero-energy building at the moment.
4)	Financing instruments *(NEEAP)* • Residential sector o Support for the modernization of housing stock by means of building society savings schemes (since 1995) o Regeneration of high-rise pre-fabricated buildings – renamed NEW PANEL Programme in 2009 (since 2001) - Financial assistance for the repair of static defects and improvements in the technical thermal properties o State Housing Development Fund grant for the repair of apartment buildings (since 1998) - Grants to cover part of the costs o Loans to municipalities to upgrade housing (since 2001) o State Housing Development Fund grant for the repair of apartment buildings - repairs are part of the NEW PANEL Programme as of 2010

- Loans to municipalities to upgrade housing
- Green Savings Programme (2009- 2012)
  - Revenue from the sale of carbon credits is revenue of the State Environmental Fund (SEF)
  - Used to promote selected measures to increase energy efficiency, implemented in residential buildings: Energy savings for heating, New construction to nearly zero energy standard, Use of renewable energy sources for heating and hot water.
  - Bonus grant for selected combinations of measures.

- Industry
  - Operational Programme Enterprise and Innovation (OPEI)(2008-2015), among others: Improvements in the thermal and technical properties of buildings
  - Promotion of voluntary energy saving commitments - grants for final energy consumers who undertake to make a certain reduction in energy intensity (since 2011)
- Horizontal
  - MIT and ČSOB rotating fund for the financing of energy saving projects (since 1997)
  - Promotion of energy efficiency under other Operational Programmes (especially the OPE) (2007-2015)
- Planned/Proposed:
  - Systematic support (time limited) from public resources for those investors who seek to meet set mandatory criteria before they are prescribed, e.g. e.g. grants to subsidize the level of interest on loans
  - Subsidy schemes and grants for R&D including co-financing with the business community (p. 52)

(Concerted Action – EPBD)

- Green Savings programme (2009- 2012)
  - Support for heating installations utilising RES and investment in energy savings in reconstructions and new buildings
  - Funds for this programme from the sate of emission credits under the Kyoto Protocol on greenhouse gas emissions
  - Overall anticipated programme allocation is up to 25 billion Czech crowns (about 1,000M€).
  - Subsidy may be granted before or after the implementation of the measure

(Additional Information)

- Incentives are under negotiations.
- nearly zero-energy building research is financed by Ministry of Industry and Trade in programmes EFEKT and TIP. The demonstration projects were created.
- There is a media campaign focused on energy performance of buildings.
- Some demonstration projects were created on Czech Technical University of Prague - faculty of civil engineering. The demonstration buildings were partly suported by Ministry of Industry and Trade.
- Education about very efficient buildings is included in the curricula and training programmes of Universities. CKAIT (Czech Chamber of Authorized civil engineers and technicians)

organizes training courses. Centrum pasivniho domu (Czech Passive house centre) organizes training courses for passive house design etc.
5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard • In force since 2009 *(Concerted Action – EPBD)* • Since 2001, there is a methodology for energy audits and certificates for the building envelope in place • EPCs obligatory since the January 2009 for new buildines (above 50 m2) and renovated buildings (above 1,000 m2) o EPC is an obligation linked to the building permit. o EPC sets minimum requirements for the energy performance of new buildings, as well as for existing buildings under major renovation • Energy performance is expressed by the total annual delivered energy consumption (kWh/m2 p.a.) Primary energy and CO2 emission are not assessed in the energy building certification • Concrete measures leading to savings described, for each measure volume of energy savings is stipulated in technical units, along with financial assessment, amount of investment, simple payback period, and the impact on the energy rating if all measures are implemented. • Owner should present a valid certificate to the buyer or renter when the selling or renting contract is in preparation, but in practice this happens only in the cases described above only if the property is newly constructed or renovated • Ministry of Industry and Trade (MIT) authorises energy experts for certification schemes, keeps the list of authorised experts and annually collects experts' record (number of issued EPCs, energy saving potential and other monitoring indicators). *(Additional Information)* • The energy performance of nearly zero-energy building will be proved by the energy performance certificate. • According to the research (e.g. IEE Project Ideal-EPBD) the energy performance certificates are more trusted when they provide information and recommendations about improvement of the building. So the EPC will include the special recommendations for each building reconstruction. • The EPC are prepared by authorized experts (by Ministry of Industry and Trade) signed and stamped.
6) Supervision (energy advice and audits) *(NEEAP)* • Inspections of boilers and air-conditioning systems are performed in accordance with the EPBD o List of certified persons is published on the MIT website, contains approximately 120 certified energy experts. o Far greater number of certified energy auditors and experts for the production of energy performance certificates for buildings

(NREAP)

- Inspections of efficiency of boilers and air conditioning systems in place through Act No. 406/2000 Coll on energy management

(Concerted Action – EPBD)

- Energy audit (EA) is mandatory for all types of buildings with total energy consumption higher than 1,500 GJ per year
- Part of the energy audit was also the energy certificate with a graphical scale, representing the thermal characteristics of the building envelope
- Authorised energy auditors are registered on a List of Energy Auditors kept by the Ministry
- Inspection of boilers
    - Started in November 2007
    - Obligation does not apply to boilers and internal heat distribution systems in residential buildings
    - Residential owners are provided with consultations and advice, free of charge, by the network of Energy Consultancy and Information Centres (EKIS).
    - Time interval between periodic boiler inspections depends only on the fuel used
- Inspection of AC Systems - since 2007

(Additional Information)

- There are about 1000 independent energy auditors registered by Ministry of Industry and Trade in the Czech Republic. Some of them are experts in nearly zero-energy building and are able to sufficiently advice.
- Moreover Ministry of Industry and Trade supports so called EKIS centers, where independents experts are availabe to advise on nearly zero-energy building free of charge. Another possibility where to get information is to visit Czech Green Building Council or Czech Passive house center.

7) Information (tools)

(NEEAP)

- Awareness – State support for activities leading to the reduction of thermal energy consumption in households (since 2001)
- Proposed (p. 52)
    - From 2013 Information and educational activities in the field of low energy building construction
    - Promotion of international exchanges of information and know-how in cross-border projects

(NREAP)

- Programme for the Promotion of Energy-Saving Measures and the Use of Renewable Energy Sources. Website: www.mpo-efekt.cz, containing all information regarding the possibilities of obtaining subsidies for renewable energy installations. Furthermore, it provides information on energy audits. (p.34)

(Concerted Action – EPBD)

- No official state campaign supporting the EPBD implementation
- Local campaign in the frame of IMPLEMENT projects

- o Started in 2007, raise interest among all target groups regarding the EPBD, energy savings and using urban renewable energy sources

(Additional Information)

- There is a media campaign focused on energy performance of buildings for the general public. Lot of conferences are organized and supported by Ministries for the professionals also non-profit associations are very active in encouraging the market with nearly zero-energy building and promote high performance construction that is both sustainable and profitable.
- The feedback of these campaigns and conferences is used to adjust the legislation

8) Demonstration

(NEEAP)

- Planned: promotion of pilot projects (specific construction of model buildings for each type, with detailed monitoring and publicity)

(Additional Information)

- Some demonstration projects of energy efficient buildings and systems were created on Czech Technical University of Prague - faculty of civil engineering. The demonstration buildings were partly supported by Ministry of Industry and Trade. The projects are not finished yet. Leading role of public sector is not clearly defined yet.
- Other demonstration projects:
  - o Training center of the civic association Moravskoslezsky drevarský klastr, o.s. - passive house, partly granted from EU and operational project OPPI. The building is used for long-term data collection, as a training center and illustrative educational tool. There is installed learning set of several heat sources and heating systems in the building. (http://www.msdk.cz)
  - o Training center INTOZA in Ostrava, the building is the first passive administrative building in the Czech Republic. The building is not only used as headquarters of the firm Intoza, but it is also used for organizing seminars, training and promotion of existing and new technologies in energy savings.
  - o Design of the experimental house by HELUZ in Ceske Budejovice. Building will be used as test of the capability of thermal properties of their products. Project is partly granted from operational project OPPI.
  - o 12 passive houses and training center in Koberovy is the first mass-implemented experimental construction of buildings with the parameters of passive buildings in the Czech republic. The general designer and investor is Atrea Ltd., the design was made in cooperation with the Research Centre CIDEAS of Faculty of civil engineering of Czech Technical University in Prague.

9) Education and training

(Concerted Action – EPBD)

- Specific training course with high passing grades in the exam is required for experts to issue EPC
- Experts in building certification as well as inspectors of boilers and A/C systems have to pass different examinations, but the same expert can be simultaneously authorised to perform more than one of these activities.
- At the end of 2010, there are about 788 authorised experts for EP certification, and 275 authorised experts for inspections

(Additional Information)

- Education about very efficient buildings is included in the curricula and training programmes of Universities.
  - CKAIT (Czech Chamber of Authorized civil engineers and technicians) organizes training courses for civil engineers.
  - Centrum pasivniho domu (Czech Passive house centre) organizes training courses for passive house design.
- Energy auditors and professionals are trained and certified by Association of Energy Auditors under Ministry of Industry and Trade and they will have to be re-trained every 3 years.
- The trainings are regularly revised to consider development.

10.3.1.3 France

France

1) National targets

(NEEAP)

- Targets by Environment Round Table (p.10) (Implemented in national law Grenelle 1 (Programme Law of 3 August 2009)
    - New build: widespread development of low consumption buildings (bâtiments basse consommation, BBC) by 2012 and positive energy buildings by 2020
    - Existing building stock: a 38% reduction in primary energy consumption (by 2020) (no base year mentioned)
    - Target to achieve average primary energy consumption of 150 kWhep/m2/year, compared with a current average of 240 kWhep/m2/year.
    - Most energy-consuming buildings to undergo major renewal at a rate of 400 000 renovations per year between 2013 and 2020 and (p.14)
    - Intermediate renewal of 9 million dwellings (p.14)
    - Aim to begin renovation of audited public buildings by 2012 which should achieve a reduction of at least 40% in energy consumption and 50% in greenhouse gas emissions by State building stock within eight years (p.36)

- 2012 Thermal Regulation
    - Seen to make possible to achieve the BBC (low consumption buildings) standard for new constructions
    - Will allow annual final energy consumption to be reduced by 0.41 Mtoe in 2016 and 1.15 Mtoe in 2020 (assessment only concerns the residential sector and does not take account of gains in the service sector)

(NREAP)

- RES-energy and shares 2020:
    - Reduction of 38% in consumption by housing by 2020 (p.10)
    - Estimated share of renewable energy in the building sector in 2020(%):
        - Residential: 36%
        - Tertiary sector (including public, commercial): 23%
        - no data for industrial
        - total: 32%
    - RES-shares: initial value, target 2020:
        - 2005: 9,6%,
        - Target 2020: 23%
        - Expected amount : 415244 GWh
    - RES-share 2020 by NREAPs
        - Electricity: 155284 GWh
        - Electricity: 13354 ktoe
        - Heating and Cooling: 229442 GWh

- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 27%
  - Heating and Cooling: 33%
  - Overall RES-share (with Transport): 23%
- Share RES-Electricity 2020
  - Hydro: 46,2%
  - Geothermal: 0,3%
  - Solar: 4,4%
  - Tide, wave, ocean: 0,7%
  - Wind: 37,7%
  - Biomass: 11,1%
- Share RES-Heat 2020
  - Geothermal: 2,5%
  - Solar: 4,7%
  - Biomass: 83,4%
  - Heat pumps: 9,4%

2) Regulations

(NEEAP)

- 2005 Thermal Regulation (RT2005)
  - All constructions with building permit after 1 September 2006 must comply
  - Imposes constraints for: overall primary energy consumption of the building for heating, domestic hot water, cooling, auxiliary and lighting equipment
  - Primary energy consumption must be below the reference consumption applicable to that building;
  - Minimum performance of certain components (insulation, ventilation, heating system, etc)
- 2012 Thermal Regulation
  - All new buildings with a building permit lodged after 1 January 2013 must have primary energy consumption below a threshold of 50 kWhep/m2/year
  - Must be applied from 28 October 2011, in the case of public and service buildings
- since 1 January 2008
  - Global RT (for buildings with a surface area of more than 1 000 m2)
    - New buildings with a net floor area of more than 1000 m² must undergo a feasibility study of the various energy supply solutions, and in particular the use of renewable energies and the most efficient systems
    - Requirement also applies to buildings built before 1948 and undergoing major renovation
  - Element-by-element RT
    - Surface area of less than 1 000 m2 or buildings with a surface area of more than 1 000 m2 undergoing minor renovation
    - Regulation sets a minimum performance level for replaced or installed elements

(NREAP)

- Thermal Regulation 2012 (2011-2020 or 1 January 2013 - 2020 depending on the type of building). Current thermal regulations, known as RT 2005, will be reinforced so that all new constructions have a conventional primary energy consumption lower than a threshold of 50 kWh/m2 per year on average

- Private
  - o 400 000 major renovations per year from 2013.
- Public
  - o Reduction of at least 40% in energy consumption and of at least 50% in greenhouse gas emissions in a period of 8 years
- Social housing (p.26)
  - o Reduce their primary energy consumption below 150 kWhPE/m2 per year
  - o Over the first two years of the programme, starting in 2009, 100 000 units of social housing must be renovated
- Private tertiary (service) sector
  - o Improve their energy performance within eight years from 1 January 2012 (not exactly specified)
- Planned/Considered:
  - o Mandatory use of renewable energies in new buildings
  - o For single family houses: choice between either the use of a solar heating domestic hot water production system or the use of a system to take advantage of 5 kWh/m2 per year of renewable energies or connection to a heating network more than 50% supplied by a renewable or recuperated energy

(Concerted Action – EPBD)

- Implementation of the first EPBD completed, transposition of the recast prepared
- 20% tightening of the regulatory requirements for new buildings between 2000 and 2005 (through thermal regulation 2005)
- Grenelle II - Revision of the current legislation signed to accommodate the requirements of the recast of the EPBD

- In May 2006: minimum requirements for new buildings, type and level depend on function of the type of building (dwellings, office buildings, schools, etc.) and may cover (for values see III-142)
  - o Maximum U-values for windows, walls, roofs and ceilings
  - o Requirements on average insulation level
  - o Maximum primary energy consumption per m2 of floor area
  - o Maximum interior temperature in the summer.

- In 2007: minimum requirements for the installation of new building components, during building renovation and extensions of existing buildings
  - o Requirements for fossil fuel heating are the same as those for new buildings, performance levels for electric heating are less demanding
  - o After major renovations a minimum rating has to be achieved (B)

- New thermal regulation RT-2012 has to undergo some minor modifications before being put into effect on January 2013. It mandates that all new buildings must need less than 50 kWh of primary energy per m². (III-141 - III-143)

3) Economic incentives

(NEEAP)

- If maximum consumption 10% lower than set by Thermal Regulation/Achieving the BBC level possible to claim various forms of financial support---> see also financing instruments
- Exemption from property tax on existing buildings (TFPB) of 50% or 100% for new dwellings completed after 1 January 2009 and holding the BBC label
- Zero-rated loan (PTZ) (amounts increased to €15 000 for households of between one and three persons and €20 000 for households of four persons or more)
- Tax credit for loan interest (so-called TEPA tax credit), increased for dwellings with BBC label, period of the tax credit increased from five to seven years, the rate maintained at 40% for the entire period

- From 1 January 2011
  - PTZ and TEPA tax credit provisions are replaced by new provision known as PTZ+: amount of PTZ+ varies according to the location of the dwelling and whether it is new or old and its energy performance, only new dwellings with the BBC label and old dwellings in DPE (Energy Performance Diagnosis) class A to D are eligible for maximum loan percentage
  - Aid for investment in rental property ('Scellier' provision) also depends on a dwelling's energy performance: the applicable tax rate reduction is less for dwellings without BBC label: it falls to 13% in 2011 and then 9% in 2012 for non-BBC dwellings, while being maintained at 22% in 2011 and then 18% in 2012 for BBC dwellings

4) Financing instruments
(NEEAP)

- Sustainable Development Tax Credit (CIDD) (since 2007)
  - Tax credit to purchase the most efficient materials or equipment in the area of energy saving (for existing build only) or of production of energy from renewable sources (for new and existing build)
  - Eligible for tax credit: low-temperature boilers (BT - until 2008), condensing boilers, insulation of opaque and glazed walls, solar water heaters (CESI), heat pumps and wood-burning heating appliances
  - Finance Law for 2009 renewed this mechanism until the end of 2012 and extended it to social landlords
  - Benefited more than 1.5 million households in 2009 at an estimated tax cost of €2.6 thousand million
- Zero-rated eco-loan (éco-PTZ) (since 1 April 2009)
  - Interest-free loan designed for owner-occupiers or landlords to finance major renovation work
  - Loan finances up to €30 000 of work to improve the energy efficiency of a dwelling over a period of 10 years
- Exemption from property tax on existing buildings (Finance Law for 2006),
  - Exemption from property tax on existing buildings for five years, at an exemption rate of 50% or 100%, for structures completed by 1 January 1989 in which significant work eligible for Sustainable Development Tax Credit had been undertaken
- Relief on property tax on existing buildings (TFPB) (p. 186)
  - HLM (low-cost housing) agencies or SEM (mixed investment companies) that carry out

energy saving work

- o Equal to a quarter of expenditure committed during the year preceding the year in which the tax is due
- o Lower VAT rate for renovation work (5.5% instead of 19.6%).

- Sustainable Development Account (LDD)
  - o Grants low-cost loans to finance energy saving work in dwellings built more than two years ago
  - o Work that qualifies for financing is that eligible for Sustainable Development Tax Credit.
- 'Live Better' Future Investments programme
  - o €500 million support programme for thermal renovation of buildings for owner-occupiers with modest incomes
- Relaunch Plan (2009)
  - o €200 million devoted to energy renewal of State buildings, split into €50 million for energy audits and €150 million for works

(NREAP)

- Individuals/Residential
  - o Sustainable Income tax credit
  - o Reduced rate VAT
  - o Zero rate eco-loan
- Other: Renovation of social housing and public buildings
  - o Targeted: council housing managers, State, local and regional
  - o Thermal renovation of all of these homes by 2020
  - o Social housing eco-loan, on average 12 000 euros at a fixed rate of 1.9% over 15 years

(Concerted Action – EPBD)

- The sustainable development tax credit (Crédit d'Impôt Développement Durable) incites citizens to install very high energy performing equipment, single person can be reimbursed an amount of 8,000 €, and a couple 16,000 €.
- The zero percent eco-loan (éco-prêt á taux zéro) aims at financing energy renovation, If people order two types of work, they can receive a zero percent loan for 20 000 €, and 30 000 € for three types of work
- The tax for energy renovation in existing buildings has been reduced from 19.6% to 5.5%, in order to encourage renovations. (III-140 - III-141)

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- Maintenance/Performance certificate for heating systems since 2006
- Energy Performance Diagnoses (DPEs)
  - o New buildings and new parts of buildings for which the building permit application was lodged after 30 June 2007;
  - o Required in metropolitan France by both private individuals and professionals when any dwelling or building is sold
  - o For residential or service buildings offered for rent
  - o In public buildings open to the public; the DPE must then be displayed in the entrance hall of the building
  - o Since 1 January 2011, it has been mandatory to display the DPE 'energy' label in property

advertisements.

- Two energy performance - renovation labels
    - ‘High energy performance - renovation, HPE 2009’ label for buildings achieving primary energy consumption below 150 kWhep/m2/year
    - ‘Low energy consumption building - renovation, BBC 2009’ label for buildings achieving primary energy consumption below 80 kWhep/m2/year.

(NREAP)

- Thermal Regulation 2005 - "haute performance énergétique" ("high energy performance") label confirms that the building achieves an overall energy performance level higher than regulatory requirements
- BBC 2005: low energy consumption building This level is aimed at buildings with a much lower consumption than the regulatory energy consumption
- Energy Performance Diagnosis - since 2007, goal: More information for buyers, occupants and visitors
- Energy savings certificates - since 2005, goal: Increase in the number of actions allowing for energy savings or producing renewable heat, in homes and industry

(Concerted Action – EPBD)

- "Dìagnostíc de Performance Energétigue" (DPE)
    - 2005: certification transposed into French legislation through the Building Code
    - As of January 2009, al existing residential and non-residential buildings need to be certified when they are sold or rented
    - Public buildings: certificates have to be displayed in buildings over 1,000 m2
    - Defines energy consumption of the dwelling or building and the impact of this consumption on the greenhouse effect
    - Shows calculated or measured consumption of heating, cooling and domestic hot water, in final and primary energy and the corresponding costs
    - Buildings labelled from A to G depending on the energy consumption
    - Recommendations include a short description, estimates of costs, savings, paybacks and the impact on the energy rating if all measures implemented
    - Validity 10 years
    - In collection of EPCs in a database is nearly completed.
    - Basic calculation methodology is called 3CL (Conventional Consumption Calculation in Housing)
    - Experts have to be certified by an accredited body and have to pass a practical and theoretical exam, no educational or experience background is required
    - At the end of 2010, there are about 4,000 qualified Experts for issuing EPCs

6) Supervision (energy advice and audits)

(NEEAP)

- Audit of Pubic building stock
    - 40 % in 2009, 100% in 2010
- Requirement for annual maintenance of boilers (between 4 and 400 kW)
    - Since October 2009
    - Certificate by expert: evaluation and advice
    - Integrate environmental, energy and public health issues at the same time

- Regular checking of boilers (> 400 kW)
    - o Subject to minimum energy performances (not defined)
    - o Operators required to install equipment, to check and measure performance & assess combustion quality.
    - o Mandatory check every two years to ensure they meet minimum regulatory performance standards
- Advice in National Law
    - o Article L. 224-1 of the Environment Code
    - o Customised advice to users during regular boiler visits
    - o Provision of advice at national level on the most efficient heating systems, on improving the energy performance of buildings and on financial support.

(NREAP)

- all buildings belonging to the State and its government-owned corporations will be subject to an audit in 2010 with the aim of initiating their renovation by 2012 (p. 26)

(Concerted Action – EPBD)

- Provision of advice during periodic inspections (since 2009)
    - o Boilers from 4 to 400 kW
    - o Boilers from 400kW to 20 MW (stricter and the professional has to be qualified according to ISO standard 17020).
    - o Reports are not (yet) collected in a central database.
    - o Inspection of air conditioning systems and reversible heat pumps with an output of 12 kW or more (Since April 2010) by a certified expert is mandatory at least every 5 years. (III-137 - III-138)
    - o At the end of 2010, the cert¡ficat¡on bodies were still in the process of accred¡tation. Therefore, no inspector is yet certified.
    - o

7) Information (tools)

(NEEAP)

- Maintenance certificate (for boiler inspection) - intended as a regular and customised awareness-raising and information tool
- Publicity regarding annual boiler maintenance
    - o Guide aimed at private individuals published in December 2009 (more than 50 000 distributed in first half of 2010)
    - o Sector professionals produced guide for professionals to ensure early correct application of the new regulations
    - o MEDDTL website (www.developpement-durable.gouv.fr) sets out the provisions of the new regulations
- ADEME and Ministry publicity campaigns
    - o conducted to promote most efficient heating systems and to inform about financial support for replacement
    - o campaigns covered improving energy performance of a building as a whole and possible financial or tax support
- Energy Info Sites
    - o National network to inform and advise private individuals
    - o Organised by ADEME and local authorities

- o Since 2001 purpose is to give advice on energy efficiency and renewable energy sources at local level
- o There are 230 centers, with around 400 advisers

(NREAP)

- Energy Information Spaces (since 2000) (p.17) - goal: Increase in the number and quality of thermal renovation projects
- ADEME campaigns (p. 17) - goal: Awareness towards global warming and thermal renovation

(Concerted Action – EPBD)

- Ministry has published guidebooks to inform the citizens and experts on the several aspects of the regulations, such as thermal regulation, EPC, financial incentives and renovations.
- A directory of experts certified to issue EPCs has been set online.
- Guide for the public regarding annual maintenance of boilers published and can be downloaded form the Ministry's website.
- Espaces Info Energies - in 230 locations around 400 trained advisors give information on energy efficiency and renewables sources at the local level.

8) Demonstration

(NEEAP)

- ADEME Demonstrator Fund - €1 350 million programme, placed under ADEME management, to finance demonstrators in relation to renewable energies and green chemistry (p. 45)

(Additional Information)

- Training center of the civic association Moravskoslezsky drevarský klastr, o.s. - passive house, partly granted from EU and operational project OPPI. The building is used for long-term data collection, as a training center and illustrative educational t *(...???)*

9) Education and training

(NEEAP)

- Number of mechanisms have been put in place at the initiative of professionals and/or public authorities--> (p.42,135)
- Examples of Programs supported by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
  - o Housing Improvement Club - implemented a training mechanism dedicated to the basics of building renovation crafts: it involves an online learning management system for construction professionals
  - o PRAXIBAT programme - helps regional to allocate equipment to training centres to implement solar thermal, photovoltaic, wood-burning and heat pump energy)
  - o BEEP (built environment - professional space) network - since 2006 this network has sought to pool knowledge and know- how
  - o PREBAT2 (programme de recherche et d'expérimentation sur l'énergie dans les bâtiments,Research and Testing Programme on Energy in Buildings)
    - Launched in 2010 to cover the period 2010-2015.
    - National mechanism to coordinate and be responsible for public research concerning energy in buildings
  - o The Construction-Energy Foundation aims to provide financial support, over at least five years, for research operations

(NREAP)

- Qualification/certification programs (Progress Report 2011)
  - Regulatory, non-binding
  - Aim: Improved quality of thermal renovations and renewable energy production installations in buildings
  - Targeted: Building professionals

10.3.1.4 Germany

Germany

1) National targets

(NEEAP)

- Reduction in the heat requirement of the building stock by 20% by 2020 and in the primary energy requirement by 80% by 2050, with the aim of achieving an almost climate-neutral building stock by 2050
- Doubling of the renovation rate for buildings from 1% to 2% of the entire building stock annually - renovation roadmap for buildings in the stock begins in 2012 and by 2050 leads continuously to a target level for a reduction of 80% in the primary energy requirement
- Overall savings for the buildings and installation area amount to 775 PJ in the period 1995–2016
- Expected savings in the construction sector for the 2008–2016 commitment period amount to 610 PJ (p. 33)

(NREAP)

- RES-energy and shares 2020
  - RES-shares: initial value, target 2020
    - RES-share 2005: 5,8%
    - Target 2020: 18%
    - Expected amount : 412698 GWh
  - RES-share 2020 by NREAPs
    - Electricity: 216935 GWh
    - Electricity: 18656 ktoe
    - Heating and Cooling: 167801 GWh
  - RES-share 2020 by NREAPs (data source: Table 3)
    - Electricity: 38,6%
    - Heating and Cooling: 15,5%
    - Overall RES-share (with Transport): 19,6%
  - Share RES-Electricity 2020
    - Hydro: 9,2%
    - Geothermal: 0,8%
    - Solar: 19,1%
    - Tide, wave, ocean: 0,0%
    - Wind: 48,1%
    - Biomass: 22,8%
  - Share RES-Heat 2020
    - Geothermal: 4,8%
    - Solar: 8,6%
    - Biomass: 78,7%
    - Heat pumps: 7,9%

(Additional Information)

- Until 2050 reduction of greenhouse gas emissions between 80 and 95% compared to 1990

(2020: 40%)

- Until 2050 reduction of primary energy consumption by 50% compared to 2008 (2020: 20%)
- Unitl 2050 reducing the electricity consumption by approximately 25% compared to 2008 (2020: 18%)
- Until 2050 development of renewable energy sources at a fraction of 60% for gross final end energy consumption (2020: 18%) and 80% of gross electricity consumption (2020: at least 35%)
- Until 2050 reduction of heat consumption in buildings by 80%
- climate neutral building stock up to 2050
- to increase the number of renovation from 1 % to more than 2 % per year

2) Regulations

(NEEAP)

- Energy Saving Order (EnEV) and its amendments (EnEV 2002, EnEV 2009) (p. 34)
  - Sets minimum requirements for the energy-related quality of the building shell and the system technology for new buildings and for larger renovations of existing buildings
  - Energy-related minimum requirements were tightened by 30 % (for residential) on average by the most recent amendment in the year 2009
  - Further amendment envisaged for the year 2012.
- Act on the Promotion of Renewable Thermal Energy (EEWärmeG) (since 2009)
  - Encourage the expansion of renewable energies in the heating and refrigeration sector
  - Imposes the use of renewable energies, including from solar heating systems or heat pumps, in the construction of new buildings (so-called obligation to use)
- Heating Costs Order (1981, revised version in force since 2009) (p. 39)
  - Creation of incentives for the economical use of energy through the consumption-dependent determination (increased to 70 %) and billing of heating and hot water costs
  - Incentive for reachingpassive house standards (heating requirement less than 15 kWh/m2) is created by the provisions of the Heating Costs Order in conjunction with the building and the renovation of multiple dwelling units

(NREAP)

- Renewable Energies European Law Adaptation Act (EAG EE): Approved by Bundesrat (German upper house) on 18.03.2011; goal: EAG EE has caused amendments to the EEG, Renewable Energy Heat Act, Energy Statistics Act, Building Code, Building Construction Statistics Act and in the Biomass Sustainability Regulation. The focus areas of the EAG EE are the introduction of an electronic national register of guarantees of origin and for public buildings to act as good examples of using renewables.
- Renewable Energies Heat Act (EEWärmeG): since Jan 2009; Amendments through EAG EE of 18.3.2011, particularly introduction of role model function for public buildings, specification of rules on RES cooling
- Energy Saving Regulation (EnEV): in force since 2002, EnEV 2009 tightened and adapted to the new directive on energy performance of buildings (Directive 2010/31/EU) ; goal: Respect for minimum standards for heating and energy efficiency of buildings, as well as cooling facilities in renovation and new builds of residential and non-residential properties (Table 2)

(Concerted Action – EPBD)

- In Germany the requirements concerning the energy performance of buildings reach back a long time (Wärmeschutzverordung since 1977) and the requirements have been continuously increased. The last amendment of the Energy Saving Ordinance came into force in October 2009 and strengthened the level of requirements by 30% on average. Additionally it has been compulsory to use renewable energies for heating in new buildings according to the Renewable Energie Heat Act (Erneuerbaren-Energien-Wärmegesetz). Minimum requirements were set for the energy efficiency of the building envelope components and for the specific transmission heat loss, witch is calculated with the help of a reference building. For existing buildings there are also minimum requirements for building components in case of modification. In 2012 the Energy Saving Ordinance will be amended and may be tightened again by up to 30% according to the Recast EPBD. Additionally the standard for nearly zero-energy buildings is in preparation. (III-79 - III-80; III-87 - III-90)

(Additional Information)

- Roadmap - the introduction of energy performance requirements is defined in the amendment of Energy Management Act 406/2000 Coll. As mentioned above, requirements for new nearly zero building will be introduced gradually according to the size (floor area) of buildings since 2016 for building owned by public authorities (2018 other buildings).
- beside EPBD-"definition" no explicit governmental definition of nearly zero-energy building performance standard available
- update of EnEV 2009 in 2012 or 2013, further updates possible before 2020
- changes in feed-in tarifs in EEG from 01.04.2012
- minimum amount of renewable energy generation regulated by Erneuerbare-Energien-Wärme-Gesetz (EEWärmeG)
-

3) Economic incentives

(NEEAP)

- Ecological tax reform acts as a cross-sector instrument across all spheres of activity (p.32)
- Market incentive programmes (MAP) – BAFA part (since 1999)
  - Strengthen the sale of technologies for renewable energies through investment incentives
  - Grant provided by the Federal Office of Economics and Export Control (BAFA).
- Market incentive programmes (MAP) – KfW part (since 2007)
  - Strengthen the sale of technologies for renewable energies through investment incentives
  - Low-interest loans and redemption subsidies provided by the KfW (premium programme part).

- Länder activities in the buildings sector (since 1995) (p. 37) - Several programs by states.

(Additional Information)

- R & D: to increase the funding for research in the sectors of Energy efficiency (+ 60 %) and Renewable Energies (+ 100 %) (not only building sector) from 2010 to 2014
- Funding concept „Solarthermie2000plus“ (BMU)
- Funding concept „Solares Bauen – energieeffiziente Stadt“
- Funding concept "EnEff:Wärme - Forschung für energieeffiziente Wärme- und Kältenetze"
- Funding Program for Plus Energy Houses ("Häuser nach dem Plus-Energie-Standard"), renamed to "EffizienzhausPlus" (www.bmvbs.de/SharedDocs/DE/Artikel/B/effizienzhaus-plus-infos-zum-projekt.html?nn=36330)

- Competition "EffizienzhausPlus im Altbau"
- Competition "Wettbewerb energieeffiziente Stadt" (BMBF)

4) Financing instruments
(NEEAP)
(note: Only current and recently finished programs mentioned)

- Private
  - KfW CO2 building renovation programme (2001- 2009)
    - Promotion of the energy-related renovation of existing buildings through low-interest loans
    - Direct grants were awarded from 2007 onwards, subject to certain conditions, as an alternative to low-interest loans
  - KfW Modernisation of Living Space. Eco Plus (2005- 2009)
    - Supported individual measures in the building sector by means of long-term, low-interest loans -->Continuation of the programme as an element of the KfW energy-efficient rebuilding programme
  - KfW Ecological building (2005- 2009)-->continuation in KfW Energy efficient building
  - KfW Energy-efficient rebuilding (since 2009)
    - Promotion of renovations of the existing building stock, according to which the buildings standard concerned exceeded
    - Investment grant or alternatively is in the form of low-interest loans
    - Depending on what KfW energy-efficient house standard is achieved, the grant amounts to up to 13 125 euro per dwelling unit. For individual measures, the grant amounts to up to 2 500 euro per dwelling unit
  - KfW Energy efficient building (since 2009)
    - Promotion of new buildings which exceed the applicable building standard: KfW energy-efficient house 70, 55, 40 as well as the passive-house standard.
    - Financing is provided for a maximum of 50 000 euro per dwelling unit, and a maximum of 100% of the eligible costs
- Planned
  - For the years 2012 to 2014 the funds of the CO2 building renovation programme will be increased to 1.5 billion euro annually
- Public
  - KfW Energy-efficient rebuilding – Municipalities (since 2009)
  - Direct loans to municipalities for the energy-related renovation of schools, school sports halls, day-care facilities for children and buildings used in connection with child and youth work
  - Funds in the order of 10 billion euro in total are currently available via the second Economic Stimulus Package of the Federal Government in effect from 2009 to 2011 for additional investments in infrastructure measures in public buildings
- SME
  - Environmental and Energy Efficiency Programme (part B)
    - Implemented by KfW
    - Low-interest loans are made available to SMEs for the implementation of

energy efficiency

- Measures for the optimisation of buildings or processes
- Loans amounting to 675 million euro in total were granted in the year 2010

(NREAP)

- Market incentive program (MAP): Support in places since 1999, new conditions since 15 March 2011; goal: Investment in renewables in the heating sector
- KfW promotional programs for Energy-Efficient Construction and Renovation

(Concerted Action – EPBD)

- The CO2 building refurbishment program of the KfW Bankengruppe promotes measures for saving energy and reducing CO2 emissions in residential buildings by financing corresponding measures at low interest rates and in the long term. It is linked to the requirements included in the current Energy efficient Ordinance. (III-86)

(Additional Information)

- Different options for lowered loans or government grants by KfW Bankengruppe for new buildings and renovations, KfW-standard
- Erneuerbare Energie gesetz (EEG)

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- Energy certificate
  - Requirement to be issued to every owner of a new building.
  - Since 2009: vendor, landlord or lessor required to make a building energy certificate available to the potentially interested party in the event of sale, rental or leasing
  - Contains: details of the year of construction, type of use of the building, building floor space, type of heating, hot water production and the type and proportion of renewable energies, modernisation recommendations
  - Validity of 10 years
  - 1.9 million building energy certificates for residential buildings had been issued by May 2009

(NREAP)

- Programmes

(Concerted Action – EPBD)

- An Energy Performance Certificate has been compulsory for new buildings and major refurbishments since 2002. There are two types of certificate: certificates based on calculated demand, mandatory for all new and major refurbished buildings, and certificates based on the metered consumption. In case of minor renovation the type of calculation method can be chosen. The certificate consists of information on the building, the calculation method and recommendations for cost efficient modernization given by the assessor. It is valid for 10 years. The method of calculation is described in the standard DIN V 18599 and considers the building envelope the lighting and the systems for heating, ventilation, cooling and hot water. Consumption based certificates are determined on the basis of a record of heating costs for at least 36 continuous months. Issued certificates do not have to be reported and there is no central register. So far no independent control system has been stipulated. In contrast to other member states, in Germany there is no official software for energy certificates. But private sector software suppliers have joined together in 2009 to form a "Quality community 18599" to ensure the quality of their products. (III-80 - III-83)

- The qualification required for certificate assessors are described comprehensively and conclusively in the Energy Saving Ordinance. There is no official approval certification. (III-85)

(Additional Information)

- energy performance certificates for all buildings available, no actual plans for nearly zero-energy buildings

6) Supervision (energy advice and audits)

(NEEAP)

- BAFA On-site advice (since 1998)
  - o On-site advice by approved energy advisors, which relates extensively to heat insulation in buildings as well as heat production and distribution including hot water production and the use of renewable energies, is eligible for funding
- Advice on Contracting for Federal Government properties (p. 70)

(Concerted Action – EPBD)

- In Germany, regular inspection of boilers has been mandatory for many years and to a much greater extent and at shorter intervals than those provided for in the EPBD. Air conditioning units with a thermal output of more than 12 kW have to undergo an inspection by a specialist engineer every 10 years, who the condition of the system and provides recommendations according to the EPBD for the improvement of efficiency. (III-84)

7) Information (tools)

(NEEAP)

(note: many more information programs (p.71), only a few mentioned)

- Energy hotline and Internet platform
  - o Provide end consumers as well as specialists with information about the various kinds of energy production, the rational use of energy and renewable energies
  - o In 2010 alone there were more than 2 600 written inquiries and around 9 700 telephone inquiries
- Energy saving guidelines
  - o Aimed at private households and private enterprise as well as the public sector
- Energy efficiency initiative
  - o Targeted with the help of intensive public relations activities, such as the provision of information brochures and Internet sites, fundamentally at around 40 million private households, at industry and trade and also at service providers

- "House of the Future" campaign
  - o Targeted at house owners, tenants, engineers and architects as well as the construction industry, municipalities and house building companies

- Municipal and national heating survey
  - o Heating assessments and the associated information campaigns

• Heat from renewable energies o Targeted at house owners, tenants, energy advisors and other technical experts o Aim is to explain the use of renewable energies in the construction sector to the relevant market actors and to provide them with detailed information. • *"Climate Seeks Protection" campaign (by co2online) among others* ***concerned with concerns*** *itself with the following topics: information on energy-related building renovation, energy-efficient heating and cooling systems*
8) Demonstration •
9) Education and training •

10.3.1.5 Greece

Greece

1) National targets

(NEEAP)

- *"new buildings should cover their entire primary energy consumption with energy supply systems based on renewable energy sources" v*

(NREAP)

- RES-energy and shares 2020
  - RES-shares: initial value, target 2020
    - RES-share 2005: 6,9%
    - Target 2020: 18%
    - Expected amount : 50477 GWh
  - RES-share 2020 by NREAPs
    - Electricity: 28973 GWh
    - Electricity: 2492 ktoe
    - Heating and Cooling: 22186 GWh
  - RES-share 2020 by NREAPs (data source: Table 3)
    - Electricity: 39,8%
    - Heating and Cooling: 19,7%
    - Overall RES-share (with Transport): 18,0%
  - Share RES-Electricity 2020
    - Hydro: 22,7%
    - Geothermal: 2,5%
    - Solar: 12,4%
    - Tide, wave, ocean: 0,0%
    - Wind: 58,0%
    - Biomass: 4,3%
  - Share RES-Heat 2020
    - Geothermal: 2,7%
    - Solar: 18,6%
    - Biomass: 64,1%
    - Heat pumps: 14,6%

(Concerted Action - EPBD)

- "Building the future" program:
  - Refurbishing of 54,000 buildings until the end of 2014 (III- 154)

(Additional Information)

- Until 2050 reduction of primary energy consumption by 50% compared to 2008 (2020: 20%)

2) Regulations

(NEEAP)

- Effective implementation of regulatory measures started only at the beginning of 2011
- Law 3661/2008 on the energy efficiency of buildings
  - Targeted at all buildings with surface area of more than 50m2, either new or existing, which undergo complete renovation, existing buildings with surface area of more than 50m2 or parts thereof, when they are sold or leased, and all buildings of the public

sector.

- Focuses exclusively on energy efficiency in the building sector with the implementation of new regulation on the energy performance of buildings (KENAK), setting two key requirements:
  1) submission of a Study on the Energy Performance of Buildings for issue of a building permit,
  2) performance of Energy Inspections to Buildings, Boilers, Heating and Air Conditioning Systems.

- Law 3851/2010 on the acceleration of the development of Renewable Energy Sources and climate change
  - by 31.12.2019, all new buildings should cover their entire primary energy consumption with energy supply systems based on RES, electricity and heat cogeneration, district or block heating systems, and heat pumps with seasonal performance factor (SPF)
  - by 31.12.2014 new buildings where government and public services are housed, this obligation should enter into force

- Law 3855/2010 on the improvement of the energy end-use efficiency
  - if building permit is submitted after 1.1.2011 required to cover part of needs for domestic hot water with solar thermal systems, minimum percentage of solar share on an annual basis is set to 60%
  - requirement does not apply to exceptions referred to in Article 11 and when demand for domestic hot water is covered by other energy supply systems based on RES, electricity and heat cogeneration, district or block heating systems, and heat pumps with seasonal performance factor (SPF)

(NREAP)

- Energy Performance of Buildings Regulation KENAK (OG 407/B/2010)
  - obligation for new or refurbished buildings to meet 60% of their needs for hot water through solar thermal systems

(Concerted Action - EPBD)

- 60% of Domestic Hot Water should be provided by Solar Thermal or Alternative Systems and from 2020 all new buildings should cover their primary energy consumption using RES, CHP, District Heating or high efficiency Heat Pumps (for Public Buildings the provision is form 2015) (III-154)

- New Buildings
  - energy study must prove that all new buildings are classified at least as B
  - all applications for building permits after the 1't of October 2010 must be accompanied by an Energy Study that proves that the building under planning is in compliance with minimum requirements which depend on type of building (dwellings, tertiary sector buildings)
    - Design of the building
    - Maximum U-value for walls, windows, roofs

        - Maximum value for the average U value for the whole building
        - At least 50% heat recovery in the central air conditioning units
        - At least 60% hot water production from solar panels
        - Minimum requirements for the U-values differ in climatic zones (see III-154)
- Existing Buildings
    - undergoing major renovation should be upgraded in order to be classified at least as B

(Additional Information)

- No standard on nearly zero-energy buildingsis available. The recast of EPBD is implemented in the National Law. All public buildings have to be nearly zero-energy buildings after 2015. It seems that this is under revision and nearly zero-energy buildings will be mandatory after 2019. A new building regulation based on the recast is under preparation. The new regulation will define the roadmap for nearly zero-energy buildings. The new Building construction (law?) that has been voted on in the Parliament offers specific credits for nearly zero-energy buildings and in particular 20 % more space to built in the specific land. No other regulations are available.

3) Economic incentives

(NEEAP)

- since 2000: Tax exemptions for energy saving interventions for expenditures for building upgrade interventions following energy inspection (p. 46)
    - deduction of expenses from taxable income of 20% of expenditure for amounts of up to 3 000 Euros and of 10% of expenditure for amounts of between 3 001 and 6 000 Euros

- Energy upgrading of existing buildings through Energy Services Companies through Energy Performance Contracts (EPC), Third-Party Financing (TPF) and Public and Private Joint Ventures (PPJV)(Start: 2012) (p.49)
    - institutional /financial
    - targeted: Buildings of the residential and tertiary sectors

- Residential
    - "Energy saving at home" programme (OIK1 measure) (start 2/2011)
        - financial aid for the upgrading of heating system boilers / burner units in existing buildings
        - eligible budget per beneficiary application ≤ 15,000 Euros
    - Regional Operational Programmes (ROP) and the Operational Programme "Competitiveness and Entrepreneurship" (OPCE) and "Environment and Sustainable Development" (OPESD)
        - financed by European Regional Development Fund (ERDF) and national resources
        - Category A: Owners of eligible residences whose individual or family declared income does not exceed 40,000 Euros or 60,000 Euros, incentives include 100% interest subsidy (interest-free loan) as well as 35% grant
        - Category B: Owners of eligible residences whose individual or family declared income is between 40,000 and 60,000 or 60,000 Euros and 80,000 Euros

respectively, 100% interest subsidy (interest-free loan) as well as 15% grant

- Public
  - o budget of €15 million for installation of high-efficiency CHP units in conjunction with natural gas cooling systems in hospitals

(NREAP)

- Programme "Exoikonomo" for energy efficiency in municipal building, stock, lighting and transport: energy conservation upgrades of residential buildings are eligible for funding.
- Tax incentives are in place for the owners who install solar collectors and implement RES/EE measures in their buildings. (p. 46)

(Concerted Action - EPBD)

- Major Energy Saving Programmes for buildings
  - o (all require the issue of an EPC and/or audit procedures)
  - o Private houses, 'Energy Saving at Home', direct subsidies (up to 30%) and low rate bank loans (covering the remaining share of the investment)
  - o Municipal Buildings, 'Save Energy' (covers 100% of the expenses), Public Buildings (100% of the investment costs, Schools (100% of the investment costs.)

(Additional Information)

new Building construction that has just voted in the Parliament offers specific credits for nearly zero-energy buildings and in particular 20 % more space to built in the specific land

4) Financing instruments (see economic incentives)

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- Requirement for Energy Performance Certificate in case of purchase, sale and lease of buildings from January 9, 2011.(p. 54)
  - o A private energy inspector, who has joined in the Energy Inspectors Record of YPEKA, shall inspect the building and place it in an energy category based on the ratio of the building's consumption to the reference building's consumption

(NREAP)

(Concerted Action - EPBD)

- Obligatory for new buildings with a building permit issued after the 1st of October 2010
- display of the certificate is compulsory for public buildings
- certificate is required as a legal document in the case of rental or sale of buildings after the 9th of January 2011
- EPC issued by energy auditors, who are listed in the official registry of auditors (provisional for the time being)

- displays "normal" features such as basic data, classification, calculated primary energy consumption, calculated CO_2, recommendations etc. (III- 148)
- so far 4 000 issued certificates
- majority of certificates is issued for setting a property or for applying for the Programme 'Energy Saving at Home'

(Additional Information)

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6) Supervision (energy advice and audits)

(NEEAP)

(NREAP)

- Inspection is carried out by certified energy inspectors of boilers of those buildings heated with ordinary fossil fuels, as follows:
  a) at least every five (5) years, of boilers with total net nominal capacity of twenty (20) to one hundred (100) kW,
  b) at least every two (2) years, of boilers with total net nominal capacity higher than one hundred (100) kW and, if they are heated with gas fuel, at least every four (4) years (p.49)
- Inspection is carried out by certified energy inspectors of the air conditioning installations of buildings, with total net nominal thermal / cooling capacity higher than twelve (12) kW, at least every five (5) years.

(Concerted Action - EPBD)

- Energy Building Code and the Technical notes issued by the Hellenic Technical Chamber describe in detail the procedures for auditing boilers, heating systems and air-conditioning units
- not obligatory to perform audits until July 2014

(Additional Information)

- Guidelines issued by CRES based on the nearly zero-energy building demonstration project. Not official documents

7) Information (tools)

(NEEAP)

- Implementation of Energy Management System
- Compulsory implementation in all public sector buildings (from 2012) and buildings with overall surface area exceeding 1 000 m2 (p. 58)

- Electronic/intelligent metering of electricity and natural gas cosnumers (start 2009) targets (among others) residential/tertiary buildings

(NREAP)

- In 2008, during the national campaign for the promotion of RES, CRES prepared and distributed guidebooks for the assessment, evaluation, environmental impact and installation procedure for all different RES technologies (p. 42)

(Concerted Action - EPBD)

- A software tool was developed with funding from the Hellenic Technical Chamber to calculate energy performance (III -146)
- CRES
  - o database development on energy auditors and maintenance, together with the development and operation of the Energy Certificates database
- Main campaign for the issue of EPCs is combined with the campaign of the 'Energy Saving at Home' programme (radio and TV commercials, targeting the general public was launched by the Banks that are involved in the programme)
- Ministry (MEECC) has produced a brochure including general information on the energy efficiency of buildings, the Energy Certificate and the new Energy Building Code. *(Additional Information)*
- Campaigns, websites and dissemination are foreseen only for the nearly zero-energy building demonstration project. No general campaign on nearly zero-energy buildings.

8) Demonstration

(NEEAP)

- "Building the Future" Project (start 2011)
  - o partnership between the public sector, construction industry and citizens
  - o Voluntary agreements on energy savings
  - o demonstration of innovative systems and products for large-scale demonstration projects
  - o industrial and applied research to develop innovative products

- Compulsory procurement procedures with respect to public buildings (green procurement – energy-efficient and RES technologies)
- Implementation of Green Roofs to public buildings (from 2011) (p. 90) (€ 20 million)
- Interventions for improving energy efficiency in school buildings (from 2011)
  - ▪ financing for the programme “Bioclimatic Demonstration Schools”: 25 million Euros
- Total financing of the programme "Model demonstration projects on the use of RES and/or ES in public buildings":40 million Euros
- Energy upgrading of social housing buildings-“Green Neighbourhood” programme (€ 7 million)

(NREAP)

(Concerted Action - EPBD)

(Additional Information)

- A large demonstration project on nearly zero-energy residential buildings . The Green Neighbourhood is under construction. It involves the retrofitting of 4 blocks of social residential buildings into nearly zero-energy buildings. The first block is almost ready.
- The project is designed and constructed by CRES with voluntary agreements with industry. The cost of the project is close to € 7 million.

9) Education and training

(NEEAP)

(NREAP)

The guidance is provided through technical seminars and workshops organised regularly mainly

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from CRES and the Technical Chamber of Greece.

(Concerted Action - EPBD)

- Training of Experts for Energy audits and the issue of EPCs is outlined in the new regulation:
  - foresees 120 hour training courses and exams, and is going to be organised by the Hellenic Technical Chamber and will start at the end of 2010
  - training courses can also be carried out by other academic institutions
  - Qualified experts should be engineers and architects with at least 3 years of experience
  - Training of Trainers is already under way since September 2010 and will be completed at the end of 2010.
  - Inspectors responsible for incorrect inspections and EPCs will incur penalties, such as fines or temporary or even permanent suspension of their qualification

    (Additional Information)
- Many educational and training projects by the private sector (but not embedded in higher organizational structures)

10.3.1.6 Hungary

Hungary

1) National targets

(NEEAP)

- construction of approx. 30 000 to 60 000 new buildings can be expected annually following 31 December 2020 (four-fifths residential buildings)
- construction of buildings with low energy demand expected to rise significantly between 2015 and 2020, annual number of new buildings with low energy demand could be approx. 100 to 1000
- Quantified policy target values are set out in Chapter 2.2 of the New Széchenyi Plan on Energy Efficiency: target values recommended for the period between 2011 and 2020:
  - average energy savings of investments should be at least 60%;
  - aim of the grant for newly built buildings is to encourage more efficient construction as regards energy performance with a target value of 25 kWh/m2/year.

- Summary of overall final energy savings (of sub-programs including ee of appliances):
  - Total (until 2010): 12.25 PJ (thereof 4.09 residential, 3.16 Pubic institutions)
  - Total (until 2016): 57.4 PJ (thereof 21.00 residential, 14.75 Pubic institutions)

(NREAP)

- RES-shares: initial value, target 2020
  - RES-share 2005: 4,3%
  - Target 2020: 13%
  - Expected amount : 33477 GWh
- RES-share 2020 by NREAPs
  - Electricity: 5598 GWh
  - Electricity: 481 ktoe
  - Heating and Cooling: 21663 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 10,9%
  - Heating and Cooling: 18,9%
  - Overall RES-share (with Transport): 14,7%
- Share RES-Electricity 2020
  - Hydro: 4,3%
  - Geothermal: 7,3%
  - Solar: 1,4%
  - Tide, wave, ocean: 0,0%
  - Wind: 27,6%
  - Biomass: 59,4%
- Share RES-Heat 2020
  - Geothermal: 19,2%
  - Solar: 4,4%
  - Biomass: 68,7%
  - Heat pumps: 7,7%

- Strategic objective of the Government to reduce energy consumption of newly constructed buildings to 120 kWh/m2 within five years (p.69)
- Planned:RES ratios and/or maximum CO2 emission values for certain building types and construction sites (p. 70)
  - no reliable data to estimate RE use in building types (until 2020)
  - promote complex renovations that enable energy savings of at least 60 percent (p 72)
- Targets of programs under New Széchenyi Plan:
  - renovation of an average of at least 50 thousand traditional/30 thousand panel buildings, construction of 22 thousand new, energy-efficient homes per year
  - renovation of an average of 3.2 thousand public institutions per year
  - energy modernisation of all national educational institutions, hospitals, official and other buildings of justice and administration that require renovation (during the 10-year duration of programme)
  - the average energy savings achieved by the investments must be at least 60 percent
  - promote construction that is more energy efficient than required by the specifications; the target in this case is 25 kWh/m2 per year. (p 76)

(Concerted Action - EPBD)

(Additional Information)

- Until 2050 reducing the electricity consumption by approximately 25% compared to 2008 (2020: 18%)

2) Regulations

(NEEAP)

- Hungarian legal framework TNM Decree No 7/2006 (V.24.) and amendment of Gov. Decree No 176/2008 (VI.30)),

  Residential sector:

  1.) Liveable Panel Dwellings Renovation Sub-Programme
    - mitigation of district heating demand in residential buildings built by industrialised technologies (Target value of the measure for 2016: 9.82 PJ)

  2.)"Our Home" Renovation Sub-Programme: Mitigation of heat demand of residential
    - buildings (family homes and multi-occupied residential buildings) with individual or central heating (Target value of the measure for 2016: 8.21 PJ)

  2.) Renewable Public Institutions Sub-Programme
    - mitigation of the heat demand of public buildings through complex energy-efficient investments (Target value of the measure for 2016: 13.55 PJ)

(NREAP)

- 2020 target and estimated trajectory of energy from renewable sources in heating and cooling (heating & cooling only)

2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
9.0%	*8.8%*	*8.6%*	*8.5%*	*9.1%*	*9.8%*	*11.8%*	*13.7%*	*15.7%*	*17.4%*	*18.9%*

- In effect from 1 January 2012 for public buildings (subsequently extended to all buildings): Construction of new buildings and the increased application of renewable energy sources during the renovation of existing ones in accordance with technical/technological and economic conditions (e.g. stipulation of a mandatory ratio for four-dwelling or larger condominiums, or in the case of the construction of offices larger than 250 m2)

- Planned: launch a comprehensive energy programme for buildings in 2011 as a part of the New Széchenyi Plan, the aim of which will be the energy modernisation of buildings, the promotion of energy efficiency, and contribution to the use of renewable energy sources. Programmes intended to provide a single framework for the energy efficient development of residential, public and other buildings
- national laws in force on building energy can be drawn from page 63
- Decree No 7/2006 (V. 24.) (p.63)
  - heat transmission coefficient requirements for building enclosure structures(p.64)
  - compulsory assessment of possibility of using decentralised energy supply systems based on RES, district/block heating/cooling or heat pumps when planning new buildings (>1000 m2)--> H waits for cost-effectiveness methodology proposal from Commission before specifying national regulation
  - solar cells and solar collectors can be installed without a final construction permit
  - facilitated authorization for “household-scale power plant” from RES

- National Environmental Protection Programme (2009–2014)
  - specific goals in EE&RE, but no specific quantified targets of buildings, includes drawing up and implementation of a coordinated government programme
- National Climate Change Strategy – NCCS
  - no specific goals of RES in buildings, but mentions necessity of renovation/replacement of doors and windows, heat insulation of building enclosure surfaces
- Draft Complex Building Energy and Climate Protection Programme (CBC)
  - support renovation of all types of residential building in single framework, support use of RES in residential buildings

(Concerted Action - EPBD)

The EPBD has not been fully implemented by the end of 2010. For 2011 a strengthening of the requirement system is planned. And in consideration of the recast of the EPBD a fundamental revision is expected in 2016, direct requirements regarding active solar and PV systems will emerge. (III-173 - III-174)

- regulation only covering Articles 3, 4, 5 and 6 of the EPBD
- regulation covering Articles 7-10 has been delayed
- since September 2006 fulfilment of energy requirements is a precondition for acquiring a building permit

The main feature of the new regulation, issued in 2006, is its three levels: setting a limit for the U value of building elements, specific volumetric value, and the specific yearly primary energy consumption, includes heating, cooling, domestic hot water & lighting needs--> strengthen requirements will take place in 2011

Planned: Requirement strengthening in 2016

- U value limits will be lowered by 15-20%, and for walls by 33%
- Minimum requirements introduced for some mechanical system elements, such as boiler efficiency, thermal insulation of storage tanks, and pipes

- o floor area limit for major renovations will be changed from 1,000 to 200 m2

  For approaching near-zero or zero energy buildings: yearly rate of embodied energy becomes comparable to the yearly operational energy consumption,

(Additional Information)

The requirements for energy performance of nearly zero-energy buildings will be defined in the Decree of the energy performance of buildings which is under construction.

3) Economic incentives

(NEEAP)

BUILDING NEW GREEN HOMES SUB-PROGRAMME

- grants for newly built homes is to encourage a level of efficiency in construction as regards energy performance that exceeds requirements.
- current Hungarian requirement is category C, which is mandatory when constructing new buildings. Since category B is better than category C by only 5% to 25% in terms of energy efficiency, the promotion of category A (better than the minimum requirement by 25% to 50%), A+ (better than the minimum requirement by more than 50%) and A++ is appropriate.

LIVEABLE PANEL DWELLINGS RENOVATION SUB-PROGRAMME

- modernise the energy performance of panel dwellings together with the renovation of constructed surroundings, encourage complex renovations permitting energy savings of at least 60%,

DISTRICT HEATING EFFICIENCY SUB-PROGRAMME. T

- ensure that district heating systems are renovated in the most complex way in terms of energy efficiency
- supports energy performance audits, the possibility to involve renewable energy sources and the more efficient operation of existing systems

"OUR HOME" RENOVATION SUB-PROGRAMME

- .modernise energy performance of traditionally built residential buildings, encourage complex renovations permitting energy savings of at least 60%
- beneficiaries of tender: owners/communities through targeted support of the population

RENEWABLE PUBLIC INSTITUTIONS SUB-PROGRAMME:

- covers energy-wasting, traditionally built and panel buildings not complying with heat provisions owned by the state or local governments

(NREAP)

- Tender schemes give special priority to public buildings, and can provide as much as 100 percent aid for energy performance modernisation and development works.
- In the tender schemes, new constructions or renovations meeting the parameters of "low energy requirement building" or "passive house" can receive special support through a "bonus system.
- Preferential electricity tariff for the electricity to operate equipment (e.g. heat pumps, thermal solar collectors, circulation pumps, etc.) for the heat supply of buildings from renewable energy sources. The subsidized tariff is only available in the heating season. (p. 156)

(Concerted Action - EPBD)

Current & Past Programs

National Energy Saving Programme (NEP) ended in 2009 and substituted by the GIS Climate Friendly Home Programme.

- 15-30% non-refundable subsidies for individual renovations (thermal insulation of building elements, exchange of windows, and modernisation of heating systems or installation of RES systems) of traditional buildings (family houses and multi-residential buildings) built using masonry construction
- number of projects 1,000-5000/year, support between 1 and 2 billion HUF/year (3.5-7.0 M€/year)

Panel Programme ---> in 2009 under GIS

- for buildings built using industrialised technology.
- Only whole buildings could submit application-->larger scale, support range between 33% and 66% of the costs, independent of the achieved energy saving (500-2,000 projects yearly), first step that involved using energy certification to motivate people towards more efficient projects, but complex

GIS Climate Friendly Home Programme (from January 2010)

- subsidising traditional building types,
- project preparation costs (management, expert and design costs) are not eligible for subsidy and this strongly decreases the number of projects applied for

Environment and Energy Operative Programme

- 30-100% non-refundable grants for public and commercial buildings
- energy calculations according to the EPBD are required but achieved energy level doesn't influence the amount of the grant. preparation costs eligible for subsidy
- 831 projects submitted (total grant request 81 bn HUF during this period (approx. 290 M€)).

Planned

Energy Efficient Construction Programme

- Retrofit 50,000-100,000 flats yearly with an average energy saving of 60%.
- involve all building types, including public buildings and close to zero energy new buildings, Energy Efficiency and Renewable systems in the building sector under one umbrella
- Energy points will be given to the projects, as a function of the original and the targeted category, additional Bonus points possible (sustainability, quality, social impact)

(Additional Information)

4) Financing instruments

(NEEAP)

- for most programs: tender mechanisms or state ESCO; Promotion of ESCO-type investments by regulatory means

(NREAP)

- In current EE tenders, only limited eligibility to aid when implementing heating/cooling from RES (p.68)

I.EEOP – Environment and Energy Operational Programme (total budget of EUR 4916 million):

- most relevant support scheme in place to encourage use of RES in buildings--> H planning to continue the tender scheme by launching an independent energy operational programme.
- EEOP-2009-5.2.0/B Third-party financing: energy modernisation of buildings combined with renewable energy utilisation: Eligible applicants organisations providing third party financing(ESCO), non-refundable grant (HUF 3.5 million -HUF 200 million) max support available 35%
- EEOP-2009-5.3.0/B Energy development of buildings combined with renewable energy utilisation: Eligible applicants are businesses/bodies funded from the governmental budget/institutions, non-refundable grants. (HUF 1 million- HUF 500 million) support of 10%-80%

II. CHOP-2009-3.3.3. – Increasing the use of RES, supported by region of Central Hungary through an operational mirror programme" corresponding to the renewable energy priorities of EEOP.

III. Energy Efficiency Credit Fund (EECF)

- credit provided at preferential interest rates

IV. National Energy Saving Programme (NESP)

- tender scheme to provide incentives to projects aimed at energy saving and use of RES with preferential
- loans and non-refundable aid

V. Green Investment Scheme (GIS)

- source of funding from GIS tenders are revenues from the transfer of CO2 allowances, provides aid on the basis of Government Decree No 323/2007 (XII. 11.)
- Additional aid for RE use investment can be obtained within the framework of the EEA/Norwegian Financial Mechanism (to be established in near future)
- GIS Panel Sub-programme: aid for renovation of residential buildings built using industrialised technology/investments resulting in noticeable energy saving/increase in the use of RES
- GIS Energy Efficiency Sub-programme: funding for properties built by traditional technology (natural persons, housing associations, apartment blocks)

(Concerted Action - EPBD)

Two of the preconditions for getting financial support are certification of the building in its existing state and identification of the label to be achieved after the retrofit. (p.166)

(Additional Information)

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5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- Spread of the practice of issuing energy performance certificates for buildings Gov. Decree No 176/2008 (VI.30.) on the on certification of the energy-related characteristics of buildings was drawn up to transpose Directive 2002/91/EC(p.63)-->revision has pointed out that more detailed and stricter regulation is necessary-->Hungary will introduce in its legislation until June 2012.

(NREAP)

- New energy certificates must be issued in the case of New buildings constructed on the basis of a final and enforceable *construction authority permit (p. 84)*

(Concerted Action - EPBD) • Compulsory certification (in case of sale or rental) of existing buildings supposed to launched on January 1st 2012: all existing residential and non-residential buildings need to be certified, when sold or rented, no minimum requirement for an existing building, New buildings must achieve at least a C label (same for major renovat¡on of buildings with over 1,000 m2 floor area) • Voluntary certification of existing buildings has already started and certification became a precondition for receiving a subsidy already in 2008 • Certification process: for new buildings, it started in January 2009, • Set of regulations and rules of certification (incl.creating relevant software) completed in January 2006. • Fulfilment of energy requirements is precondition for acquiring a building permit • 49,000 certificates have been issued for new buildings and about 4,000 for existing buildings • Electronic certificate check of uploaded documents to central server available *(Additional Information)*
6) Supervision (energy advice and audits) *(NEEAP)* Operation of an energy efficiency consultancy network planned (p.24) *(NREAP)* Accreditation for products, service providers and contractors, professional/consultancy services provided by Climate-Friendly Buildings Development Agency Network, (p.67) *(Concerted Action - EPBD)* Hungary has adopted option a) on Article I of the EPBD, establishing a regular inspection of boilers. • Governmental Decree 264/2008on the inspection of heat generation equipment and air' conditioning systems",(n force since January 2009) • Deadlines: January 2011 - inspection of all heating installations with boilers (effective rated output of over 20 kW older than 15 years), January 2013 - first inspection of boilers and AC systems installed before January 2007, January 2015 - first inspection of boilers and A/C systems installed after the January 2007 • Inspections can be carried out by: experts with license issued by the Hungarian Chamber of Engineers, engineers with at least one year of experience, who must take an exam at the Hungarian Chamber of Engineers, technicians with at least five years of experience, who must take an exam at the Hungarian Chamber of Engineers *(Additional Information)*
7) Information (tools) *(NEEAP)* Establish data supply and data processing system for measuring the energy consumption and energy state of buildings owned by the state or municipalities is included among the EU 2020 objectives in Hungary's National Reform Programme, first steps have already been taken concerning the development of the data supply system.(p.7) *(NREAP)* Newly established:

- Accreditation for products, service providers and contractors
- Professional/consultancy services provided by Climate-Friendly Buildings Development Agency Network
- electronic tender management system and the monitoring and registration system for successfully completed projects. (p.67)
- *Integrated information and awareness-raising programme (p. 215)*
- *Energy programme for the buildings of public institutions (p. 215)*

(Concerted Action - EPBD)

- Intensive information campaign in early stages after 2006: TV /radio interviews addressing public, workshops/open forums were available to the professional community
- homepage/electronic guide for correct interpretation of the Directive and national regulations, printed guides for architects/engineers
- Later, the emphasis of the campaign shifted to providing information to the general public:
- The Energy Club (NGO): home page basic concepts, everyday tips for energy saving, detailed booklet presents the features of "Passivhaus"-->campaign supported by the Ministry - to date with 200 million HIJF (approx. 80,000 €)
- In cooperation other NGOs, workshops for local authorities and housing associations were run in 2010, counting 510 participants, who represented the owners of 75,277 flats. 30,000 booklets distributed
- The ECOHOUSE road show (by Energy CLUB) in 15 cities
- links for certification and display on the Ministry's homepage, display programme is subsidised
- Civil organisation helps in reviewing and evaluating energy bills.
- Special attention to younger generation: display of certificates in school buildings, social events, raising the children's awareness towards the environment.
- current software already allows for the calculation of the cost and the expected savings of different retrofit measures (building, mechanical systems

(Additional Information)

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8) Demonstration

(NEEAP)

(NREAP)

Ministry of National Development initiated the drafting of a modernisation programme aimed at the energy reconstruction of state-owned public buildings,(tba in 2011)

(Concerted Action - EPBD)

- Certification of new buildings and the display campaign for public buildings started in 2009 (not compulsory)
- Larger public buildings (exceeding 1,000 m2 floor area) required to display their energy certificate, so that it is visible to the public.
- 28 local authorities have joined the programme and over 100 public buildings have displayed their data

(Additional Information)

9) Education and training

(NEEAP)

(NREAP)

- Importance of training stressed by New Széchenyi Plan (vocational training and retraining in the construction industry is of exceptional importance)
- Preference given to courses for increasing the energy efficiency of buildings and energy efficient facility management.
- Qualification schemes in the field of energy efficiency, renewable energy sources and related areas (by the individual initiatives of institutions): Information available at professional associations (Hungarian Chamber of Engineers – MMK, Hungarian Chamber of Building Engineers..etc.) (p.88)

(Concerted Action - EPBD)

(Additional Information)

10.3.1.7 Italy

Italy

1) National targets

(NEEAP)

(NREAP)

- Estimated share of RES
  - Residential 84% (10'), 82% (15'), 81%(20')
  - Commercial 9%(10'), 10%(15'), 10%(20')
  - Public 7%(10'), 8%(15'), 8%(20')
  - Industrial 1%(10') 1%(15') 1% (20')

- RES-shares: initial value, target 2020
  - RES-share 2005: 4,9%
  - Target 2020: 17%
  - Expected amount : 262988 GWh
- RES-share 2020 by NREAPs
  - Electricity: 98885 GWh
  - Electricity: 8504 ktoe
  - Heating and Cooling: 121581 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 26,4%
  - Heating and Cooling: 17,1%
  - Overall RES-share (with Transport): 17,0%
- Share RES-Electricity 2020
  - Hydro: 42,5%
  - Geothermal: 6,8%
  - Solar: 11,5%
  - Tide, wave, ocean: 0%
  - Wind: 20,2%
  - Biomass: 19,0%
- Share RES-Heat 2020
  - Geothermal: 2,9%
  - Solar: 15,2%
  - Biomass: 54,2%
  - Heat pumps: 27,7%

(Concerted Action – EPBD)

(Additional Information)

- Until 2050 development of renewable energy sources at a fraction of 60% for gross final end energy consumption (2020: 18%) and 80% of gross electricity consumption (2020: at least 35%)
- At this moment the most important national energy efficiency target for 2020 is the reduction of 17% of energy consumption, delegated to the Decree DM 15/03/12 called “Burden sharing” that defines the distribution of the minimum rate of increase of energy, generated from renewable sources between regions and autonomous provinces. The “burden sharing”

gives interim target to decrease energy consumption fixed to 2012, 2014, 2016 and 2018.

- At the regional level Lombardia intends to increase of 50% the generation from renewable sources like photovoltaic or biogas (regional law 18/04/12 n.16 Art.25) and to anticipate to 2015 the nearly zero-energy building target given by the directive 31/10/UE.
- At this moment (April 2012) there aren't explicit numbers or percentages available on the planned number of nearly zero-energy building. The proposal for EPBD transposition is in Parliament, but there is the risk that it will be not adopted by July 2012.

2) Regulations

(NEEAP)

- Regulation 59/2011
  - contains methodologies for calculating the minimum energy performance requirements for buildings and heating systems
  - provision also regulates the installation, operation, maintenance and inspection of heating plants.

- Legislative Decree No 192 of 19 August 2005

  New criteria set:
  - Minimum mandatory requirements for Primary Energy Needs for winter heating the building envelope in connection with summer air conditioning for all new constructions and for total refurbishments of buildings (1 000 m2 or more), phased-in application over 2006-2008-2010
  - Limits in annual consumption of new buildings (kWh/m2 p.a.) 70 (2005), 45 (2010), 45(2015), 45 (2020)
  - higher levels of thermal insulation for the building envelope and minimum requirements for buildings that are undergoing refurbishments (without limit to size or amount)

  - Public and private buildings (new & or refurbished): promote the use of higher efficiency plant and equipment, (for example: heat pumps, three- or four-star gas boilers, for new buildings and refurbishments),
  - Mandatory to carry out works on both building envelope and building plant to enable connection to district heating networks (if there is a stretch of a network within 1 km)

- Minimum levels for usage of renewable sources for newly constructed buildings or refurbishment of existing plant : 50 % of the annual primary energy need for domestic hot water be met with the use of renewable energy sources (20 % for buildings in old town centres)

(NREAP)

- Energy requirements from RES (new buildings and for major renovations)
  - 50% of the expected consumption of domestic hot water
  - heating and cooling:

    a) 20% where the application for the relevant building permit is submitted between 31 May 2012 and 31 December 2013

    b) 35% where the application for the relevant building permit is submitted between 1 January 2014 and 31 December 2016

c) 50% where the application for the relevant building permit is submitted on or after 1 January 2017

  - For public buildings the requirements are increased by 10%.

- Planned
- Minimum quota for electrical capacity installed using renewable sources , targeted: End users owning newly-constructed refurbished buildings

(Concerted Action - EPBD)

Minimum energy performance (EP) requirements entered into force on the 1st of January 2010EP of a class varies with the climatic zone and with the shape factor of the building (ratio of envelope surface to heated volume)

- For new buildings and major renovations the minimum EP corresponds to a C rating
- For summer cooling thermal load of the new residential building (therefore excluding system performance) has to respect the following maximum levels (III-190)
  - Climatic zones A and B: 40 kWh/m2 year
  - Climatic zones C through F: 30 kWh/m2 year.
- For all other new buildings the maximum level is:
  - For climatic zones A and B: 14 kWh/m2 year.
  - For climatic zones C through F: 10 kWh/m2 year.

(Additional Information)

At this moment there are no official definitions of nearly zero-energy building performance standard and a regulation roadmap is not available. CTI (Italian Thermo-technical Committee) is active on these points and on the review of the national standards UNI TS 11300-1-2-3-4 about the modelling of envelope and building systems.

2 Economic incentives

(NEEAP)

- Tax deductions (55%) for improving the energy efficiency of existing buildings (individuals and companies)(p.24, 41), since 1 January 2007 to 31 December 2010 (subject to further extensions)
- White certificates
  - initially for the five-year period 2005-2009
  - creation of a market in Energy Performance Certificates or White Certificates
  - attest to the reduction in consumption of primary energy resulting from energy efficiency measures
  - applicable to energy saving measures in buildings (p.46), e.g. Installation of solar heating panels for hot water, use of efficient air conditioning systems, use of efficient central heating systems (p. 66, 68, 70)

- White certificates and tax deductions---> double counting possible in some cases

- Regional support carried out by state provinces (p.151)
  - smaller scope projects
  - audits, investments, co-financing, grants
  - both targeted at residential and non-residential buildings

(NREAP)

- Volume bonus of 5%, if new buildings and major renovations of existing buildings ensure coverage of heat, electricity and cooling consumption that is at least 30% higher than certain compulsory minimum values

- Tax relief of 55% on costs incurred for the installation of heat pumps, solar thermal systems or biomass systems (currently in place until the end of 2010), to be reviewed, targeted: end users who own existing buildings

- "Energy Efficiency Credits" or "white certificates" for various types of buildings (industrial, tertiary and residential)

(Concerted Action - EPBD)

- A 55% tax credit, to be distributed in ten fiscal years maximum available for:
  - o Electric, absorption cycle and geothermal heat pumps, condensing boilers, solar thermal collectors
  - o Retrofitting of building envelope elements that satisfy building performance of less than 2O% of the Energy Performance requirements in force

- Incentives for low energy buildings (Decree of March 2010)
  - o public grant of 83 €/m2 and 116 €/m2 for new residential buildings, if achieved Energy Performance is less than 30% and 50% respectively of the minimum requirements in force
  - o limited to 5 000 € and 7 000 € respectively per intervention
- (Additional Information)

  Past and ongoing programmes:
- From 2004, White Certification scheme for energy efficiency measures.
- From 2006 national Incentives scheme ("ContoEnergia") for PV plants, especially if integrated in the building envelope and linked to refurbishment actions.
- From 2007 national/regional tax deduction (36% - 55%) scheme for energy efficient retrofit of existing buildings.

Future:

- National/regional incentive measures addressing nearly zero-energy buildings are not yet in place, but probably the ongoing programmes will be upgraded in order to achieve the targets of EPBD recast.
-

3 Financing instruments

(NEEAP)

Interregional Operating Programme "Renewable energy and energy savings" 2007-2013 (POI Energia) (p.49)

- *existing buildings located in the Convergence Regions that are publicly owned (Calabria, Campania, Apulia and Sicily) (€52 m)*
- *aimed at local health authorities and hospitals (60 € million)*
- *schools (overall 240 € million, thereof € 20 million from POI Energia)*
- *municipalities up to 15 000 inhabitants including historic and heritage villages (EUR 60 m)*

Public buildings, Energy efficiency improvement programs available for (p.56)

- airport facilities (EUR 17.3 m)

- museums and archaeological sites (€ 40 m)
- General Directorate for the Management and
- Maintenance of the Offices of the Judicial Complex of Naples (€ 40 m)
- buildings of the State Police
- buildings of the Armed Forces (€ 30 m)
- municipal building stock (€ 6.5 m)
- provincial building stock (€ 12 m)
- building stock of marginal mountain communities (€ 2 m)

Revolving Fund

- set up by the 2007 Italian Finance Act
- EUR 600 million, three annual programme cycles aimed at renewable sector, energy efficiency and forestry

Planned

ECO PRESTITO - National fund for energy efficiency

- financing by a revolving concessionary loan fund, should the upgrading work result in achieving a level of energy savings greater than 50% (p. 119)
- support to public and private bodies and/or ESCOs through loans at favourable rates
- fund could operate in conjunction with traditional channels of financing (e.g. bank loans) to facilitate access to credit
- volume-based bonus in case of demolition or reconstruction
- for residential buildings constructed before 1976 (about 70% of the national building stock)

(NREAP)

Calls for bids for CAPITAL (p.56)

Interregional operational plan for renewable energy sources and energy saving

- budget of €30 million to provide up 100% funding for projects with a unit costs of between €100,000 and €1 million
- competitive public tendering procedure to provide funding for initiatives to create energy production plants using renewable sources to serve buildings owned by the administrative bodies located in the Convergence regions of Italy (Campania, Calabria, Apulia and Sicily)

National level

"Sun in Public Buildings"

- initially allocated €10 million and has been extended with € 2 mn
- promotes the creation of solar thermal systems for low temperature heating in public buildings through the third-party financing mechanism
- maximum permitted percentage of public contribution is equal to 50%
- percentage increases to 65% in the event that the applicant's share of the investment is covered through a third-party financing mechanism

KYOTO ROTATING FUND (p.127)

- among other measures supports heat production from RS

(Concerted Action - EPBD)

Kyoto Fund

- revolving fund for sustainable energy investments, which will be managed by the Regions

(Additional Information)

National level:

- "Fondo Kyoto" (soft loan of 400 million euro) has been activated in march 2012 for incentivating energy efficiency measures in the building sector.
- In accord with Art.3 of DM 15/03/12 (Burden Sharing) the Regions have to promote the realization of education programmes for companies and public corporations.

Example of instruments at the regional level:

- Lombardia (regional law 18/04/12 n.16) promoted the implementation of renewable and low-energy systems (e.g. GSHP) also simplifying the administrative authorization procedures.
- Sardegna made available 12,4 millions of euro for companies investing in renewable sources and using 70% of energy generated for own production
- Puglia made available 31,7 millions of euro for energy efficiency actions on schools and public buildings.

4 Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

National Guidelines for Energy Performance Certification of Buildings in Ministerial Decree of 26 June 2009

- mandatory energy performance certification of public buildings (greater than 1 000 square metres), certification displayed in a part of the building easily accessible to the public,

Planned

- mandatory energy performance certification of buildings (of all?) , by also implementing the related framework of sanctions

- creation of a regional and national IT system that will facilitate the gathering of data on energy certification and monitoring of the energy efficiency of buildings (p. 167)

- from 1 January 2012 in notices for the sale of buildings it will be obligatory to state the energy performance index value

(NREAP)

(Concerted Action - EPBD)

National Guidelines that specify procedures, the performance classes and the basic elements for certification adopted at national level in 2009

- All the required buildings were included in the certification system: new buildings, major renovations, public buildings and all buildings when sold
- all existing residential/non-residential need certification when sold
- Fines foreseen for building owners refusing to deliver the certificate: non compliance with the certification rules (30% of invoice), misconduct (70% of invoice and communication to the professional association), falsification of the certificate (fine ranging from500 € to 31000 €)
- Certification is compulsory, in order to gain access to most public incentives for energy efficiency (55% tax credit)
- Certificates list measures for improving their energy performance, sorted by cost-effectiveness

- Scale ranging from A+ (high energy efficiency) to G (poor efficiency)
- Validity of energy certificates is 10 years, but they have to be updated whenever the energy performance is modified by interventions on the envelope or on the system.
- Regionalisation of the EPC system, therefore varying regulations across regions-->National Guidelines not fully implemented!

(Additional Information)

In recent years, many Italian regions have promoted and developed their own certification schemes to implement the EPBD (2002/91/EC), but it is still not fully implemented at the national level: for this reason at the end of April 2012, Italy is been referred to the European court of justice.
In this context it is unlikely that there will be significant advances in the short term about the implementation of the nearly zero-energy building target.

At this moment the most active bodies in this field are SACERT (Association of some local public governments and stakeholders in Lombardia) and CasaClima (agency of the Provincia Autonoma di Bolzano). Both these subjects are proposing and disseminating energy certification schemes ("Sacert ZEB" and "CasaClima Oro") in line with the new European goals.

5 Supervision (energy advice and audits)

(NEEAP)

- energy audits of public buildings or buildings for public use mandatory (refurbishment of heating systems, replacement of generators, or building refurbishment involving at least 15 percent of the external surface of the building envelope)

(NREAP)

- Professional/consultancy services provided by Climate-Friendly Buildings Development Agency Network, electronic tender management system and the monitoring and registration system for successfully completed projects in place(p.67)

(Concerted Action - EPBD)

- Boiler inspection legislation has been finalised (2009), giving more responsibility to the regions, allowing for a longer maximum interval (up to 4 years) for maintenance and control of small gas boilers.
- procedures for inspection of air conditioning systems are still under discussion

Public buildings

- Since December 2006, about 8 M€ has been budgeted for energy diagnosis and certification of public buildings, throughout the Regions

(Additional Information)

At the moment no official regulation/recommendation documents clearly discussing about the nearly zero-energy building definition and proposing how to reach this target. ENEA (Italian Energy Agency) is active on this topic, but it is very difficult to understand when these documents will be produced.

-

6 Information (tools)

(NEEAP)

- technical and financial 'round tables' with the participation of the sector's stakeholders, for preparing proposals and outlines of provisions and measures, to accelerate the process of

realising high-efficiency and Nearly Zero Emission buildings. (p.117)
Planned: information framework relating to the financial incentives

(NREAP) (Progress report)
Information website by SE (Gestore dei Servizi Energetici SpA [Energy Services Operator])

- by September 2011
- containing 'guidance enabling all interested parties, in particular planners and architects, to properly consider the optimal combination of renewable energy sources, high-efficiency technologies and district heating and district cooling systems during the planning, design, building and renovation

Campaigns
"Raising awareness of solar thermal systems and energy saving in public buildings"
"Operation10"

- encouraging procedure managers within public administrative bodies to insert solar thermal systems and energy-saving technology into public calls for tender

(Concerted Action - EPBD)

- Some regions have specific websites for information
- ADICONSUM (www.adíconsum.ít)l provides a network of Qualified Experts to citizens asking for an energy audit with certification
- Local initiatives of private companies, in collaboration with local administrations provide free energy audits and certifications for multifamily buildings (condominiums) as a promotional tool for offering building/system renovation works
- Information and communication campaigns for boiler inspections have been organised by most provinces and cities

(Additional Information)

- At this moment more than 20 calculation methods/software are available for the energy certification of building. Some of these have been developed by national/regional energy agencies and used for the official certification scheme (e.g. DOCET, CENED, CasaClima); the others (not officially recognized) are been proposed by professional associations or private bodies.
- In general these tools are not still linked to the nearly zero-energy building target (except for the software "BestClass" proposed by Sacert ZEB) and in this context it is difficult to predict the evolution of the available instruments.
- Some information campaigns have been promoted by stakeholder associations in collaboration with local public authorities (e.g. "Tour nearly zero-energy building 2012" by Edilportale website and "CE forum 2012").

7 Demonstration
(NEEAP)
National Action Plan on Green Public Procurement (NAP GPP)

- in process of definition and adoption

(NREAP)
(Concerted Action - EPBD)
(Additional Information)

- In Italian territory there are some Demo project promoted and disseminated by research bodies, private companies (e.g “Velux lab”, "Leaf house") and local governments (e.g. the school of Laion (BZ)). Also about this topic the national public sector have not a leading role.

8 Education and training

(NEEAP)

(NREAP)

Interregional operational plan

- Information programmes accompanied by training programmes for designers, manufacturers, maintenance
- technicians, installers, administrators and technicians working for the public administrative bodies

(Concerted Action - EPBD)

Regions have the responsibility for the management of the QA (Qualified experts) aspects of Energy Certification of Buildings

- Training/examination organized by provinces, no universal regional coverage (8 out of 21 regions) (III-191)
- Certificates can only be issued by Qualified Experts (QE). QEs may be architects, engineers, and technicians with a secondary school technical degree, duty qualified and recognised by their professional associations
- Qualified Experts, who make up the control staff (for boiler inspection) are trained by public and private organisations, according to a programme defined by ENEA (the national body for environment, energy and innovation) and have to pass an examination. The maintenance personnel are usually trained through entrepreneurial associations.

(Additional Information)

At the moment education official plans are not active. The available training materials are provided only by private subjects (front-runner industries) and specialized magazines/portals.

10.3.1.8 Netherlands

Netherlands

1) National targets

(NEEAP)

'Energy Leap' [Energiesprong] programme: aim to achieve a 45-80% energy saving in the built environment and zero-energy new buildings from 2020

(NREAP)

- Estimated share of renewable energy in 2015, 2020, and growth 10'-15', 15'-20',total final demand
  - Household: 2.8%, 3.8%, 21.7%, 65.0%
  - Services 2.7%, 3.7%, 50.0%, 105.6%
  - Industry 0.8%, 0.7%, 0.9%, -12.5%, 12.5%
- EPC 2007 requirement on building-related energy consumption:
  - 25 % lower standardised energy consumption in 2011
  - 50% lower standardised energy consumption in 2015
- RES-shares: initial value, target 2020
  - RES-share 2005: 2,4%
  - Target 2020: 14%
  - Expected amount : 82256 GWh
- RES-share 2020 by NREAPs
  - Electricity: 50331 GWh
  - Electricity: 4328 ktoe
  - Heating and Cooling: 25337 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 37,0%
  - Heating and Cooling: 8,7%
  - Overall RES-share (with Transport): 14,5%
- Share RES-Electricity 2020
  - Hydro: 1,4%
  - Geothermal: 0%
  - Solar: 1,1%
  - Tide, wave, ocean: 0%
  - Wind: 64,4%
  - Biomass: 33,1%
  - Share RES-Heat 2020
  - Geothermal: 16,2%
  - Solar: 1,4%
  - Biomass: 58,7%
  - Heat pumps: 23,6%

(Additional Information)

- Until 2050 reduction of heat consumption in buildings by 80%

- New Buildings
  - NL does not have a general national energy-efficiency target for 2020.

- Our aim is to build 50% more energy-efficient (new) buildings in 2015 compared to 2007. Our aim is to build (new) nearly zero-energy buildings by 1 Jan. 2021 and (new) nearly zero-energy building occupied and owned by public authorities by 1 Jan. 2019.
- There are no explicit numbers or percentages available on the planned number of nearly zero-energy buildings.
- There are no explicit numbers or percentages available for residential/non-residential nearly zero-energy buildings. However, we have estimated that as of 1 jan. 2020 approximately 60.000 houses will be built. This is including existing buildings that are be replaced by new buildings.

Major renovation

- No specific measures have been prepared yet. However when a building is currently renovated, the renovated part must meet the energy performance requirements that apply for new buildings. The insulation value (RC-waarde) of the building envelope will be tightened to 3,5.

2) Regulations

(NEEAP)

- Energy performance requirement for new building, the EPC, will be tightened up in 2015
- Tightening of the EPC will gradually be incorporated into the Building Decree over the next decade.
- Rate of the tightening of the energy performance coefficient New building (house)
  - from 0.8 to 0.6 on 1 January 2011 and to 0.4 on 1 January 2015 with the aim of achieving zero-energy houses (EPC=0) in 2020 , A comparable tightening (in comparison with 2007) applies to non-residential buildings, so that new buildings will be 50% more energy efficient in 2015.
- Buildings housing public authorities
  - 1.1 in 2011, 2015: 50% more energy-efficient than 2007

- The Netherlands will use the following definition for zero-energy
  - A building is a zero-energy building if it has an energy consumption of at least zero
  - The building draws no more energy from the public network (gas and electricity) than the renewable energy it generates or draws from renewable sources in the immediate vicinity of the building.

(NREAP)

Requirements for the energy performance of a building have applied in the Netherlands since 1995 to the construction of new residential and non-residential buildings, and to substantial renovation projects. Gradual tightening of requirements using EPC.

(Concerted Action - EPBD)

- Energy Performance Standard (EPN) sets requirements for the energy efficiency of new and major renovations of existing buildings.
- Dutch building legislation sets minimum requirements for building components. Each couple of years both sets of requirements are evaluated and if necessary adjusted.
- The way to achieve the EPN is decided by the builders or architects, they can choose their own package of measures to achieve the goal. (III-247-249)

(Additional Information)

The Construction Act already requires to meet the energy performance requirements, so it won't be updated.

- NL has not formally decided on the definition of nearly zero-energy buildings.
- To realize nearly zero-energy buildings the NL will gradually tighten the Energy Performance Coefficient (EPC): Since 1 January 2011 new buildings are built 25% more energy-efficient compared to 2007. Our aim is to build 50% more energy-efficient (new) buildings in 2015 compared to 2007. On 1 January 2021 the EPC will be nearly zero.
- In NL there are 20 innovative housing projects in the residential and commercial construction. The projects are called The 'Excellent areas'. Here homes and offices are built with at least a 25% tighter energy performance coefficient (EPC) than the Building Regulation currently requires. The parties involved gain extensive practical experience with innovative building methods and techniques. And especially with the search for innovation in the construction and new forms of cooperation and financing.
- There are also tenders for Zero energy buildings (residential and non-residential buildings).

3) Economic incentives

(NEEAP)

EIA: Energy Investment Allowance (all sectors) (since 1997)(p.34, 42)

- incentives for house building
- tax reduction for Entrepreneurs from all sectors that pay income or corporation tax

Reduced VAT rate for insulation work' and 'Reduced VAT rate for labour costs for the maintenance and renovation of houses' (ends on 1 October 2011)

(NREAP)

Sustainable heat subsidy scheme (p.104)

- investment subsidy for solar boilers, heat pumps and micro-CHP systems in existing homes
- budget of EUR 66 million is available from 2008 to 2011

(Concerted Action - EPBD)

(Additional Information)

There are some grants available for the innovation of techniques and grants for supporting the process to building nearly zero-energy buildings (pilots).

4) Financing instruments

(NEEAP)

Energy Savings Credit Guarantee / Green Projects Scheme /National Mortgage Guarantee

- loans targeted at home owners
- discount on the market interest for loans
- tax rebate, co-financing

Energy efficiency funds under program "Energy Leap" (2011-2014)

- aims to halve energy-use in the built environment in 2030 (in comparison with 1990)
- projects targeted specifically at acceleration and renewal may be eligible for support under the Innovation Agenda for the Built Environment (IAGO)

(Concerted Action - EPBD)

By the end of 2010, many subsidies and other incentives are available to Dutch consumers, related to the Energy Performance Certificate, improvement of the current installation and energy saving measures in general. (III-252)

Examples:
'More With Less' program

- energy saving programme for existing buildings
- also aimed at training building workforce through educational programs.
- goal of the program to create a substantial market for energy savings

' Energy subsidy guide'

- subsidies include a grant of 200 € for a detailed Energy Performance Advice
- subsidy of 350€ or 750 € when improving EP of dwelling and a higher mortgage when achieving class A
- lower VAT rate for insulation of roof, wall and floor and further incentives

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

All government buildings larger than 500 m2 which are accessible to the public will be provided with a visible energy label from 2013. This will apply to buildings larger than 250 m2 from 2015.

(NREAP)

(Concerted Action - EPBD)

- Energy Performance Certificates are in force for new buildings since 1995 and for existing buildings since 2008. For each existing building an Energy-Index is calculated and energy certificate class assigned
- Certificates can only be issued by qualified assessors.
- The calculation software is connected to a central database which is operated by NL Agency and guaranties the algidity of the EPC. A list of qualified assessors is permanently updated and always available online for the public at the website of KBI, the Dutch quality assurance association.
- Up to September 2010 25% of the total residential buildings were issued a EPC. (III-245-249)

(Additional Information)

As a result of the recast EPBD the NL is currently developing an Energy Performance Certificate for New Buildings. New buildings must meet the energy performance requirement that applies to new buildings.

6) Supervision (energy advice and audits)

(NEEAP)

Inspection of installations

- for central heating boilers between 20 and 100 kW
- Air-conditioning systems above 12 kW

(Concerted Action - EPBD)

- Inspection of boilers is based on a voluntary inspection scheme and legislation
- Boilers are inspected and maintained depending on their size

- For small boilers a simulation tool has been developed, to show consumers if a new boiler is economically viable.
- Another tool was developed for larger and collective boilers to advice the owner on possible measures to make the installation more energy efficient.
- For large heating systems in non-residential buildings a law (BEMS) was published in 2010 that sets requirements for emission standards in new installations with an output ranging between 1 and 50 MW.
- Inspection of air-conditioning systems was not aggregated into law by 2010, but planned for mid 2011 (III-250-251)

(Additional Information)

- SEV Energiesprong provides information on knowledge and the distribution of knowledge. http://energiesprong.nl/

- Major renovation: Foundation 'Meer Met Minder' (More with Less, Public-private coalition of associations of energy companies, building companies and installation companies) provides information (to consumers) on how to achieve energy-efficient renovations and how to apply for grants.

7) Information (tools)

(NEEAP)

- MeerMetMinder [More With Less] (www.meermetminder.nl) gives consumers reliable information about how to save energy in buildings and about possible subsidies.(p. 18)
- MilieuCentraal information campaign

(NREAP)

'Smart Energy' campaign to inform facility managers about energy saving and use of renewable energy in their buildings

(Concerted Action - EPBD)

- Specific information for professionals issued by NL agency website
- ' Energy subsidy guide': internet tool gives an overview of financial instruments (subsidies, loans)
- 'Energy Scout': interactive tool on the internet that gives insight into the possibilities of energy saving measures in existing houses and financial consequences.

(Additional Information)

8) Demonstration

(NEEAP)

- 'Areas of excellence' : 12 innovative building projects which are built with a strict EPC.
- Demonstration projects: Block by Block approach (5 pilots starting in 2011)
  - o aim is to use standard packages, with a management role at local level and using money from the market (for example from institutional investors).

(Additional Information)

- Demonstration projects
  - o nearly zero-energy building's: Energiesprong: http://energiesprong.nl/,
  - o Kennishuis http://kennishuisgo.nl/voorbeeldprojecten/
  - o Zero energy school buildings.

- The NL has some demo projects of several offices and schools which were renovated and transformed into nearly zero-energy building's.

9) Education and training

(Concerted Action - EPBD)

The training of assessors is the first (voluntary) stage to guarantee high level quality of Energy Performance Certificates. The second stage is a mandatory national exam that each individual assessor needs to pass

(Additional Information)

The Universities (Hogeschool) of Arnhem and Nijmegen (HAN) is developing/has developed a Bachelor in Engineering. They will start with a project on Zero energy houses in the eastern part of the NL. See also expertisecentrum energieneutraal bouwen. http://www.energieneutraalbouwen.nl/

10.3.1.9 Poland

Poland

1) National targets

(NREAP)

- Estimated share of renewable energy in the building sector:
  - Residential: 11% (2010) ,14% (2015), 16%(2020)
  - Public:10%(2010), 13% (2015),15%(2020)
  - Commercial and industrial: 9% (2010), 12% (2015), 14% (2020)
  - TOTAL: 10%(2010), 13% (2050), 15% (2020)
- RES-shares: initial value, target 2020
  - RES-share 2005: 7,2%
  - Target 2020: 15%
  - Expected amount : 120698 GWh
- RES-share 2020 by NREAPs
  - Electricity: 32400 GWh
  - Electricity: 4328 ktoe
  - Heating and Cooling: 68849 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 19,1%
  - Heating and Cooling: 17,1%
  - Overall RES-share (with Transport): 15,5%
- Share RES-Electricity 2020
  - Hydro: 9,2%
  - Geothermal: 0%
  - Solar: 0%
  - Tide, wave, ocean: 0%
  - Wind: 46,9%
  - Biomass: 43,9%
  - Share RES-Heat 2020
  - Geothermal: 3,0%
  - Solar: 8,5%
  - Biomass: 85,9%
  - Heat pumps: 2,5%

2) Regulations

(NREAP)

- The Building Act
  - no explicitly set ratios for share of energy from RES in building sector
  - facilitates instalment of RES in buildings: for standalone solar panels no building permit necessary
  - introduction of obligatory notification on installed RES, installed power and amount of energy produced by every (including individual) investor considered

- Regulation of the Minister of Infrastructure of 3 July 2003 on the detailed scope and form of the building design (Journal of Laws No 120, item 1133, as amended).
  - includes obligation to consider RES for heating/cooling/hot water supply in case of buildings with useful floor area > 1,000 m2 at stage of designing the building (Provisions of Directive 2002/91/EC)

- Planned
  - incorporate requirements for new and modernized buildings (including public buildings) in new regulation (Act on energy from RS), planned to be passed in 2010 (p.45)
  - no guidance for administrative bodies on planning, designing, building and refurbishing industrial and residential areas to install equipments and systems using RES
  - promotion of RES, primarily through incentives and premiums-->see economic incentives/financial instruments

(Concerted Action - EPBD)

- Minimum quality requirements in building regulations
  - new regulations expressed in prescriptive (U - value) and performance way (primary energy expressed in kWh/(m2.year)) (way of expression can be chosen by expert)
  - comparison between new requirements with requirements set before the EPBD difficult, but comparative analysis shows insignificant differences between new and the old requirements (III-274):
- New buildings :U-Values after transposition of EPBD (in 2008): External wall (0.3), Floor roof (0.25), floors over unheated and closed under-floor spaces(0.45), floor and floor-roofs under unheated attics(0.25), windows (1.7-1.8), external doors (2.6)
- building market not seriously affect by implementation of EPBD (2002)

(Additional Information)

- No definition in place yet for "nearly ZEB". The Zero Emission Building Research Centre, ZEB centre, is working on a national definition.
- Lightning Requirements for buildings (W/m2)
  - classified by building types and divided into basic requirements/extended requirements/requirements with full visual communication
  - Office: A: 15 B: 20 C:25
  - School, education: A: 15 B: 20 C:25
  - hospitals: A:15 B:25 C:35
  - Restaurants: A:10 B:25 C:35
  - Sport & recreation: A:10 B:20 C:25
  - Retail: A:15 B:25 C:35

- Architect must fulfil one of below described conditions:
  - Secure quality of building components Secure that primary energy factor for building does not exceed value calculated for

  a. For residential buildings for heating, ventilation and DHW (EPH+W)

  b. For residential buildings for heating, ventilation, DHW and cooling (EPHC+W)

  c. For, commercial and industrial buildings
- It is possible to choose one of mentioned condition, usually architects secure U values for component and do not calculate primary energy for building. -->MORE THAN 50% of new

buildings DOES NOT FULFILL EP requirements (which is visible when energy certificate is issued)

(source: Zwischenbericht (Energetische Anforderungen und flankierende Maßnahmen) zum Gebäudebestand)

- EPBD implemented only in January 2009
- U Values for new buildings divided into private/public
- Delay of implementation of announced new national regulation due to late implementation of methodology on EU level (intended July 2011, realized March 2012), therefore not completed

(Ministry of Transport...)

- Upcoming regulation
  - U-value and primary energy use maintained, but intended to be stricter (no quantitative data given)
  - According to source: orientation on German legislation

(Former concerted Action)

- Association/ Initiative of private firms and producers to present draft of new building regulations (without cost) to Ministry to replace current building regulation

3) Economic incentives

(NREAP)

Thermomodernisation premium (p. 43)

- for reducing annual demand (not mentioned which kind), energy losses, reducing costs of heat production, replacement of an energy source with a renewable energy source or using highly efficient co-generation

Renovation premium (p.43)

- -for reducing annual demand for energy in multi-family buildings for heating and hot water

Green certificates (p.49)

- part of the system for the promotion of RES
- every producer of green energy is entitled to green certificates that can be traded on the Commodity Energy Exchange (Towarowa Gielda Energii S.A.)

Planned

- savings from white certificates from eeRE techn in buildings can be traded sold

Options for co-financing investments in RES (p. 50)

- National Fund for Environmental Protection and Water Management ((Narodowy Fundusz Ochrony srodowiska i Gospodarki Wodnej, NFOsiGW)
- Voivodship Funds for Environmental Protection and Water Management (WojewódzkieFundusze Ochrony srodowiska i Gospodarki Wodnej, WFOsiGW)
  - credits (lending period up to 15 years),
  - loans (cooperation with Bank Ochrony Srodowiska, interest rate of about 2%, lending period up to four years, maximum investment implementation period six months)
  - co-financing interest on loans and credits
  - grants
- EU funds –(available for home owners?) Operational Programme: Infrastructure and

Environment
• European Economic Area EEA (available for home owners?)(Norwegian Financial Mechanism)
  o grants for institutions from the public and private sector and non-governmental institutions,
  o minimum co-financing value – EUR 250 thousand,
  o co-financing up to 85% (project financed from the state budget),
  o co-financing up to 60% (project financed in cooperation with the private sector)
• 16 Regional Operational Programmes
  o investments below PLN 20 (€ 5.2) million
(Concerted Action - EPBD)
1)Overhaul and Thermo-Modernisation Fund (from 1998)
  o building owners or administrators
  o premium which can cover up to 25% of a credit loan
  o premium is paid to the crediting bank directLy from the premium fund
2)Thermo-modernisation of public buildings (from 2001)
  o projects should fulfill technical (minimum energy savings) & financial criteria, e.g.: Improvement resulting in the reduction of the annual energy consumption for heating and hot water purposes
  o where only Heating system modernised - by at least 10%
  o where the heating system has been already modernised - by atleast 15%
  o in other buildings - by at least 25% etc. (II-272)
3) Programme (name not mentioned)
  o introduced in 2010, granting 40% non-refundable support for investment in solar collectors for hot water preparation, eligible for existing buildings (public/private not mentioned) ((III-272-273))
  o methodologies for the energy performance of buildings used in these programmes are different from the methodology used for the energy certification of buildings
  o no introduction of incentives/subsidies directly related to implementation of the EPBD and energy certification
(Additional Information)
(Information source from Ministry of Transport)
White & green certificate scheme
  o basic regulation in place but lack of rules for technical and practical implementation-->not yet functioning

4) Financing instruments *(NEEAP)* Residential Thermomodernisation & Repairs Fund (Fundusz Termomodernizacji i Remontów) • began 2009, (approx. PLN 200 (€52 million)/year) • by Bank Gospodarstwa Krajowego • thermomodernisation bonus constitutes 20% of the amount of loan for the investment, but no more than 16% of expenses incurred for the investment or twice the amount of expected annual energy savings • repair bonus (for multi-dwelling units) for paying back part of the loan taken for a repair investment, awarding the bonus depends on energy savings effect (decrease in annual

demand for energy delivered to multi-dwelling units for heating and water heating by at least 10%, and if the cost indicator of the investment exceeds 0.3 – by at least 25%).

Subsidy Priority Programme (p. 78)

- addressed to natural persons and housing associations
- PLN 300 (€ 79) million for subsidies for loan agreements between 2010 and 2014
- by National Fund for Environmental Protection and Water Management and banking sector
- partial repayments of bank loans for solar collectors for heating service water/energy supply for other heat receivers in dwellings
- subsidy of fund up to 45% of the bank loan capital

Public

Green Investment Scheme (GIS) (Part 1) – energy management in public utility facilities

- 2011-2014, (PLN 555 (€ 78) million as a subsidy, PLN 1 010 million as a loan)
- by National Fund for Environmental Protection and Water Management
  aims at decrease in energy consumption in public utility facilities
- loan of up to 60% of investment's eligible costs

Green Investment Scheme (GIS) (Part 5) – energy management in the facilities of selected public finance sector entities

- 2010-2015, PLN 500 (€ 131) million (100% subsidy), minimum investment cost: PLN 2 million
- by National Fund for Environmental Protection and Water Management
- aims at decreasing energy consumption in the facilities of selected public finance sector entities.

Programme "Energy efficiency and the promotion of renewable energy sources" (within the EEA Financial Mechanism and the Norwegian Financial Mechanism)

- 2012-2017, EUR 75 million.
- implementation by Ministry of the Environment, National Fund for Environmental Protection and Water Management
- improving energy efficiency in buildings, replacing obsolete heating sources (among others)

Operational Programme Infrastructure and Environment (OPIE) – Measure 9.3 Thermomodernisation of public utility facilities

- 2007-2015, EU fund allocation (Cohesion Fund) – EUR 76.7 million
- implemented by National Fund for Environmental Protection and Water Management

SME

Efficient energy use (Part 1) – Supplementary financing of energy and electrical energy audits in businesses

- 2011-2014, PLN 40 (€ 11) million, from the National Fund for Environmental Protection and Water Management

Efficient energy use (Part 2) – Supplementary financing of investment measures aiming at energy savings or at increasing energy efficiency of businesses

- 2011-2015, PLN 780 (€ 205) million, from the National Fund for Environmental Protection and Water Management

Programme offering access to financial instruments for SMEs (PolSEFF) (from 2011)

Horizontal Measures

White certificate scheme

- 2013-2016
- by Energy Regulatory Office
- support mechanism to improve energy efficiency

(Additional Information)

(Ministry of Transport....)

Support program for solar collectors in residential sector

- subsidy system (up to 45%)
- implementation through banks, extended from big banks (mostly in cities) to smaller banks---> extended range of support scheme
- no concrete numbers but raising interest in population

Thermomodernization & Repairs fund

- extension of range of program since 2009
- functioning well

Further funds for additional support programs difficult to raise, because of economic crisis

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- Energy Performance Certificate displayed in a prominent place clearly visible to the public in all government buildings where (>500 m2)
- Lowering of threshold to 250 m2 in 2015

- Open register of persons authorised to prepare energy performance certificates for buildings by minister for construction, spatial development and housing, entry in the register may be granted to persons who have completed the training and passed the examination (currently 7699) (p.37)

(NREAP)

Obligation for EPC imposed 2007 by amendments to the Building Act

- contains basic data/ratios describing thermal protection/consumption of energy
- based on methodology regulated by Minister of Infrastructure of (2008)
- issued at commissioning, sale of building/flat, leasing , expiration of EPC, change of EP
- calculation results in ee classes (p. 51)
- issued by authorised expert (completion of training before the minister in charge of building affairs, spatial and housing development or completion of >1 year post-graduate studies in architecture, construction, environmental engineering etc.) (p.44)
- can include additional information, such as a percentage share of RES in overall energy consumption.

Planned

- include recommendations to potential improvement of the energy performance level

(Concerted Action - EPBD)

- building certification started in January 2009
- new buildings +major renovations subjected to a certification process at planning stage , at start of operation, energy certificate is required

- existing buildings: EPC at transaction
- public buildings: visible to public
- types of performance certificates: residential buildings, other buildings (non-residential), apartments and building parts constituting separate technical/functional areas (non-residential)
- validity of EPC is 10 years.
- costs of a certificate reach from 50€ (simple single family houses) to 750€ (public buildings)

Certificates contain:
1. basic information like primary energy use, Energy Performance with information on reference buildings, information on the expert issuing the EPC
2.Technical characteristics of the building and its systems
3. Recommendations for possible improvements (seems as if already implemented)
4. Descriptions, additional information

- calculation methodology as described in building regulations contains mistakes-->certificates issued strictly using methodology provide results with huge error (sometimes corrected by experts)-->legal questions regarding validity of the certificate
- no decision regarding the national calculation software, few companies provide tools for calculation and certification, Ministry plans to introduce changes with the transposition of the Recast of the EPBD
- no quality control procedures for energy performance certificates and energy experts established
- no regulations for national register of ECs (experts obliged to archive copies of issued Cs for 10 years), so far no reliable information on the number of certificates issued

(Additional Information)
(Former Concerted Action)

- 20 errors in methodology for EPC, thereof 3 major errors which are sometimes corrected by experts, but lead to legal invalidity of certificate

6) Supervision (energy advice and audits)
(NEEAP)
Regulation of Minister of Infrastructure (17 March 2009) on the detailed scope and form of energy audit and a part of repairs audit, templates of audit sheets, and the algorithm for evaluating cost-effectiveness of thermo-modernisation investments (Journal of Laws No 43, item 346).
Planned
Establishment of national ESCO contact point (p. 39)
(Concerted Action - EPBD)
Building Act - Article 62

- Regular inspection of boilers and AC systems(>12kW) that can be performed by engineers and technicians competent for supervising installations works
- Performed inspections take into account only safety aspects, no legislation for energy efficiency and other parameters of inspections introduced by the EPBD developed as secondary legislation.

- All audits delivered to commercial banks and then to the Bank of National Economy (BGK) as a basis for applying for grant (Thermo-Modernisation Fund) are verified by independent institutions
- Standard of energy audit and calculation methods precisely described in (Journal of Laws 2002, No 12, item 114, Decree on ,,Scope and form of energy audit")

(Additional Information)

(Ministry of Transport)

- since 2009 Thermo-modernization fund provides support for renovation audit

7) Information (tools)

(NEEAP)

Planned: National information and educational campaign (p.35)

- 2012-2016
- increase social awareness regarding energy efficiency, funding (and in particular ESCO formula and White Certificates)
- promotion of nearly zero-energy buildings and passive construction
- promotion of ESCO financing

(NREAP)

- Time to save energy (Czas na oszczedzanie energii) campaign with participation of regional TV, radio, press and Internet centres, among others it should include building fairs in the schedule of fairs promoting renewable energy and energy efficient buildings and equipment (p.55)

Planned: Information campaign targeted at local governments to raise awareness on energy from renewable sources. (p.42)

(Concerted Action - EPBD)

- Central register of experts for issuing EPCs (access possible through the webpage of the Ministry of Infrastructure)
- Information campaign concerning the EPBD started in 2005 (under Ministry of Infrastructure)
  - organised within the scope of educational and information programme ,,Dom przyjazny" (Friendly house) aimed at facility managers and building owners
  - in 2008, the Ministry suspended work on preparation of brochures, posters, TV spots, international conference, etc. and also stopped supporting the "Dom przyjazny" programme
- Since September 2010, information about EPBD in brochures addressed to potential buyers/tenants and to those interested in working as qualified experts. Additional information placed on Ministry webpage.

8) Demonstration

(NEEAP)

Exemplary role of public administration (p. 38)

- awarding EU funding for public utility facilities – construction of schools, hospitals etc., primarily (and after 2015 exclusively) to buildings with increased energy efficiency, including in particular nearly zero-energy buildings

Planned

- support for the promotion of demonstration and pilot projects in the construction of nearly-zero energy public utility facilities, subsidy component should be higher than in the case of conventional actions related to thermo-modernisation of public utility facilities (p. 38)

- preparation of exemplary designs of nearly zero-energy buildings

(NREAP)

Planned

Energy conservation programme (p.47) in order to ensure the exemplary role of a public building at national, regional and local level by using renewable energy installations or becoming a zero energy building, the energy conservation programme needs to be implemented though

1. elimination of energy wastage;
2. raising the level of knowledge of administrators;
3. raising the awareness of persons using the building;
4. monitoring of the heat consumption level;
5. obtaining the energy certificate for the building;
6. verifying the power ordered for the building;
7. assessing potential application of the Act on supporting thermo-modernisation and renovation work and implementing thermo-modernisation investments;
8. comparison with the others – parameters and organisation.

Bill on energy efficiency

- takes into account exemplary role of public buildings
- assumes that public sector units will play the exemplary role in the field of economical energy management
- process of notifying the society will be based on websites, information boards and other communication media

(Additional Information)

- pilot projects in passive construction in public/buildings (schools, hospitals) planned (no figures)-->monitoring of energy performance until 2017, shall deliver information on "profitability" of passive housing /nearly zero-energy building
-

9) Education and training

(NREAP)

Trainings on building energy performance assessment available, covering for e.g. the use of energy certification computer programmes, energy performance certificates, energy audit

(Concerted Action - EPBD)

EPCs

- Minister of Infrastructure signed the Ordinance (2008) on the scope of training and examination for experts qualified to issue EPCs for buildings: no specific requirements for entities offering training courses, but scope/method of training, form of certificate, training fees are subject to regulation.
- Up to September 2010, 56 postgraduate courses for future energy experts have been launched at Technical Universities. Between January 2009 and September 2010, over 7,000 persons certified as qualified experts after passing the ministerial exams. Number of engineers that acquired the permit to issue Cs due to their competence for performing design or supervision of works estimated at approximately 100 000 (No information about

percentage of engineers active in field of certification is available)

General

- In last few years many papers related to different aspects of energy efficiency were published in technical and scientific journals. Scientists prepared proposals on the methodology for the energy assessment of buildings. Vital discussions on the variety of the proposed solutions activated research in that field.

(Additional Information)

10.3.1.10 Spain

Spain

1) National targets

(NEEAP)

- Final energy savings by sector (in ktep and percentage terms with respect to the sector's total consumption) BUILDINGS AND EQUIPMENT
  - 2016 - 2.674 (ktep), 9,3%
  - 2020 - 2.867 (ktep), 9,7%
- From 2021 all buildings constructed in Spain should have primary energy consumption that is 70% less that under the current policy and 85% less than buildings representative of the stock for 2006 (p.233)
- 13% of existing homes should be renewed by 2020 (p.237)

(NREAP)

- RES-shares: initial value, target 2020
  - 2005: 8,7%, Target 2020: 20%
  - Expected amount : 225674 GWh
- RES-share 2020 by NREAPs
  - Electricity: 158053 GWh
  - Electricity: 13593 ktoe
  - Heating and Cooling: 65744 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 40%
  - Heating and Cooling: 18,9%
  - Overall RES-share (with Transport): 22,7%
- Share RES-Electricity 2020
  - Hydro: 25,1%
  - Geothermal: 0,2%
  - Solar: 18,8%
  - Tide, wave, ocean: 0,1%
  - Wind: 49,5%
  - Biomass: 6,3%
- Share RES-Heat 2020
  - Geothermal: 0,2%
  - Solar: 11,4%
  - Biomass: 87,5%
  - Heat pumps: 0,9%

(Additional Information)

- Spain assumes the national targets defined within the EU Directive of 2010. However, Spain still hasn't finished the adaptation of the EPBD 2002. Within the next months (October 2012), a new Royal Decree will be put in place the Energy certification scheme for existing buildings. At present there is no target for nearly zero or low energy consumption in buildings.

2) Regulations

(NEEAP)

- Energy Efficiency Action Plan for the State General Administration's buildings (approved 2007 July)
  - o Sets minimum energy saving objective for all of the State General Administration's buildings in 2016 (20%)
  - o Executed by Energy Services Companies

- Technical Building Code, RITE
  - o Sets out Minimum solar contribution to sanitary hot water (not mentioned how much)

(NREAP)

- Technical Building Code
  - o New and refurbished buildings must, in addition to other energy requirements, be equipped with solar thermal and photovoltaic energy
  - o In the case of solar thermal technology, it establishes a minimum share of energy depending on the climate zone and demand for hot water
  - o Compliance is a basic requirement to obtain the certificate of habitability
  - o Planned: Adding a minimum contribution of renewable energies for the heating and cooling of newly constructed buildings
- Regulation on Thermal Installations in Buildings, RITE
  - o Requires the use of renewable energies, meaning that thermal installations must use available renewable energies in order to cover a part of the building's needs
  - o Minimum requirements must be met in order to obtain an operating permit for the installations
- Exact levels are calculated regionally and according to methodology described in regional law

(Concerted Action – EPBD)

- Technical building code
  - o Revision envisaged for 2011
  - o Use of renewable energies becomes compulsory to meet part of the energy needs of buildings, either to produce sanitary hot water or electric power in tertiary buildings
  - o Example of current requirements: in the case of Madrid, the maximum thermal transmittance for the facade is 0.66 w/m2.K
- Regulation approving the basic procedure for the energy certification of new build.
- Thermal Building Regulations
  - o Winter and summer limit temperatures for indoor air have been set for administrative, commercial and public buildings when fossil energy is used to heat or cool the building (21oC for winter and 26oC for summer)
- In Spain the EPBD has no been fully implemented by the end of 2010 but was planned to for 2011. But a roadmap for the implementation of the recast of the EPBD has started being defined and for achieving objectives like "nearly zero energy standard" for all new buildings in 2020. (III-247)

(Additional Information)

- Review of CTE (Building Spanish Code) in three steps: 2012 -->2015 --> 2019
  - o a. Integration of disconnected parts of CTE and other laws (RITE, etc...)

- b. Global index for energy consumption based on PE (kWh/m2 y) and complemented probably with other index based on CO_2, depending of climatic zone, type of building
- c. Complementary indexes (e.g. limits in the thermal loads)
- d. Absolute energy indexes (not comparison with a reference building)

- Plans 2012:
  - a. Global index still based on CO_2 emissions (as it is now in the labelling system in Spain)
  - b. New buildings should be “C”
  - c. Related to heating and cooling load should be “B”
- Plans 2015:
  - a. Adopt global energy indexes
  - b. Define “High Energy Efficiency Buildings” based on cost-optimality studies
  - c. Review certification system (labelling).
  - d. Include “reference building”
  - e. Redefine letters (levels)
  - f. Integrate with new CTE
- Plans 2019:
  - a. Adopt final definition of nearly zero-energy building
- (Source from table): No definition of nearly zero-energy building available.
- (additional document) Roadmap of implementation:
  - In 2012 the CTE and the RITE will be revised
  - In 2015, the CTE will be again revised, possibly introduced
  - Coupling of the energy certification with the CTE, “maximum” energy consumption introduced within the building regulation, max energy in coherence with the previous defined “maximum” energy demand, A label considered as the nearly zero energy
  - Cost optimality of the energy efficient measures to be applied
  - In 2018:third revision of CTE planned (nearly zero-energy building concepts included)

  - Recast procedure of existing building regulation (Código Técnico de la Edificación (CTE), launched in 2006) affecting new buildings and integral retrofitting projects started in 2011, planned to be finished in 2012, no concepts of nearly zero-energy building introduced but some concepts aiming at becoming starting steps. Changes include:
    - 1. Set up of maximum energy demand per climate region: only based on demand, not energy consumption (only considered in energy certification)
    - 2. Technical revision of the official regulation of thermal installations (RITE). Only some technical improvements will be introduced.
    - 3. Include small retrofitting in evaluation of buildings within the CTE. The level of fulfilment is not defined yet.
    - 4. Artificial lighting: evaluation of the lighting energy consumption will be included and calculated separately. Definition of a maximum lighting power per building typology and use will be defined.
    - 5. Renewable Energies. The Solar Thermal production percentage will be kept at the same level (60 % of DHW energy consumption). Other energy thermal uses will be included and more flexibility towards other Renewable Energies will be introduced.

3) Economic incentives

(Concerted Action – EPBD)

- Deduction on the Spanish Income Tax Revenue for improvement works on residential housing
- Reduction on the Spanish Value Added Tax for renewal and repair works of the main residence

4) Financing instruments

(NEEAP)

Public aid and investment aid for

- Energy renewal of the thermal envelope of existing buildings
  - o The total aid managed by the public sector in the 2011-2020 period will be 1.109,5 M€
- Improvement in the energy efficiency of thermal installations in existing buildings
  - o Total aid managed by the public sector in the 2011-2020 period will be 283 M€
- Improvement of the energy efficiency of interior lighting plants in existing buildings
  - o Total aid managed by the public sector in the 2011-2020 period will be 192 M€
  - o Subsidised, generally, by 22% of the investment , amount may rise to 27% if the action aims for the building to have an energy rating of B or up to 35% in it is an A rating(p.39, 228)
- Construction of new buildings and renovation of existing buildings with high energy ratings:
  - o Total aid managed by the public sector in the 2011-2020 period will be 788 M€
  - o Subsidises the construction of buildings with A or B energy ratings, grant varies according to type of building (single Family, multi-family or tertiary) and the rating obtained(A or B) from 50 €/m2 for a single-family house with an A energy rating up to15 €/m2 for tertiary buildings with a B energy rating
- Construction or renewal of buildings with almost zero energy consumption
  - o Total aid managed by the public sector in the 2011-2020 period will be 5 M€
- State Housing and RENOVE plan 2009- 2012 (PEVR), resources totalling 1.082 M€
- "Programme of RENEWAL aids for the renovation of housing and existing residential buildings" (grants and loans)
  - o Aid of between 1.100 Euros and 6.500 Euros per household
- “Programme of aids for the promotion of energy efficiency in homes"
  - o With aids of between 2.000 and 3.500 Euros per home, provided projects achieve an energy rating of A, B or C
- "Programme of aids for the promotion of energy efficiency in homes"
  - o With aids of between 2.000 and 3.500 Euros per home, provided that the projects achieve an energy rating of A, B or C
- Programme of aids aimed at renovation
  - o Grants and loans agreed without finding to finance rehabilitation/renovation in whole neighbourhoods, including, as financeable aspects, both rehabilitation/demolition activities and newly built homes, and works to re-urbanise neighbourhoods

(Concerted Action – EPBD)

- Measures within the incentive scheme:
  - o The thermal rehabilitation of the envelope of existing buildings;
  - o The improvement of the energy efficiency in thermal installations in existing buildings
  - o The improvement of the energy efficiency in lighting installations in existing buildings.

- o Aim is to cut back the energy consumption in a building by 2O%, with a subsidy of 22% of the necessary investment to be made; this amount could be increased up to 27% of the investment if such action seeks an energy efficiency rating B for the building, or up to 35% if rating A is achieved
- o Sometimes, these measures are incorporated in the so-called Renovation Plans, either for windows, façades or boilers
- Optional measure (not applied by all communities):
  - o Construction of new buildings with high energy rating (A&B) - Subsidy varies in accordance with the kind of building (house, block of flats or tertiary) and achieved rating (15-50 €/m2)
  - o Within the framework of the State's Housing and Rehabilitation Plan 2009-2012 - Subsidies for building dwellings with rating A, B or C, (3,500 2,800 2,000 €/home)
  - o Fund tines directly managed by IDEA - articulated through energy service companies (ESCO), qualified by IDEA. IDAE provides low-interest financing to the ESCOs that undertake investments within the scope of these programmes

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard *(NEEAP)*

- Energy certification of new buildings and undergoing major renovation transposed in 2007 (p. 227)
- Application of energy certification in public buildings (1000m2) transposed in 2007
- Energy efficiency certification of existing buildings transposed in 2011 (p.228)

(Concerted Action – EPBD)

- Building energy certification procedure, called CALENER
- For new buildings put in place 2006 & 2007
- For existing planned in 2011: According to the draft version , existing buildings with an installed capacity over 400kW will have to be rated, regardless of whether they will be sold or rented, prominent place of certificate in public building (>1000m2) (approved or not?)
- Autonomous Communities are in charge of the registration, inspection and control of the energy efficiency certificate and decide on the type of controls to apply and the penalties to be imposed in case of finding deficiencies
- Neither fixed cost nor administrative tax at national level, but Autonomous Communities can establish tax
- Administrative tax varies between a minimum amount of 150 € for single-family houses and a maximum amount of 1,200 € for big tertiary buildings
- Cost of the certificates is established by the market
- Work is being done to develop a more detailed framework for penalties, where the sanctions are clearly stated as well as the amount of the applicable fines

- There are two kinds of energy efficiency certificates
  - o Project energy efficiency certificate
  - o Finished building certificate
  - o Technicians qualified: architects, building surveyors, engineers and technical engineers

- Number of registered buildings with a certificate in the Autonomous Communities where a certification scheme exists is still very low (tota number of certificates by the end of 2010 is 1,791)

(Additional Information)

- Before ending 2012 it is planned that the Energy Certification of existing buildings will be put in place through a Royal Decree. This Energy labelling scheme will start at the beginning of 2013.
- Energy certificate of existing buildings will be based on simulation, simplified procedures include module of identification and evaluation of energy saving measures:
  - o Energy rating baseline (What is the existing building's energy efficiency?)
  - o Diagnostic of the energy performance of the building in its baseline situation (Why this energy efficiency?)
  - o Individual and combined assessment of Energy Conservation Measures (MAES).
  - o MAES applied to building must be technically and economically quantified, quantification will follow the concept of cost optimality of the new EPBD.
- Energy certification does not define maximum requirements for energy consumption.

6) Supervision (energy advice and audits)

(NEEAP)

- periodic energy efficiency inspection obligatory for heat and cold generators and complete thermal installations when they are over 15 years old (p. 245)

(NREAP)

- Advisory Committee for Thermal Installations in Buildings (p. 96)
  - o Permanent competent national and collegiate body organisationally attached to the Secretariat- General of Energy of the Ministry of Industry
- RITE Advisory Committee is likewise responsible for advising the competent Ministries regarding thermal installations in buildings

(Concerted Action – EPBD)

- Inspection of cold and heat generators
  - o All heat generators with a nominal thermal capacity over 20kW
  - o All cold generators whose nominal capacity is over 12kW
  - o Intervals for inspections of heat generators depending on the kind of fuel used and the nominal capacity of the installation (2-5 years)

7) Information (tools)

(NEEAP)

- National informational campaign by IDAE (p. 83)
  - o Numerous actions aimed at the citizen in terms of training, communication, dissemination and information in terms of saving and energy efficiency and the measures contained in the Plan

(Concerted Action – EPBD)

- IDAE (Institute for Energy Diversification and Saving) in collaboration with ATECYR (Spanish Technical Association of Air Conditioning and Refrigeration), published a collection of guides

about Energy certification, energy saving and Efficiency in Buildings o Specific information campaigns have been made for citizens, regarding the building energy certification o Various conferences on the introduction and dissemination of building energy certification have taken place in all the Autonomous Communities, addressed both to the professionals in the sector and to citizens o IDAE takes part in many sectoral fairs, where it intends to promote the building energy certification • IDAE's website, www.ídae.es and the website of the Ministry of Industry, Tourism and Commerce, www.mityc.es, provide information on building energy certification
8) Demonstration •
9) Education and training *(NEEAP)* • Training courses on the new energy policy for buildings (p.91) • Planned: guidance, in-depth courses aimed at designers, facultative management and agents, appropriate to the functions performed by each of them, management of software programmes relative to the energy certification of existing buildings (p.241) *(Concerted Action – EPBD)* • 140 courses in relation to building energy certification were held in the year 2007 at the expense of the Work Plans of the Energy Saving and Efficiency Plan 2004 - 2008 and 2008 - 2012 in the various Autonomous Communities, with a total number of trainees of approximately 2,800

10.3.1.11 Sweden

Sweden

1) National targets

(NEEAP)

- Targets for savings in Final energy consumption buildings: (p. 10)
  - 20% in 2020 vs. 1995 (kWh per m2)
  - 50% in 2050 vs. 1995

(NREAP)

- Estimated share of energy from renewable sources within the building sector (%) 2005 2010 2015 2020:
  - Residential housing 55.9% 60.3% 64.7% 69.1%
  - Commercial buildings 50.7% 55.0% 59.3% 63.6%
  - Public buildings 50.5% 55.1% 59.7% 64.3%
  - Industrial buildings NA NA NA NA
  - TOTAL 55.9% 60.3% 64.7% 69.1%

- RES-shares: initial value, target 2020
  - RES-share 2005: 39,8%
  - Target 2020: 49%
  - Expected amount : 223523 GWh
- RES-share 2020 by NREAPs
  - Electricity: 97193 GWh
  - Electricity: 8359 ktoe
  - Heating and Cooling: 122593 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 62,9%
  - Heating and Cooling: 62,1%
  - Overall RES-share (with Transport): 50,2%
- Share RES-Electricity 2020
  - Hydro: 70%
  - Geothermal: 0%
  - Solar: 0%
  - Tide, wave, ocean: 0%
  - Wind: 12,9%
  - Biomass: 17,2%
- Share RES-Heat 2020
  - Geothermal: 0%
  - Solar: 0,1%
  - Biomass: 90%
  - Heat pumps: 10%

2) Regulations

(NEEAP)

- New Buildings Act was adopted in 2011; it sets minimum requirements for buildings, including energy management; energy requirements have been tightened up by 20%
- Differentiate between office and residential buildings as well as between regions/climates (p. 27, 28)
- Other regulations: Efficiency requirements for installations (heating and cooling installations, air-conditioning systems, control systems and efficient use of electricity) have been set up (p. 27)

(NREAP)

- No national, regional or local legislation that specifically regulates an increased share of renewable energy within the building sector. It does exist indirectly in the form of targets and plans for the phasing-out of fossil-fuelled heating and funding for certain renewable heating and electricity (p. 36)
  - In the area of heating an explicit long-term prioritisation on the use of fossil fuels for heating being phased-out by 2020.
- The requirements are designed to be a verifiable functional requirement, which means that technical solutions are not specified. The building regulations are also general in nature (p. 40)
  - Primary focus is on using instruments other than the setting of minimum levels for renewable energy in the building sector in order to promote renewable energy (p. 44)
  - Proposed amendments to the regulatory framework must be able to come into force by 31 December 2014

(Concerted Action – EPBD)

- In Sweden the EPBD, 2002/91/EU, is in full action and the implementation the recast of the EPBD has started.
- Revised building code (2006)
  - Stated the maximum use of energy allowed in new buildings for the first time
  - Demands on all buildings going through a renovation, irrespective of size
  - Maximum used energy and maximum U value have been set as requirements. (see III-305)
- Regulations regarding even more energy efficient buildings when heated with electricity were launched in 2009. Next tightening of the demand planed for all buildings in 2011, with the aim of a revision in 2015 and 2018/2020 towards nearly zero-energy buildings. (III-297; III-304)
- Planned: within some years the renovation of the so called "one million dwellings program's will start (Between the end of the 60s and the beginning of the 1970 one million new dwellings were built in ten years)

(Additional Information)

- Sweden has new building regulations from 2012, but nothing about nearly zero-energy building.
- The energy use for heating ventilation and domestic hot water should be reduced by

approximately 20 % in new buildings not heated with electricity.

- The requirements for electrical heated buildings have not been changed. Instead of having weighting factors for different energy sources, Sweden has different requirements for not electrical heated buildings and for electrical heated buildings.
- In the new regulation there are requirements for buildings that undergo major renovation. In principle the renovated buildings should meet the requirements for new buildings, but there exist a lot of objections for making major renovations as the architectural look should be accepted after renovation - often have changes of facades and windows to fulfil cultural considerations - meet reasonable economic profit and the indoor climate must be acceptable.
- As a complement to requirement on the whole building there exist requirements on building components - walls, roofs, floors, windows and external doors - when these components are renovated or changed. Sweden has no roadmap for 2019/2021 of how regulations will evolve

- (Swedish government Roadmap)
  - Upgrade the energy performance requirements set in the building regulations today (BBR 19), before year 2020,first interim checkpoint is set to 2015
  - Swedish government concludes that Sweden already today fulfils the EPBD requirement: "energy required should be covered to a very significant extent by energy from renewable sources"
- (Sveriges Centrum for Nollenergihus, NGO)
  - Net ZEBs must fulfill the passive house requirements
  - Energy for plug loads and lighting are excluded
  - Weighting factors: a.) Electricity: 2, 5 b.) District heating; 0, 8 c.) All other; 1,0

3) Economic incentives

(NEEAP)

- Tax deduction for 50% of the cost of the building work carried out in residences or holiday homes.
  - Maximum deduction of SEK 50 000 per person per annum.
  - Does not apply to new-builds or to conversion and extension work on new-builds (p. 29)
- Between 2004 and 2009, the owners of single-dwelling residence had the opportunity to apply for assistance from the state for the installation of energy-efficient windows and biofuel installations. The assistance was first granted via a tax deduction and then via a state grant (p. 29)
- From 2006 to 2010 Sweden gave a grant for the conversion from direct electric heating into district heating or individual heating using biofuels; from 2006 to 2007, assistance was granted for a switch from oil-fired heating to district heating, heat pumps, biofuel-fired systems or solar systems (p. 30)
- Since 2009, a grant is available for the installation of solar cells; it applies to all types of actors (business, public, private) (p. 30)
- A state grant for investments in solar heating was introduced in 2000, and finished in 2007. It applied to residences and business premises; the size of the grant was determined by the estimated annual heat produces by the solar collectors.
- In 2009, this state assistance was replaced with state grants for parties investing in solar heating, irrespective of where the solar collector is installed. The assistance is awarded in the

form of a one-off grant to individuals or companies that install solar heating for heating purposes (p. 31).

- The Delegation for Sustainable Cities manages financial support for cities. The program must show the potential in the development of sustainable cities, act as showcases and facilitate the spread and export of sustainable urban planning, environmental technology and know-how (p. 32)
- Low Energy Buildings Program (funding program): Energy consumption for those projects that receive funding must be at least 50% below the requirements laid down in the Swedish National Board of Housing, Building and Planning's building regulations and the project must have major value as a showcase (p. 33).

(Concerted Action – EPBD)

- Tax deduction of 50% is made to all building owners renovating their houses, amounting to up to 5,000 € annually/ building and owner
- The Energy Agency together with the Swedish building industry has launched a subsidy programme for low energy use

(Additional Information)

- no subsidies from government

4) Financing instruments

(NREAP)

- Aid for conversion from direct electrical heating
  - o Targeted: Owners of residential buildings
  - o Funding only for measures between 1. January 2006 and completed no later than 31 December 2010.

(Additional Information)

- No financing instruments so far for nearly zero-energy building
-

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

- An energy certificate is to be produced when a building is sold, rented or built or if the building in question is a large building occupied by public authorities or institutions that supply public services and is therefore often visited by the general public (p. 28)
- If the building is rented the Certificate must be displayed in a visible location (Most multi dwelling buildings and business premises are subject to this requirement.)
- Energy certification must include proposals for appropriate and cost-effective measures to improve energy efficiency within the building for information purposes (p. 29)
- A standardized version of the certificate is currently being prepared and should correspond to EU "refrigerator labelling" (p. 29)

(Concerted Action – EPBD)

- Energy declaration (since 2007), until 2009:
  - o Official buildings larger than 1,000 m3

- o Buildings that are rented, residential or non-residential
- from 2009:
  - o New buildings
  - o All buildings when sold.
- Currently, there are more than 30,000 non-residential buildings, including public buildings declared
- Buildings that are rented out (multifamily residential and non-residential) have to have a valid declaration on display
- Each building is assigned an energy rating
- Only be issued by an Independent Expert (IE) (juridical person).

- Declaration system closely related to building code as the verification of compliance with the building code is done through an operational rating, taking place two years after the building is brought into use, just like the first declaration of the building in the energy declaration system

(Additional Information)

- Only voluntary classification as passive houses or low energy buildings

6) Supervision (energy advice and audits)

(NEEAP)

- Municipal energy and climate consultants (participated also in the “become energy smart” campaign)

(Concerted Action – EPBD)

- Inspection of air conditioning systems in Sweden is included in the declaration system and is carried out at the same time and its records kept in the same register as the declaration
- Inspection of air conditioning systems takes place at least every 1Oth year or combined with every third (three years apart) compulsory ventilation check

(Additional Information)

- Energy saving advice can be given by advisers (Energirådgivare) available in communities
-

7) Information (tools)

(NEEAP)

- Many information tools available:
  - o The Swedish Energy Agency is responsible for and has developed Energikalkylen [The Energy Calculation], which is an online tool that can be used to calculate energy use in single-dwelling residences and flats (p. 34)
  - o Dissemination on energy services takes place via websites, training sessions, presentations and networks (p. 34). 2007-2009: information tour on “energy smart” houses; the authorities provided information about how it is possible to be energy-smart in the home. This collaboration resulted in a joint website (www.blienergismart.se) featuring tips and guidance (p. 34)

- In 2010 the “renovate energy smart campaign” was launched; The campaign was aimed at property owners and the managers of multi-dwelling residences, house builders, manufacturers, suppliers and installers of building products and various occupational groups in the building sphere, energy and building consultants, architects, municipal planning and construction case officers, trade and professional associations and banks (p. 34)
- In the spring of 2011, a web-based information and advice portal (www.energiaktiv.se) was launched; it aimed at the owners of single-dwelling residences, multi-dwelling residences, special properties and business premises seeking advice about improving energy efficiency (p. 35).
- UFOS, the Development of Public Sector Property Management, has been organizing collaboration in relation to joint development issues since 1994. Since the beginning of 2004, this collaboration has resulted in, amongst other things, 19 publications/reports aiming at presenting the methods of improving the energy efficiency of the property stock. These publications, collectively, are referred to as UFOS Energi’s “Energy library”. (p. 35).
- The construction/living dialogue is collaboration between businesses, municipalities and the government with the aim of making progress towards a sustainable construction and property sector in Sweden. The “Vision for 2025”, sets out targets and strategies for a sustainable construction and property sector (p. 35).
- The Energy IT and Design program combines expertise in IT with design know-how and knowledge about human attitudes to, primarily, electricity, everyday goods and technology use (p. 38).

(NREAP)

- The governmental agency Boverket (the National Board of Housing, Building and Planning) publishes building and design guidelines and also provides advice and support to the administrative bodies (p. 34)
- Swedish Energy Agency the duty of having complete responsibility for information under (the Renewability Directive) (p. 48)

(Concerted Action – EPBD)

- Campaign "Get Energy Smart!” was widely promoted in the press and on the internet. The concept of energy declaration of buildings (BED) has also been promoted on TV and in appendices to the big national newspapers.
- Ministry website www.boverket.se provides detailed information about BED to supervising authorities, professionals of the sector, property owners and developers, and also to the general public
- Ordinary consumers also have a website launched by the National Board and the Consumers Agency, called www. omboende.se, (about living) which they can go to with questions concerning everything about their living conditions, in dwellings or privately owned houses.

(Additional Information)

- Common handbooks are available as complement to the building code.

8) Demonstration

(NEEAP)

- District Heating program with a demonstration section (p. 26)
- Cities as showcase for sustainable development, including buildings (see Delegation for Sustainable Cities, p. 32)
- Low Energy Buildings Program (funding program): Energy consumption for those projects that receive funding must be at least 50% below the requirements laid down in the Swedish National Board of Housing, Building and Planning's building regulations and the project must have major value as a showcase (p. 33)

(Additional Information)

- Swedish Energy Agency gives subsidies for major renovation of multifamily houses and premises. The main goal with the renovation should be to reduce the energy use by 50%. The demonstration projects are very well designed and carefully evaluated.
  A lot of information about the buildings are collected before renovation in order to have a very good base for decisions of the most efficient measures that give required energy saving.
  The process of realising the projects is carefully documented.
  The energy savings are measured during one year after finishing the renovation.
  Conclusions are summarised in reports.
- 4 - 6 multifamily buildings and 15 - 20 office buildings are studied so far.
- There exist preliminary plans for many new demonstration projects.
- The Swedish Energy agency has plans to support approximately 500 buildings the coming years, but financing is not yet decided. The support should go to new buildings of different categories and also for major renovations of different kind of existing buildings

9) Education and training

(NEEAP)

- Supply of qualified workers (and reduction of illicit employment) is stimulated by a scheme which allows tax deductions for energy savings (p. 29) => no specific training component in this measure

- CERBOF is a research and innovation program initiated by the Swedish Energy Agency. CERBOF is run in collaboration with actors in the construction sector. It aims to be the leading meeting place where the state, trade and industry, academia and consumers stimulate the advent of relevant research and innovation projects. CERBOF's activities are supposed to help bring about the utilization of the results in commercial products, services, systems or methods (p. 37).

(NREAP)

- Svenska värmepumpsföreningen (SVEP) (the Swedish Heat Pump Association) provides installer training for heat pump certification (p. 53)

(Additional Information)

- There exist training courses for passive houses and some education to get environmental classification of buildings like Green Building and LEED.
- The Swedish Energy Agency supports development of new technologies or new processes of how to introduce existing technologies in the renovation process. Example on projects are introducing of new ventilation systems with heat recovery in existing multifamily buildings and development of industrial technologies for additional insulation of facades incl. windows when renovating existing buildings

10.3.1.12 United Kingdom

United Kingdom

1) National targets

England / Wales

(NEEAP)

- As required by the Directive the UK is required to meet an indicative national energy savings target for 2016 of 9% or 136.5 terawatt hours (TWh).(5)

(NREAP)

- RES-shares: initial value, target 2020
  - RES-share 2005: 1,3%
  - Target 2020: 15%
  - Expected amount : 238430 GWh
- RES-share 2020 by NREAPs
  - Electricity: 116980 GWh
  - Electricity: 10060 ktoe
  - Heating and Cooling: 72081 GWh
- RES-share 2020 by NREAPs (data source: Table 3)
  - Electricity: 31,05%
  - Heating and Cooling: 12,04%
  - Overall RES-share (with Transport): 15%
- Share RES-Electricity 2020
  - Hydro: 5,4%
  - Geothermal: 0%
  - Solar: 1,9%
  - Tide, wave, ocean: 3,38%
  - Wind: 66,9%
  - Biomass: 22,4%
- Share RES-Heat 2020
  - Geothermal: 0%
  - Solar: 0,5%
  - Biomass: 63,1%
  - Heat pumps: 36,3%

(Additional Information)

- In July 2007, the Government's Building a Greener Future: Towards Zero Carbon Development announced that all new homes in England & Wales should emit zero net carbon1 from 2016 with a progressive tightening of the Building Regulations in 2010 and 2013. Similar ambitions for new buildings other than dwellings were made in the Budget Report 2008. The ambition for these buildings is to set net zero carbon standards from 2018 for new public sector buildings and from 2019 for other new buildings other than dwellings.

- The Government has announced that from 2016 all new homes, and from 2019 all new non-domestic buildings, in England will be built to zero carbon standards. Options for changes to the

Regulations in 2013 have been developed to act as an interim step on the trajectory towards achieving zero carbon standards from 2016/19. (CLG, 2012 Part L Buildings Regulation consultation, p.15)

- There are currently 2 consultations going on until April 2012 on the new regulations involved in this target: Standard Assessment Procedure - SAP (DECC consultation) and Part L of Buildings Regulation (CLG consultation). The consultations present the ideas of the government for the implementation of the zero carbon buildings.

- Much has been done through previous Building Regulation amendments to strengthen energy efficiency standards when building owners decide to carry out building work to existing properties. Although current analysis suggests that this is approaching the point of diminishing return, there remains some potential to further raise performance standards for extensions and domestic replacement windows and potential improvements in controlled services like non-domestic lighting. (CLG, 2012 Part L Buildings Regulation consultation, p.16)

Ireland

(NREAP)

- Estimated share of renewable energy in the building sector (%) , 2010, 2015, 2020
  - Residential 0.26% 0.59% 0.88%
  - Commercial 0.09% 0.35% 1.05%
  - Public 0.03% 0.09% 0.16%
  - Industrial 1.45% 1.51% 2.09%
  - Total 1.84% 2.54% 4.17%
- Government has committed to achieving a carbon neutral building standard for dwellings by 2013. (p.58)

(Additional Information)

- The Government has committed to a move towards low or zero carbon buildings from 2016 for dwellings and from 2019 for buildings other than dwellings. Particular objectives of this proposed amendment as the next step in this progression are to set:
  - · energy efficiency standards for new dwellings and buildings other than dwellings that will achieve a 25% reduction in CO_2 emissions from buildings relative to the level of emissions that result from the Part F standards introduced in 2006;
  - And tighter standards for energy efficiency in existing buildings.

Scotland

(Additional Information)

- On 1st of May 2011 Sustainability labeling was introduced to the Scottish Building Standards through the Building (Scotland) Act. Applicable to all new buildings, the principles build upon the degree of sustainability already embedded within the building regulations. Developed with a working group drawn from across the design and construction industry the proposals were made available for public consultation in late 2010.
- The labelling system has been designed to reward the achievement of meeting 2010 standards; and opting to meet higher levels that include energy and carbon emissions targets, but also

broader issues such as water efficiency and flexibility in design.

- The label can be utilized by developers or planners who may wish to demonstrate their environmental commitment by referring to the sustainability labels.
- The system could also be used to link with the new local development plans to give planning authorities a consistent route to achieve their obligations under Section 72, 'Development plans: inclusion of greenhouse gas emissions policies', of The Climate Change (Scotland) Act 2009 that placed clause 3F into the Town and Country Planning (Scotland) Act 1997.
- Section 7 also includes levels that identify whether buildings incorporate a low or zero carbon generating technology (LZCGT).
- The Sustainability labelling system has been fully developed for domestic buildings, however due to the more varied and complex nature labeling for non-domestic buildings has only been partially developed.
- The long-term goals are net zero carbon buildings, if practical and the ambition of total-life zero carbon buildings.

2) Regulations

England / Wales

(NEEAP)

- From 2016 for homes + 2019 for non-domestic buildings, all buildings will be required as zero carbon standard. (46)
- 2010:amend of building regulation to ↑ efficiency standards about 25% for new homes + non-domestic buildings (across building mix) + strengthen standards if work is carried out to existing properties (47)
- Review of Part L with further changes planned for 2013, to take the next step towards zero carbon for new buildings (as above) and to support wider retrofit policy for existing buildings. (47)
- Planning policy statement overhaul (public consultation 2011), defining new standards for major infrastructure planning (49)
- Rollout of smart meters + in-house displays (IHD), / expected savings £7.3 billions (60) – timescale (start mass rollout 2014, completion until 2019)+ overall strategy in DECC (2011) / For data transfer an independent central data and communication Company(61-65)
  Accurate bills, switching between suppliers faster, competitive + efficient market in energy supply + management (60)
- Welsh housing quality standard (WHQS) in social housing and local authority housing, housing associations rose between 2004-08 (equivalent to Energy Performance Certificate rating of ‘D’. (192)
- Public buildings projects have to meet the BREEAM Excellent standard (England, Wales.)(193)

(NREAP)

- England
  - Zero Carbon Buildings and Building Regulations: Existing; goal: New homes (from 2016) and new non-domestic buildings (from 2019) should not add extra carbon emissions to the atmosphere.
  - Start/End: Proposals for options for 2013 change to the Building Regulations planned for publication in early 2012. (Table 2: 13. measure)
- Wales
  - Zero carbon homes Wales: Existing (Under review); goal: All new homes in Wales to be low

carbon from 2013– will stimulate greater uptake of on-site renewables; Start/End: To come into operation (subject to current review) from 2013. Proposals including further steps towards zero carbon due for consultation in April 2012 (Table 2: 45. measure)

(Concerted Action – EPBD)
new buildings:

- Requirements for new buildings came into force in Oct. 2010, ADL1A for dwellings and ADL2A for buildings other den dwellings. key criteria:
  - o Target Emission Rate as maximum rate of CO2 emission; TER is calculated by using a notional dwelling or building of the same size and shape but constructed to a series of reference values.
  - o Limited performance vales for building fabric and building services.
  - o Passive control measures to limit solar gains
  - o Adequate information on operation and maintenance of the building services must be provided
- Approved Documents ADL1B and ADL2B came into force in Oct. 2010. Standards are prescribed for newly constructed thermal elements and for fabric elements that are to become thermal elements. Also Standards for heating and lighting in the extension.

(Additional Information)

- Consultation going on January-March 2012 on changes to the Standard Assessment Procedure (SAP), by DECC. This consultation seeks views on proposed changes to the Standard Assessment Procedure; Government's tool for assessing the energy and environmental performance of dwellings (homes).
  http://www.decc.gov.uk/en/content/cms/consultations/sap/sap.aspx
- 2012 consultation on changes to the Building Regulations in England, by CLG. The consultation is presented as four Sections. Section one outlines the consultation approach and then presents proposals to change various technical aspects of the regulations. Section two outlines proposals to increase the energy efficiency of buildings. Section three contains proposals in relation to electrical safety in homes. Section four outlines changes to the building control system.
  http://www.communities.gov.uk/planningandbuilding/buildingregulations/buildingregulationschanges/

- Until now there is no definition of zero carbon buildings (nearly zero-energy buildings) only reports of Zero Carbon Hub (an industry body set up to aid the transition to zero carbon standards for new homes) have been developed and will be used as starting point for consultation as part of future revisions to the Building Regulations (CLG p.19).
- The Carbon Compliance limits for built performance from 2016 should be:
  - o 10 kg CO2(eq) /m²/year for detached houses
  - o 11 kg CO2(eq) /m²/year for attached houses
  - o 14 kg CO2 (eq) /m²/year for low rise apartment blocks (four storeys and below). (ZCH)
- But the phased introduction of zero carbon standards has already begun in England, with the Part L changes in 2010. The next implementations of improving the energy performance of new buildings are planed for 2016 and 2019. The new standards are as stipulated by the EPBD set on the basis of cost-effectiveness, wherefore currently cost benefit analysis and standards are

executed. (CLG p.62)

- It is the Government's view that their definition of zero carbon can be equated to 'nearly zero energy' and that they meet the EPBD requirements with their commitments to zero carbon buildings. But it is under discussion for 2013 to introduce 'absolute' energy instead of carbon targets for new homes, as recommended in the Zero Carbon Hub. (CLG p.61)

Ireland

(NEEAP)

- 2011 Building Regulations for Dwellings (2011-2013)
  - o Minimum efficiency standards for new dwellings (60% improvement compared with 2002 standard)
- Building Regulations - Nearly Zero Energy Dwellings (start assumed 2016):
  - o 70% improvement compared with 2002
- 2012 Building Regulations - Buildings other than dwellings (start 2012)
  - o Planned to improve minimum standards set in previous regulations (30% improvement compared with 2008 regulation
- Energy Efficient Boiler Regulation (started 2008)
  - o Set a minimum seasonal efficiency of 86% for boilers installed in existing or new dwellings from 2008 and 90% from 2011.

Building Regulations Part F have been amended to enhance thermal standards progressively towards carbon neutral dwellings from 2016 & carbon neutral non-dwellings from 2019; (Northern Ireland) (206)

(NREAP)

- Since 2006: ensure before work commences that consideration is given to the technical, environmental and economic feasibility of installing alternative energy systems
- mandatory renewables requirement was first introduced in 2007 and became fully effective from 1 July 2009
- Regulation 2008 requires that "a reasonable proportion of the energy consumption in the energy performance of the dwellings is provided by renewable energy sources:
  - o 10 kWh/m2/annum contributing to energy use for domestic hot water heating, space heating or cooling
  - o 4kWh/m2/annum of electrical energy
  - o A combination of these which would have equivalent effect
  - o No prescribed minimum statutory requirement for renewable energy in relation to buildings other than dwellings

- Building Regulations for dwellings will be upgraded in 2010 to provide for a 60% improvement in energy efficiency requirements and a 60% reduction in CO_2 emissions relative to 2005 standards (p. 54)

***Northern Ireland**

**Zero Carbon Homes: Planned (under review); goal: All new -homes in Northern Ireland to be low or zero carbon from 2017– to stimulate greater uptake of on-site renewables; Start/End: To come into operation (subject to review) from 2017 - 2020 (Table 2: 35. measure)*

**Zero carbon Non-domestic buildings: Planned (under review); goal: Ambition (under review) for all new non-domestic buildings in Northern Ireland from 2020 (2018 for public sector buildings) – to stimulate greater uptake of on-site renewables (Table 2: 36. measure)*

(Concerted Action – EPBD)
****Northern Ireland** very similar to England and Wales (updated standards late 2011)*
IRELAND (non UK)
Legislative updates since 2008:
- introduction of certificates for non-res buildings
- strenghtening of ep requirements for dwellings
- minimum requirement of 10kWh/m2 from RES
- minimum boiler efficiency of 86%
- minimum Energy Performance coefficient (EPC)= ratio of primary energy consulption compared to reference dwelling from 2005
- Carbon performance coefficient (CPC):= ratio of calculated C02 emissions to reference dwelling from 2005
Requirements for 2011: MPEPC 0.4, MPCPC 0.46

In 2005: max primary energy requirement of 156kWh/m2
- 40 % improvement until 2008
- 60 % until 2011
(type A1: 25 kWh/m2, B : 100 kWh/m2)

(Additional Information)

- The Executive agreed to close both the energy efficiency and low carbon homes schemes from 31 March 2011. The savings associated with closure of the schemes will be transferred into funding of the Green New Deal.
- The energy efficiency homes scheme provided a one-off rebate where loft or cavity wall insulation was installed. Application forms will not be issued after 31 March 2011 and all completed applications must be received by 30 June 2011.
- The low carbon homes scheme provided a full rebate from rates (for up to two or five years) for those qualifying for the low carbon homes scheme. Given concerns from those that are in the process of building low or zero carbon properties first occupiers will still be able to qualify for the two of five year rates holiday for a limited time, where certain conditions are met. An application for planning permission must be made by 31 March 2011 and a completed low carbon homes application lodged with Land & Property Services by 31 March 2012. The property must be completed and occupied by that date and meet the necessary low or zero carbon standards.

Scotland
(Concerted Action – EPBD)

- Extensions and alternations are not required to comply with the new emission standard. However new components installed must meet all other energy standards.(III-338 to III-341)
- Revised energy standards in the building regulations came into force in Oct. 2010. Technical Handbooks provide guidance on achieving the standards for Domestic and for Non-domestic buildings. Fewer emissions of 23-28% for domestic and 18-25% for non-domestic buildings are

intended to achieve compared to previous standards. all new buildings must be provided with an Energy Performance Certificate.

(Additional Information)

- In Scotland, minimum energy performance requirements for buildings and for building elements are set through building regulations, The Building (Scotland) Regulations 2004, as amended. These were last revised in October 2010 and are subject to review again for 2013, following a public consultation scheduled for 2012. The current review cycle of energy standards, for 2013 and 2016 accords with Article 4(1) of the Directive which requires review of requirements at regular intervals of not more than five years. (COD10)

3) Economic incentives

England / Wales

(NEEAP)

- Several funding schemes, esp. supporting low income people and smaller companies
  - o Range of funding programs to helping people to heat their homes affordable if the household is in "fuel poverty" (10% off the income for heating) (53ff)
  - o Warm front scheme (until 2012) funds measures like efficient heating systems, insulation, draught proofing / since 2000 assists 2.2 mio households, potential savings Ø<£ 650 per household/annum(54), in Ireland: warm homes scheme (202ff)
  - o NISEP (Northern Ireland Sustainable Energy program) provides £7.5 mio/year in grant funding for energy efficiency / renewable energy scheme for domestic and non-domestic properties (206)
  - o Community energy saving program (CESP) since 2009, targets low income communities in England; is designed to deliver whole home retrofits on street basis by energy suppliers and generators (57)
  - o Boiler scrappage scheme 2010 / voucher for £400 cash back on replacement of a 'G'rated boiler by a 'A'rated one / target group: all households, Administrations (67)

(NREAP)

- Renewable Heat Incentive (RHI): Existing; goal: Increase generation of renewable heat from a range of technologies across all scales
- Start/End: Opened for applications from the non-domestic sector at the end of November 2011. The Government intends that the scheme remains open to new applications until at least 2020. Once in the scheme, support lasts for 20 years. (Table 2: 3. measure)

(Concerted Action – EPBD)

- The improvement of the energy efficiency in thermal installations in existing buildings

(Additional Information)

- Beyond the on-site carbon compliance standards, Government is developing an approach to 'allowable solutions' which will allow developers to support offsite carbon reduction measures (such as district heating schemes) where it is not technically feasible or commercially viable to abate all carbon emissions through on-site means (CLG p. 57). The use of allowable solutions could be linked to a Community Energy Funds or a Private Energy Funds (ZCHub p. 24), but nothing is decided yet.

Ireland

(NREAP)

- Accelerated Capital Allowances for Energy Efficient Equipment
    - Companies which purchase specific energy efficient equipment (including renewable technologies) can claim their full cost against corporation tax in the year of purchase (100% capital allowance) instead of the usual 12½% over 8 years for plant and machinery
- Grant assistance under schemes such as Greener Homes and Houses of Tomorrow
- Social Housing Investment Programme

(Concerted Action – EPBD)

Ireland (NON UK)

- The improvement of the energy efficiency in lighting installations in existing buildings.

Warmer Home Scheme

- improve ee

- social employment and private contractor direct delivery model

Greener Home Scheme

- increase RES by fixed grant to homeowners

Home Energy Saving scheme

- grants to homeowners for ee measures

- BER must be undertaken to receive the grant

National retrofit programme

- public, residential, commercial buildings

- incorporate other grant programs from 2011 (as described above)

Other incentive schemes provided by local authorities, energy utilities and government departments

4) Financing instruments

England / Wales

(NEEAP)

- Green deal as a very smart measure in the future.
    - Green Deal, a market mechanism expected to be operating from late 2012 that will enable energy efficiency retrofit in homes and businesses to be financed through energy bill savings.(27)
    - It will enable private firms in Great Britain to offer consumers (homeowners, tenant, business) energy efficiency improvements to their homes, community spaces or businesses at no upfront cost with repayments recouped through a charge made in instalments on their energy bill. No upfront payment / charge will stay with the property, what means: everyone will pay for the savings they make (40)

(NREAP)

- Renewable Heat Premium Payment: Existing; August 2011 - March 2012, goal: Financial support to encourage the domestic deployment of renewables (Table2: 4. measure)

(Additional Information)

- The Green Deal is the Government's flagship policy designed to significantly reduce emissions

from existing buildings through promoting an increase in retrofit activity. The Green Deal will create a new financing mechanism to enable private firms to offer domestic and non-domestic consumers energy efficiency improvements to their buildings at no upfront cost, and to recoup payments through a charge in installments on the energy bill. DECC consulted on the introduction of the Green Deal and new Energy Company Obligation between November 2011 and January 2012. The framework for the Green Deal is due to be in place in October 2012.
- Because a Green Deal assessment generates a test of cost-effectiveness, it is debatable if it is the right tool for financing Zero Carbon Houses. (CLG p. 42)

Ireland

(NEEAP)

- Better Energy Workplaces (since 2011)
  - €11.5m in 2011
  - Grant aid for Public and Business sectors
  - Support is available for sustainable energy upgrades to buildings

- The CHP Deployment programme provided grants for selected renewable and alternative heat sources and was designed to prime the market and to establish a supply chain, ended in 2011(p. 7)
- ReHeat programme provided grants for selected renewable and alternative heat sources and was designed to prime the market and to establish a supply chain, it ended in 2011 (p. 8)
- Greener Homes Scheme (GHS)
  - Started 2006
    - Grant assistance is provided towards the purchase of certain energy efficient and renewable energy heating appliances for the domestic sector
    - Warmer Homes Scheme (WHS)
  - Started 2000
    - The measure is funded by SEAI via regional not for profit organisations and private contractors
    - Home Energy Saving (HES) scheme (2008-2011)
    - Energy use for domestic heating and hot water
- Incorporated in to the residential retrofit scheme, launched as 'Better Energy Homes' in May 2011.
- Better Energy Homes (residential retrofit) (since 2011)
  - Grant-aids , €80m in 2011 and thereafter dependant on annual government budget allocations
- Public Sector Building Demonstration Programme

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

England / Wales

(NEEAP)

- Exist, but voluntary:
  - Code for sustainable homes including 9 categories of sustainable design, for new homes, rates the home as whole package, since 2011, as single voluntary national standard to guide industry in the design and construction of sustainable new homes (48)

(Concerted Action – EPBD)

- EPCs give information on how to make your home more energy efficient and reduce carbon dioxide emissions. All homes bought, sold or rented require an EPC. EPCs are valid for ten years. Costs of Certificates: 50-100 pounds for domestic buildings; the cost for DECs and ECPs for non-domestic buildings differ greatly.
  Different EPCs for domestic and non-domestic buildings.(III-332-335)

- Display Energy Certificates (DECs) show the public the actual energy usage of a building, the Operational Rating and energy efficiency of a building. Produced for public authorities and institutions with floor area >1000m² providing public services. (III-333)

(Additional Information)

- Energy rating baseline (What is the existing building's energy efficiency?)

Ireland

(NEEAP)

- Building Energy Rating has been established and is also linked to funding schemes
  - An official Building Energy Rating (BER) is completed on each home which receives and energy upgrade detailing all energy efficiency measures carried out on the house (p. 26)
  - Certificates are mandatory for new buildings and for existing buildings in the event of sale or rent; the certificate is publicly accepted and visible; a national database for validated certificates exists; quality control is in place

(NREAP)

- EPCs for existing dwellings on sale are required from 2008.

Ireland (NON UK)

Known in Ireland as Building Energy Rating (BER)

Mandatory BER introduced in

- 2007 for new dwellings

- 2008 for non-res buildings

- 2009 existing buildings for sale or rent

-display of BER in public service buildings > 1000m2

(Additional Information)

- Diagnostic of the Energy performance of the building in its baseline situation (Why this Energy efficiency?)

Scotland

(Additional Information)

- Individual and combined assessment of Energy Conservation Measures (MAES).

6) Supervision (energy advice and audits)

England / Wales

(Concerted Action – EPBD)

- Boilers: efficiency advice on is provided but no inspection (III-336)
- Air-conditioning equipment: inspections in the hole UK with little distinctions.

- Inspection every 5 years for all systems >12kW. (III-336)

Ireland

(NEEAP)

- The programme “Better Energy Homes” (residential retrofit) combines “advice, subsidies and obligation scheme”.
    - o Audit/advice is linked to the programme and implementation of a measure
    - o An official Building Energy Rating is completed on each home which receives (p. 26)

(NREAP)

- Energy Audit services by SEAI and local energy management agencies and others

(Concerted Action – EPBD)

- In Northern Ireland, there has also been a phased introduction of the requirement for air-conditioning. New installations will be inspected every 5 years. Systems over 250kW will be inspected by the ***46(?)***of January 2010 and those over 12kW by the ***4ü* (?)** of January 2011

Scotland

(Concerted Action – EPBD)

- Scottish legislation for the introduction of inspections for air-conditioning systems was introduced on the 1st May of 2007.

7) Information (tools)

England / Wales

(NEEAP)

- Info via bill, suppliers, EST exist, focus on end-user
    - o Numbers of policies to improve provided info on bills + reporting of CO2 Emissions for companies (28) -> see also industries?! + 2011-12 voluntary agreement with suppliers to provide info about own consumptions + compares with similar households etc. on bills, if not voluntary DECC will initiate legislative process 2012 (66)
    - o Energy saving trust (EST) gives advices to consumers via phone, online, face-to-face alongside green deal when it starts. (52)

(Concerted Action – EPBD)

- "Major publicity campaigns have taken place in all parts of the UK through a range of media: ..." (III-338) not further specified

Ireland

(NREAP)

- SEAI engaged in various information and guidance campaigns
    - o Has developed targeted resources (brochures) for planners and architects, e.g.:PassivHAUS Standard, Passive Solar Design etc
    - o Hosted low energy building design days and workshops, seminars
- Several further initiatives at country level (p.66)

(Concerted Action – EPBD)
Ireland (NON UK)
boiler inspection based on information campaigns, not regulatory
- advertisements in newspapers , tv, internet
Four major information campaigns between 2008- 2010 on BER

Scotland
(Concerted Action – EPBD)
- Technical Handbooks provide guidance on achieving the standards for domestic buildings and for non-domestic buildings

8) Demonstration
Ireland
(NREAP)
- Local Authorities and voluntary/co-operative housing associations have been invited to submit proposals for demonstration projects to deliver sustainable energy-efficient housing developments in which homes will reach a minimum A2 Building Energy Rating; €10m has been allocated in 2009 and again in 2010 to support these demonstration projects, which will significantly advance the knowledge and experience base in the design, construction and use of high performing energy efficient housing, and promote wider awareness of the technologies involved. (p.55)
- Many regions and local areas have been involved in voluntary demonstration projects that include renewables in buildings (p. 55)
- (p. 58) The Department of the Environment, Heritage and Local Government has approved funding for flagship low-carbon housing schemes in eight local authorities which will begin construction in summer 2010.
- The Department of Environment sponsors an annual prize for the development of sustainable public buildings
- Annual Energy Show sponsored by Sustainable Energy Authority of Ireland (SEAI)

9) Education and training
England / Wales
(Concerted Action – EPBD)
- Independent experts:
  - England/Wales (similar in Northern Ireland): Energy assessors must be member of a specialist Accreditation Scheme approved by the Government. They have to ensure the suitability of the assessor and the quality of the assessments. To become accredited, each assessor must demonstrate evidence of their qualification and competence to meet the National Occupational Standards.

(Additional Information)
- In its 2010 report on Low Carbon Construction, the BIS Innovation and Growth Team recognized the need to broaden and deepen the understanding of low carbon building performance in all parts of the industry. The CLG recommends ,to achieve the improvement required, that the Sector Skills Councils, Universities and colleges, professional bodies and the education funding agencies should

develop and maintain education and training to support the production of low and zero carbon buildings. (CLG p. 54)

Ireland (NON UK)

Training for assessors required by training provider registered with national accreditation body
Training requirements differs on area of audit (dwellings, non-domestic, large public)

Scotland

(Concerted Action – EPBD)
For existing buildings EPCs must be produces by a member of a professional body with whom the Scottish Government has entered into protocol. Each organization is responsible for their members. (III-337)

10.3.1.13 Norway

Norway
1) National targets *(Concerted Action – EPBD)* • All new buildings should be of passive standard by 2O2O (III-263) *(Additional Information)* • In [1] it is proposed a plan for energy efficiency improvements in the building sector that would be in line with the EPBD recast, and it specifies: o Major renovation of existing buildings ▪ Low energy standards by 2015 (public buildings from 2014) ▪ Passive House standard by 2020 (public buildings from 2018) o New constructions ▪ Passive House standard by 2015 ▪ Nearly Zero Energy standard by 2020 (public buildings from 2014)
2) Regulations *(Concerted Action – EPBD)* • Following the implementation of the EPBD, the energy requirements in the building regulation were revised in 2007. The Norwegian building regulation contains specific energy limits for different building types. The requirements are set in kWh/m² final energy demand per year. Also there are requirements for different building components from envelop, technical installations and heat recovery systems. • Energy requirements are set with regard to 13 different building categories. (III-263) *(Additional Information)* • The Norwegian standard NS 3700 for "low energy" and "Passive House" residential buildings contains stricter requirements than the current technical requirements (TEK 10). An analogous Norwegian standard for non-residential buildings (NS 3701) is in work. • (ZEB centre, NGO) sets: o Physical boundary in building/development o Balance boundary (eg.heating, cooling, ventilation...) o Boundary conditions (functionality, effectiveness, climate, comfort...) o Metrics: CO2 factors o Passive house standard for all new buildings from 2015
3) Economic incentives *(Concerted Action – EPBD)* • Certification - energy certification for apartments and small houses e free of charge for those who accept a rather simpte data input (III-262) *(Additional Information)*

- Support programs offered by ENOVA (State Energy Agency) beginning with June 1, 2010:
  - o Feasibility studies on Passive House: The project owner receives up to 50 000 NOK and 50 % of the costs covered.
  - o Financial support for passive house and low energy building
  - o Support for existing buildings in order to reduce the energy consumption. The financial support is related to the reduction of energy consumption.

- The maximum support for Passive Houses and low energy buildings is 40 % of the expected additional costs (in relation to the building under the current regulations or rehabilitation in relation to historical energy use) and it depends on the level of ambition and the building categories:
  - o Passive House:
    - New residential buildings and day care: 450 NOK/m2
    - New non-residential buildings: 350 NOK/m2
    - Rehabilitation of residential building and day care: 700 NOK/m2
    - Renovation of non-residential buildings: 550 NOK/m2
  - o Low energy buildings:
    - New residential buildings and day care: 300 NOK/m2
    - New non-residential buildings: 150 NOK/m2
    - Rehabilitation of residential building and day care: 600 NOK/m2
    - Renovation of non-residential buildings: 450 NOK/m2

- Support for counselling (when applying for funding for Passive House):
  The advice is provided by Enova's adviser team or by another consultant (the requirements for competence are given). Maximum number of hours of counselling:
  - o 20 hours for projects with the heated area smaller than 500 m2
  - o 40 hours for projects with heated area 500 m2 or more
  - o Projects that include several construction categories will be assessed for up to 60 hours counselling
  - o The maximum support rate is 930 NOK per hour.

4) Financing instruments

(Concerted Action – EPBD)

- No incentives regarding energy efficient buildings directly connected to energy certification or inspection. Wide number of support mechanisms to stimulate building developers to go beyond minimum requirements, as well as for owners to develop a good practice of maintenance and energy administration.

(Additional Information)

- Husbanken (State Housing Bank) offers allowances for a state analysis of existing residential buildings and favourable loan with lower rates of interest than an ordinary bank, on condition that the renovation includes measures for energy efficiency or universal design. For new buildings, the prerequisite for loan is energy performance (or other environmental measures) and universal design on a higher level than required in regulations, i.e. low-energy or passive house standards, instead of the regulatory TEK10. Normally, the allowances cover 50 % of the analysis cost. Over the term of the loan, the rates of interest are approximately 1 % point lower than from an ordinary bank. In case of projects with particular challenges, it is possible to get “competence grants” in addition.

5) Energy performance certificates’ use and layout in relation to nearly zero-energy building standard

(Concerted Action – EPBD)

- As of July 2010 the obligation of energy certification is in force for both residential and non-residential buildings.
- For existing residential buildings or apartments the certificate can be assessed by home owners via internet on the Energy Certificate System in a simple version and detailed registration.
- For new or major renovated buildings and existing non-residential buildings an expert is required for the assessment. Non-residential buildings over 1000m² shall have a valid energy certificate and display a summary to the public. The energy certificate contains identity data of the building, the measured energy consumption, recommendations, central input data of the calculation and the energy label determined by the calculated delivered energy need and the extent of heating that can be done with renewable energy sources. Validity of energy certificates is 10 years. (III-256- III-258)

(Additional Information)

- Certification

  Beginning with July 1, 2010, the energy certificate is needed for:
  - New dwellings or buildings and dwellings or buildings that go through complete refurbishment
  - Sale and rent of dwellings or buildings

  - Non-residential buildings over 1000 m2 shall have a current energy certificate which has to be displayed for the public.
  - For existing residential buildings, the owner is responsible for the certification (self assessment). The owner gives input data on the Internet to the Energy Certification System. The certificate is instantly produced.
  - For new residential buildings and for non-residential buildings the certification is made by experts.

  - The energy performance certificate has the following content:
    - Energy label (the calculated delivered energy needed, and to what extend heating of space and water can be done with renewable energy sources)
    - Recommendations for energy efficiency
    - Documentation of the information that was used in certification
    - For non-residential buildings in use, it will be given the consumed energy in

the last three years

- Inspection requirements
  - o Boilers using fossil fuels serving a heated floor area over 400 m2 must be inspected every 4 years and every 2 years if over 2,000 m2
  - o Heating systems using fossil fuels, serving a heated area over 400 m2 and older than 15 years require a one-off inspection
  - o Air conditioning systems serving an area over 500 m2 shall be inspected every 4 years
  - o The building owner is responsible for the inspection. The report from the inspection shall be uploaded onto the Energy Certification System at NVE. NVE established a template for each type of inspection. NVE is the Norwegian Water Resources and Energy Directorate.
  - o It is allowed to use an expert who is already involved in maintenance, as long as he/she meets the requirements of competence.

6) Supervision (energy advice and audits)

(Concerted Action – EPBD)

- A regular inspection of boilers, air conditioning and ventilation systems has been established in 2010 but has to be implemented in practice. The inspection requirement is based on the size of the area served by a system instead the effective rated output. (III-259 - III-260)
- The regulation defines the level of competence needed to perform inspection of technical systems. (III-261)

(Additional Information)

- No other information than given in "economic incentives" and "financial instruments"

7) Information (tools)

(NREAP)

- Outstanding Construction Product trademark, the professional and consultancy

(Concerted Action – EPBD)

- The information strategy during 2010 has had the following main elements:
  - o Updated information and proper guidance on
  - o Two leaflets, directed to the public and owners of non-residential buildings
  - o Editorial material to be used by magazines, newspapers, technical magazines
  - o A help desk was established in cooperation with Enova (National Energy Fund/Administration).
  - o Homepage and an electronic guide served the purpose of facilitating the correct

(Additional Information)

- Information on passive house and ZEB buildings is availabble via the ZEB research centre, Enova (State Energy Agency), Husbanken (State Housing Bank), Lavenergiprogrammet (the low energy programme; an industry association) and a number of local events, such as conferences, seminars, breakfast meetings organised by these institutes.

8) Demonstration

(Additional Information)

- About 6-8 ZEB pilot projects will be realized with the support of the ZEB (Zero Emission

Buildings) research centre, in the period 2012-2015. These include both residential and commercial buildings, both new and renovation projects.

9) Education and training

(Additional Information)

- There are types of courses on Passive house concept/standard.
  - One course is organised by the university NTNU and targets architects and engineer. The course duration is equivalent to two weeks: three days lectures + project-assignment over a couple months. This course already includes a part on ZEB.
  - Another course is organised by the Lavenergiprogrammet ("The low energy programme, and industry association) together with research institute SINTEF. This course is diversified for the professional audience: designers, such as architects and engineers (2 days), developers and contractors (1 day) and craftsmen (1 day). The last course, for craftsmen, is also under development and expansion through the IEE project "Build-up Skills". This does not yet include a part on ZEB.

10.3.1.14 Switzerland

Switzerland

1) National targets

(NEEAP)

- Overall goal: 2000 Watt society

  Targets for 2020:
- The coordinated Building code of the Swiss Cantons shall be strengthened by 2014: The energy demand for hating and domestic hot water in new residential buildings shall be limited to probably some 30 kWh/(m2a)
- 20% reduction of CO2 and fossil energy compared to 1990
- prohibition of electric heating also for existing buildings by 2015, with execution deadline 2025

  Targets for 2050:
- increase of retrofit rate from 0.9 to 2% per year
- Obligation: optimising the energy use of technical building systems
- Obligation: energy inspection of technical building systems
- Maximum values for electrical devices, lighting
- Simplification of approval to install systems for energy generation of renewable sources (federal und cantonal government)
- Spatial planning: consideration of locations for systems for energy generation of renewable source (federal und cantonal government)

(NREAP)

RES-share 2012

- electricity: 56% (33 TWh) (hydro: 54% wind, biomass, solar: 0.26%, rubbish and waste water: 1.74%)

  Target 2050
- +22.3 TWh RES-electricity

2) Regulations

(NEEAP)

- Swiss standards for heat and electricity demand are under development
- 2014 and 2020: recast of basic agreement of the Cantons for building efficiency
- Recasts of the different energy laws of the Cantons

(Additional Information)

- EPBD-requirement of nearly zero-energy buildings for new buildings shall be integrated into the building codes of the Swiss cantons by 2014 with the deadline for the nearly zero-energy building's (new buildings) to become mandatory by 2018.
- Recently launched MINERGIE-A-standard, considered as a way to define nearly zero-energy buildings

(Additional Information)

3) Economic incentives

(NEEAP)

- Tax reduction for retrofitting the building
- Federal and cantonal government grant for retrofitting the building

(NREAP)

ongoing:

- financial support for generating energy from renewable sources (federal government)
- financial support to install and run photovoltaic systems and thermal solar collectors (federal and cantonal government)

Change until 2050

- financial support for photovoltaic systems < 10 kWp (one contribution max 30% of investment cost) (federal government)
- financial support for photovoltaic systems > 10 kWp (money for each generated kWh)(federal government)

(Concerted Action – EPBD)

- The thermal rehabilitation of the envelope of existing buildings;

4) Financing instruments

(NEEAP)

Tax-reduction and subsidy-programs for efficiency measures and renewables for efficiency measures according to cantonal laws, CO2-tax on national level to feed subsidy-Programs for efficiency measures and renewables

(NREAP)

Cost-covering refund for electricity delivered by photovoltaic plants

5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard

(NEEAP)

ongoing

- The building energy certificate is basis for a retrofit-grant (federal government, several Cantons)
- Some Cantons gives grants for building energy certificates with joint report on energetic optimisation option for the building

Target 2050:

Obligation: building energy certificate must be made when the building is sold

(Additional Information)

- Energy certificate of existing buildings will be based on simulation, simplified procedures include module of identification and evaluation of energy saving measures:

6) Supervision (energy advice and audits)

-

7) Information (tools)

(NEEAP)

The board of the energy directors of the Cantons develops a tool for retrofitting: "Gebäudeausweis der Kantone GEAK" [Energy Calculation with efficiency rating], which is an online tool that can be used to calculate energy use in residential buildings, offices and schools. The building envelope and the total demand is rated, rough proposals for improving buildings are given. This tool started in

2009. In autumn 2012 a second tool "GEAK Plus" starts. This tool is supplementary to the GEAK, regarding proposals for improving buildings incl. costs for 3 different retrofit-options. This tool could be used for new buildings, either. Different Cantons have there own tools to make proposals for improving buildings.
8) Demonstration •
9) Education and training

10.3.1.15 United States of America

United States of America
1) National targets *(Additional Information)* • No specific federal target for achievement of Zero Energy Buildings in the U.S. as of 2012 • Federal commercial buildings: by 2015, 15% of existing Federal buildings conform to new energy efficiency standards and 100% of all new Federal buildings be Zero Net Energy by 2030 • Residential building: seeks to reduce energy consumption across the sector by at least 50% by 2030 • New Homes by Climate Zone (Mixed/Hot-Dry and Marine, Mixed-Humid and Hot-Humid, Cold) (compared to benchmark) o Current "best in class" (20% or above): 2010, 2011 ,2011 o 30%: 2011, 2012, 2013 o 50%: 2014, 2015, 2016 • Goals for Existing Homes by Climate Zone o Current "best in class" (15% or above) (2011, 2011, 2011) o 30% (2012, 2013, 2014) o 50%(2015, 2016, 2017) • California: rigorous plan to reach zero energy buildings for all new construction by 2020 • Massachusetts: all new buildings, both residential and commercial will have to reach net zero energy by 2030
2) Regulations *(Additional Information)* • Building America Program: o focuses on conducting the systems research required to improve the efficiency of the approximately 116 million existing homes, as well as of the 500,000–2,000,000 new homes built each year • California: o adjusted its building codes to require net-zero-energy performance in residential buildings by 2020 o In commercial buildings by 2030 o Focused on net-zero-energy performance instead of fossil fuel use o Since 2009 studying the requirement that existing buildings be substantially improved at the time of sale and repurchase • Massachusetts o State-level “stretch” building energy code will help lead to continual improvements in building practices such that by 2030, net-zero energy buildings should comprise all new construction in the state.
3) Economic incentives

(Concerted Action – EPBD) • Aim is to cut back the energy consumption in a building by 2O%, with a subsidy of 22% of the necessary investment to be made; this amount could be increased up to 27% of the investment if such action seeks an energy efficiency rating B for the building, or up to 35% if rating A is achieved
4) Financing instruments •
5) Energy performance certificates' use and layout in relation to nearly zero-energy building standard *(Additional Information)* • MAES applied to building must be technically and economically quantified, quantification will follow the concept of cost optimality of the new EPBD.
6) Supervision (energy advice and audits) •
7) Information (tools) •
8) Demonstration *(Additional Information)* • Test House and Pilot Community Evaluations (p.3)
9) Education and training

10.3.2 Reporting template for national plans to increase the number of nearly zero-energy buildings

10.3.2.1 Introduction

10.3.2.1.1 EPBD reporting requirements on national plans for increasing the number of nearly zero-energy buildings[26]

The EPBD encompasses reporting requirements on national plans for increasing the number of nearly zero-energy buildings for both the European Commission and the Member States.

Reporting requirements for the Member States

Member States shall draw up national plans for increasing the number of nearly zero-energy buildings (EPBD Article 9 paragraph 1). These national plans may include targets differentiated according to the category of building. Furthermore the national plans shall include, in a nutshell, the following elements (EPBD Article 9 paragraph 3):

- The Member State's detailed application in practice of the definition of nearly zero-energy *buildings*, i.e. their EPBD based *national definition of nearly zero energy buildings*.
- *Intermediate targets for improving the energy performance of new buildings*, by 2015, with a view to all new buildings being nearly zero-energy buildings after 31 December 2020 or new buildings occupied and owned by public authorities being nearly zero-energy buildings after 31 December 2018 respectively.
- Information on *the policies and financial or other measures for the promotion of nearly zero-energy buildings* with a view to *new buildings.*
- Information on *the policies and financial or other measures for the promotion of nearly zero-energy buildings* with a view to *buildings undergoing major renovation.*

Reporting requirements for the European Commission

According to the Energy Performance of Buildings Directive (EPBD), the Commission shall publish a report on the progress of Member States in increasing the number of nearly zero-energy buildings (EPBD Article 9 paragraph 5). The first report is to be published by 31 December 2012 and every three years thereafter. On the basis of that report the Commission shall develop an action plan and, if necessary, propose measures to increase the number of those buildings and encourage best practices as regards the cost-effective transformation of existing buildings into nearly zero-energy buildings.

The Commission's report builds on the Member States' reports.

Related articles and paragraphs are specified in Annex 1.

[26] According to Article 2 of the EPBD, 'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The remaining energy required should be covered to a very significant extent by energy from renewable sources, including renewable energy produced on-site or nearby.

10.3.2.1.2 How to use this template

The European Commission recommends that the Member States use this reporting template. Member States should possibly leave the structure unchanged and fill/answer all requested items. If an answer cannot be given, please explain why.
National plans for increasing the number of nearly zero-energy buildings are due by 31 September 2012.

10.3.2.1.3 Evaluation of national plans by the Commission

"The Commission shall evaluate the national plans … notably the adequacy of the measures envisaged by the Member States… ." (EPBD Article 9, paragraph 4). After having received the national plan the Commission "… may request further specific information regarding the requirements set out in paragraphs 1,2 and 3", which form the basis of the questions in this template. "In that case, the Member State concerned shall submit the requested information or propose amendments within nine months following the request from the Commission. Following its evaluation, the Commission may issue a recommendation."

For the purpose of the evaluation, the Commission has developed an analytical framework, including benchmarks for the technical and economic adequacy of measures.

Based on the results of the evaluation, according to EPBD Article 9 paragraph 5 "the Commission shall by 31 December 2012 and every three years thereafter publish a report on the progress of Member States in increasing the number of nearly zero-energy buildings. On the basis of that report the Commission shall develop an action plan and, if necessary, propose measures to increase the number of those buildings and encourage best practices as regards the cost-effective transformation of existing buildings into nearly zero-energy buildings."

10.3.2.2 Starting point

As an introduction to the national report, each Member State should give an introduction by describing the starting point for the implementation of nearly zero-energy buildings in the country. For this purpose, Member States should address, in particular, the following two topics:

1. Building stock characteristics;
2. Development of national requirements on the energy performance of buildings.

Within the description of the building stock characteristics, the size and age structure of the residential as well as the non-residential building stock should be addressed and the most emerging needs should be highlighted.

Additionally, the chronological development of national requirements on the energy performance of buildings should be illustrated. As an example, Figure 166 shows how such an illustration could look like.

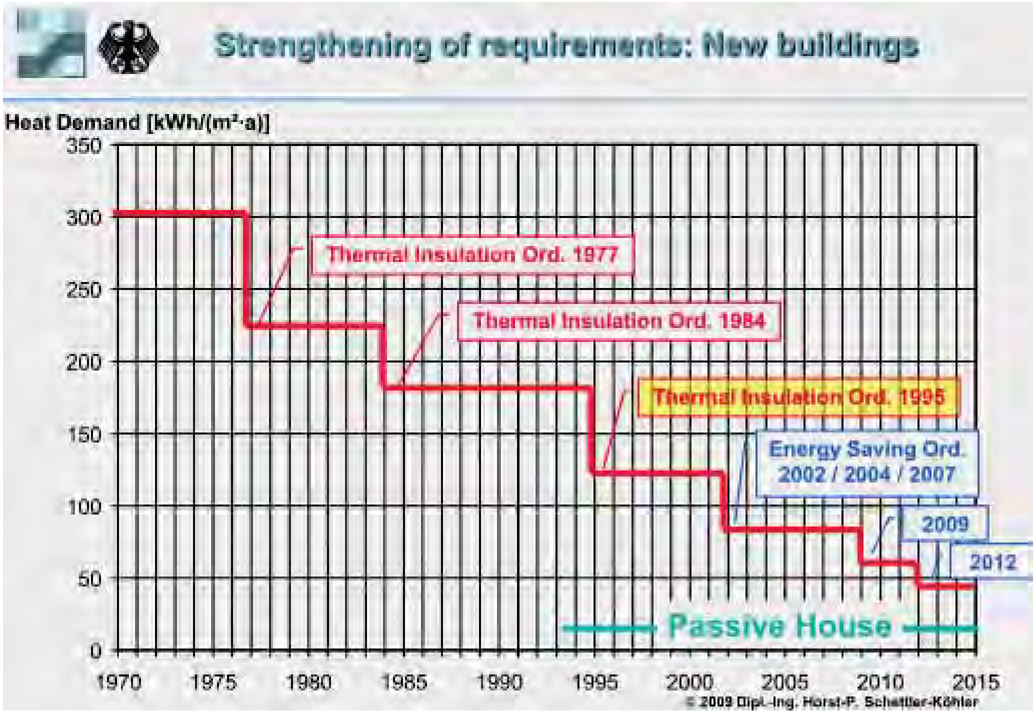

Figure 166: Example of the development of national requirements on the energy performance of buildings (Germany):

1. **Please give here a short overview of your national building stock. Describe the most important characteristics and emerging needs.** 2. **Additionally, illustrate the chronological development of national requirements on the energy performance of buildings (for an example, see Figure 27)**

10.3.2.3 Application of the definition of nearly zero-energy buildings

According to EPBD Article 9 Paragraph 3(a) the "national plans shall include (...) the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m² per year. Primary energy factors used for the determination of the primary energy use may be based on national or regional yearly average values and may take into account relevant European standards."

In this section, Member States should indicate how a nearly zero-energy building is defined within their national context and explain underlying assumptions and factors that provide the rationale for the chosen definition.
Specifically, the following EPBD requirements have to be addressed:

- The building needs to have a very high energy performance:
  - The amount of energy required should be nearly zero or very low;
  - The energy required should be covered to a significant extent by energy from renewable sources;
- Inclusion of a numerical indicator of primary energy use expressed in kWh/m² per year;
- Primary energy use may be based on national or regional yearly average values and may take into account relevant European standards.

For reporting the detailed application in practice of the definition of nearly zero-energy buildings, the table presented in Annex 2 is to be used.

0

If a national definition of nearly zero-energy buildings does not exist yet in your country, please indicate here whether precise plans are already under development and if so, please describe these plans. Please also describe if any currently used non-governmental definitions will be considered in these plans and/or a future directive.	Evaluation nZEB definition	
	Element	**Points**
	Does a definition exist? [Yes=1; No =0; In case of no, total points =0]	
	Numerical indicator of primary energy use expressed in kWh/m² per year [Yes=1; No=0]	
	Primary energy factors clearly defined (Also whether national or regional) [Yes=1; No =0]:	
	Minimum levels of energy from renewable sources in new buildings and in existing buildings;[Yes, a very significant extent is required (incl. convincing explanation)=2; Yes (RE requirement is part of national nZEB definition)=1; No=0]:	
	Energy demand should be nearly zero or very low [Yes and well explained=1; No=0]	
	SUM (Max. 6 points)	
	Reasons for delta to maximum achievable points clearly explained? (Yes/No):	
	Recommendations for decreasing delta:	

10.3.2.4 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings

EPBD Article 9 Paragraph 3(a) stipulates that “national plans shall include (...) intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1 of Article 9 (“(a) by 31 December 2020, all new buildings are nearly zero- energy buildings”).

Member States should set targets for 2015 aiming to improve the energy performance of new buildings and enabling a smooth transition towards the full practical implementation of the EPBD for new buildings in 2020. The qualitative and quantitative 2015 targets should be explicitly reported in this section. The qualitative and quantitative 2015 targets should be explicitly reported in this section.

The qualitative 2015 targets should be focus on energy related requirements for new residential and non-residential buildings and in this context specifically determine

- Requirements on the fraction of renewable energies:
- Requirements on the useful energy demand:
- Requirements on the primary energy demand:

The quantitative 2015 target should contain the aimed share of nearly zero-energy buildings according to official nearly zero-energy building definition or a comparable standard on all newly constructed buildings. Here, the reference parameter as for example the number of buildings, floor area, volume etc. has to be defined.

If available, also miscellaneous targets of all kinds for residential and commercial nearly zero-energy buildings should be stated in this chapter.

A distinction should be made between residential and non-residential buildings.

A rationale should be given for the definition of the targets and the way in which the set targets relate to and help to ensure that all new buildings are nearly zero-energy buildings (EPBD Article 9 Paragraph 1(a)) by 31 December 2020.

Note: Chapter 3.1.2 of the National energy efficiency action plan “National targets for nearly zero-energy buildings” also asks for this information. Therefore, please check whether this information has already been answered in the NEEAP and, if useful, consider this as an input here.

0

Please report the 2015 targets ensuring that by 31 December 2020 all new buildings are nearly zero-energy buildings. Also explain how they relate to and help to ensure that all new buildings are nearly zero-energy buildings by 31 December 2020.	Evaluation intermediate targets (all buildings)	
Qualitative 2015 targets: Interim energy related requirements for new residential and non-residential buildings Requirements on fraction of renewable energies:	**Qualitative 2015 targets:** Interim energy related requirements for new buildings	
	Requirements on fraction of renewable energies [Yes=1; No=0]	**Residential:** **Non-residential:**
Requirements on useful energy demand:	Requirements on useful energy demand [Yes=1; No=0]	**Residential:** **Non-residential:**
Requirements on primary energy demand:	Requirements on primary energy demand [Yes=1; No=0]	**Residential:** **Non-residential:**
Quantitative 2015 targets: Share of nZEB according to official nZEB definition on all newly constructed buildings (define reference parameter e.g. number of buildings, floor area, volume etc.):	**Quantitative 2015 targets:** Number / floor area of newly constructed nZEB buildings according to official nZEB definition	
Miscellaneous:	Share of nZEB: [Yes and it is convincingly explained why it helps to achieve 2020 target =2; Yes, without sufficient explanation=1; No=0]	**Residential:** **Non-residential:**
From your point of view, how close is your country at the moment in achieving this target? In case there is no target defined yet, please indicate when it is expected to have such a target.	**SUM (Max. 10 points)**	
	Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
	Recommendations for decreasing delta:	

10.3.2.5 Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings

EPBD Article 9 Paragraph 3(a) stipulates that “national plans shall include (...) intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1 of Article 9 (“(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.”)

Member States should set targets for 2015 aiming to improve the energy performance of new public buildings and enabling a smooth transition towards the full practical implementation of the EPBD for new public buildings in 2018. The qualitative and quantitative 2015 targets should be explicitly reported in this section. The qualitative and quantitative 2015 targets should be explicitly reported in this section.

The qualitative 2015 targets should be focus on energy related requirements for new residential and non-residential buildings and in this context specifically determine

- Requirements on the fraction of renewable energies:
- Requirements on the useful energy demand:
- Requirements on the primary energy demand:

The quantitative 2015 target should contain the aimed share of nearly zero-energy buildings according to official nearly zero-energy building definition or a comparable standard on all newly constructed buildings. Here, the reference parameter as for example the number of buildings, floor area, volume etc. has to be defined.

If available, also miscellaneous targets of all kinds for residential and commercial nearly zero-energy building should be stated in this chapter.

A rationale should be given for the definition of the targets and the way in which the set targets relate to and help to ensure that new buildings occupied and owned by public authorities are nearly zero-energy buildings (EPBD Article 9 Paragraph 1(b)) by 31 December 2018.

Note: Chapter 3.1.2 of the National energy efficiency action plan “National targets for nearly zero energy buildings” also asks for this information. Therefore, please check whether this information has already been answered in the NEEAP and, if useful, consider this as an input here.

Please report here the 2015 targets ensuring that by 31 December 2018 all new public buildings are nearly zero-energy buildings. Also explain how they relate to and help to achieve that by 31 December 2018, all new public buildings are nearly zero-energy buildings
Qualitative 2015 targets: Interim energy related requirements for new public buildings Requirements on fraction of renewable energies: Requirements on useful energy demand: Requirements on primary energy demand: **Quantitative 2015 targets: Share of public nZEB according to official nZEB definition on all newly constructed public buildings (define reference parameter e.g. number of buildings, floor area, volume etc.):** **Miscellaneous:**
From your point of view, how close is your country at the moment in achieving this target? In case there is no target defined yet, please indicate when it is expected to have such a target.

Evaluation intermediate targets (public buildings)	
Qualitative 2015 targets: Interim energy related requirements for new public buildings	
Requirements on fraction of renewable energies [Yes=1; No=0]	
Requirements on useful energy demand [Yes=1; No=0]	
Requirements on primary energy demand [Yes=1; No=0]	
Quantitative 2015 targets: Number / floor area of newly constructed public nZEB buildings according to official nZEB definition	
Share of nZEB: [Yes and it is convincingly explained why it helps to achieve 2020 target =2; Yes, without sufficient explanation=1; No=0]	
SUM (Max. 5 points)	
Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:	
Recommendations for decreasing delta:	

10.3.2.6 Policies and measures for the promotion of all new buildings being nearly zero-energy buildings after 31 December 2020

EPBD Article 9 Paragraph 3(c) stipulates that “national plans shall include (...) Information on the policies and financial or other measures (...) for the promotion of nearly zero-energy buildings.” with view to achieving the goal that “by 31 December 2020, all new buildings are nearly zero- energy buildings” (Article 9, Paragraph 1 (a)).

In this section, Member States should report on the measures targeted at all new buildings both private and public. For new buildings, Article 6 of the recast EPBD regulates that “measures should be taken (...) to ensure that new buildings meet the minimum energy performance requirements.

Guidelines for setting energy performance requirements are set out in Article 4 (1) of the EPBD and include, inter alia, that “minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels.”

The reporting in this section should include “details of national requirements and measures concerning the use of energy from renewable sources in new buildings (...)” (Article 9, Paragraph 3(c) of EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that “By 31 December 2014, Member States shall, in their building regulations (...) require the use of minimum levels of energy from renewable sources.”

Summarising the above paragraph, the measures should clearly show how they;

- promote that by 31 December 2020, all new buildings are nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources (including foreseen minimum requirements in national building codes) in all new buildings;
- increase the energy performance with a view to achieving cost-optimal levels in all new buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). When describing the measures, a differentiation between residential and non-residential buildings should be made. For further explanations of the different policies and measures, please see Annex 3. The following table lists all types of measures that should finally be described in the context of this chapter.

Note: Chapters 3.3.2.1, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

Please describe ALL relevant measures that exist and that are planned in your country and try to address for each group of measures how they: • **promote that by 31 December 2020, all new buildings are nearly zero-energy buildings;** • **increase the share of all kinds of energy from renewable sources;** • **increase the energy performance with a view to achieving cost-optimal levels.** **For every measure it is recommended to provide all or some of the following information:** • **Title of the energy saving measure/programme;** • **Timeframe;** • **Status and implementation;** • **What is the approximate total and/or annual budget for the measure?** • **Implementing body;** • **Monitoring authority;** • **Overlaps;** • **Energy savings and underlying assumptions;**		**Evaluation policies and measures (all new buildings)** Grade the policies and measures by giving them 0-3 points: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3points.
Residential buildings		**SUM residential (Max. 21 points):**
Relevant regulations		
Relevant economic incentives and financing instruments		
Energy performance certificates' use and layout in relation to nearly zero-energy building standard		
Supervision (energy advice and audits)		
Information (tools)		
Demonstration		
Education and training		

Non-residential buildings		SUM non-residential (Max. 21 points):
Relevant regulations		
Relevant economic incentives and financing instruments		
Energy performance certificates' use and layout in relation to nearly zero-energy building standard		
Supervision (energy advice and audits)		
Information (tools)		
Demonstration		
Education and training		
From your point of view, how would you evaluate the current measures that are in force? Please also try to describe the existing gap between what is in force and what should be in force in order to ensure that after 31 December 2020, all new buildings are nearly zero-energy buildings. Are there precise measures planned for the future?		**SUM residential and non-residential (Max. 42 points):**
		Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:
		Recommendations for decreasing delta:

10.3.2.7 Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero-energy buildings after 31 December 2018

EPBD Article 9 Paragraph 3(c) stipulates that “national plans shall include (...) Information on the policies and financial or other measures (...) for the promotion of nearly zero-energy buildings.” In view of the goal that “after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings” (Article 9, Paragraph 1 (b), recast EPBD)

In this section, Member States should report on the measures targeted at all new buildings owned or occupied by public authorities. For new buildings, Article 6 of the recast EPBD regulates that “measures should be taken (...) to ensure that new buildings meet the minimum energy performance requirements.”

Guidelines for setting energy performance requirements are set out in Article 4 (1) of the EPBD and include, inter alia, that “minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels.”

The reporting should include “details of national requirements and measures concerning the use of energy from renewable sources in new buildings (...)” (Article 9, Paragraph 3(c), recast EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that “By 31 December 2014, Member States shall, in their building regulations (...) require the use of minimum levels of energy from renewable sources.”

Summarising the above paragraph, the measures should clearly show how they;

- promote that after 31 December 2018, all new public buildings are nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources in public buildings;
- increase the energy performance with a view to achieving cost-optimal levels in public buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). For further explanations of the different policies and measures, please see Annex 3.The following table lists all types of measures that should finally be described in the context of this chapter.

Note: Chapters 3.3.2.1, 3.4.2, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

Please describe here ALL relevant measures that exist and that are planned in your country and try to address for each group of measures how they: • **promote that after 31 December 2018, all new public buildings are nZEB;** • **increase the share of all kinds of energy from renewable sources;** • **increase the energy performance with a view to achieving cost-optimal levels.** **For every measure it is recommended to provide all or some of the following information** • **Title of the energy saving measure/programme;** • **Timeframe;** • **Status and implementation;** • **What is the approximate total and/or annual budget for the measure?** • **Implementing body;** • **Monitoring authority;** • **Overlaps;** • **Energy savings and underlying assumptions;**		**Evaluation policies and measures (new public buildings)** Grade the policies and measures by giving them 0-3 points: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3points.
Relevant regulations		
Relevant economic incentives and financing instruments		
Energy performance certificates' use and layout in relation to nZEB standard		
Supervision (energy advice and audits)		
Information (tools)		
Demonstration		
Education and training		

From your point of view, how would you evaluate the current measures that are in force? Please also describe the existing gap between what is in force and what should be in force in order to ensure that after 31 December 2018, all new public buildings are nearly zero-energy buildings. Are there precise measures planned for the future?	**SUM (Max. 21 points):**
	Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:
	Recommendations for decreasing delta:

10.3.2.8 Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero-energy buildings

In this section, measures taken to promote the transformation of both private and public existing buildings into nearly zero-energy buildings should be reported pursuant to Article 9, Paragraph 2 of the recast EPBD: “Member States shall furthermore, following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings (...)”.

With regard to existing buildings, EPBD Article 7 provides that “Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements (...)”.

These requirements should be “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.” while “Member States may differentiate between new and existing buildings” (Article 4 (1) of the EPBD.

The reported measures should ensure “the promotion of nearly zero-energy buildings (...) concerning the use of energy from renewable sources in (...) existing buildings undergoing major renovation” (Article 9, Paragraph 3(c), recast EPBD) in view of Article 13(4) of Directive 2009/28/EC which requires that “by 31 December 2014, Member States shall, in their building regulations (...) require the use of minimum levels of energy from renewable sources.”

Summarising the above paragraph, the measures should additionally show how they;

- stimulate the transformation of buildings (both public and private) that are refurbished into nearly zero-energy buildings;
- increase the share of all kinds of energy from renewable sources in the existing building stock;
- increase the energy performance of existing buildings with a view to achieving cost-optimal levels;
- ensure that the public sector takes up a leading example in transforming existing buildings into nearly zero-energy buildings.

To avoid double work, the selection of types of measures has been adjusted to the requirements of the National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAP). When describing the measures, a differentiation between residential and non-residential buildings should also be made. For further explanations of the different policies and measures, please see Annex 3.The following table lists all types of measures that should finally be described in the context of this chapter.

Notice: Chapters 3.3.2.1, 3.4.2, 3.8 and 3.10 of the NEEAP as well as chapters 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.4 of the NREAP also ask for this information. Therefore, please check whether this information has already been answered in the NEEAP and/or NREAP and, if useful, consider this as an input here.

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Please describe here ALL relevant measures that exist and that are planned in your country and try to address for each group of measures how they: • stimulate the transformation of buildings that are refurbished into nZEB; • increase the share of all kinds of energy from renewable sources; • increase the energy performance with a view to achieving cost-optimal levels. For every measure it is recommended to provide all or some of the following information: • Title of the energy saving measure/programme • Timeframe; • Status and implementation; • What is the approximate total and/or annual budget for the measure? • Implementing body; • Monitoring authority; • Overlaps; • Energy savings and underlying assumptions.		**Evaluation policies and measures (major renovation)** Grade the policies and measures by giving them 0-3 points: No policy/measure implemented = 0 points; Seems to be insufficient=1 point; Seems to be sufficient at current point in time=2 points; A package is implemented and completely convincing=3points.
Residential buildings		**SUM residential (Max. 21 points):**
Relevant regulations		
Relevant economic incentives and financing instruments		
Energy performance certificates' use and layout in relation to nZEB standard		
Supervision (energy advice and audits)		
Information (tools)		
Demonstration		
Education and training		

Non-residential buildings		SUM non-residential (Max. 21 points):
Relevant regulations		
Relevant economic incentives and financing instruments		
Energy performance certificates' use and layout in relation to nZEB standard		
Supervision (energy advice and audits)		
Information (tools)		
Demonstration		
Education and training		
From your point of view, how would you evaluate the current measures that are in force? Please also try to describe the existing gap between what is in force and what should be in force in order to stimulate the transformation of buildings that are refurbished into nZEB. Are there precise measures planned for the future?		**SUM residential and non-residential (Max. 42 points):**
		Reasons for delta to maximum achievable points clearly explained? (Yes/No). Also consider Self evaluation:
		Recommendations for decreasing delta:

10.3.2.9 Possible improvements

This chapter should act as a kind of overall self-evaluation. Certainly the Member States themselves know best where there is room for improvement in the entire framework for promoting the construction of nearly zero-energy buildings and what could, respectively, be improved to make better progress.

Where do you see most room for improvement in order to increase the number of nearly zero-energy buildings in your country? Please also try to give examples for appropriate measures.	**Overall evaluation**	
	Category	**Sub-evaluation result:**
	Application of the definition of nearly zero	%
	Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2020 all new buildings are nearly zero	%
	Intermediate targets for improving the energy performance of new buildings in order to ensure that by 31 December 2018, new buildings occupied and owned by public authorities are nearly zero	%
	Policies and measures for the promotion of all new buildings being nearly zero	%
	Policies and measures for the promotion of all new buildings occupied and owned by public authorities being nearly zero	%
	Policies and measures for the promotion of existing buildings undergoing major renovation being transformed to nearly zero	%
	Overall evaluation result [(ΣSub-evaluation result) / 6]:	**%**
	Summarise main recommendations for decreasing the delta:	

Annex 1 – Specifics on legislation related to increasing the number of nearly zero-energy buildings and national reporting

Directive 2009/28/EC, Article 13(4) of

Member States shall introduce appropriate measures in their building regulations and codes in order to increase the share of all kinds of energy from renewable sources in the building sector:

- In establishing such measures or in their regional support schemes, Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings.
- By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation. Member States shall permit those minimum levels to be fulfilled, inter alia, through district heating and cooling produced using a significant proportion of renewable energy sources.

EPBD, Article 4

Setting of minimum energy performance requirements

1. Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The energy performance shall be calculated in accordance with the methodology referred to in Article 3. Cost-optimal levels shall be calculated in accordance with the comparative methodology framework referred to in Article 5 once the framework is in place.
   Member States shall take the necessary measures 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.
   When setting requirements, Member States may differentiate between new and existing buildings and between different categories of buildings.
   These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building.
   A Member State shall not be required to set minimum energy performance requirements which are not cost-effective over the estimated economic lifecycle.
   Minimum energy performance requirements shall be reviewed at regular intervals which shall not be longer than five years and, if necessary, shall be updated in order to reflect technical progress in the building sector.
2. Member States may decide not to set or apply the requirements referred to in paragraph 1 to the following categories of buildings:

(a) Buildings officially protected as part of a designated environment or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance;
(b) Buildings used as places of worship and for religious activities;
(c) Temporary buildings with a time of use of two years or less, industrial sites, workshops and non-residential agricultural buildings with low energy demand and non-residential agricultural buildings which are in use by a sector covered by a national sectoral agreement on energy performance;
(d) Residential buildings which are used or intended to be used for either less than four months of the year or, alternatively, for a limited annual time of use and with an expected energy consumption of less than 25% of what would be the result of all-year use;
(e) Stand-alone buildings with a total useful floor area of less than 50 m^2.

EPBD, Article 6

New buildings

3. Member States shall take the necessary measures to ensure that new buildings meet the minimum energy performance requirements set in accordance with Article 4.
   For new buildings, Member States shall ensure that, before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems such as those listed below, if available, is considered and taken into account:
   (a) decentralised energy supply systems based on energy from renewable sources;
   (e) cogeneration;
   (f) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources;
   (g) heat pumps.
1. Member States shall ensure that the analysis of alternative systems referred to in paragraph 1 is documented and available for verification purposes.
2. That analysis of alternative systems may be carried out for individual buildings or for groups of similar buildings or for common typologies of buildings in the same area. As far as collective heating and cooling systems are concerned, the analysis may be carried out for all buildings connected to the system in the same area.

EPBD, Article 7

Existing buildings

Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements set in accordance with Article 4 in so far as this is technically, functionally and economically feasible.

Those requirements shall be applied to the renovated building or building unit as a whole. Additionally or alternatively, requirements may be applied to the renovated building elements.

Member States shall in addition take the necessary measures to ensure that when a building element that forms part of the building envelope and has a significant impact on the energy performance of the building envelope, is retrofitted or replaced, the energy performance of the building element meets minimum energy performance requirements in so far as this is technically, functionally and economically feasible.

Member States shall determine these minimum energy performance requirements in accordance with Article 4.

Member States shall encourage, in relation to buildings undergoing major renovation, the consideration and taking into account of high-efficiency alternative systems, as referred to in Article 6(1), in so far as this is technically, functionally and economically feasible.

EPBD, Article 9 paragraph 1

Member States shall ensure that:

(a) by 31 December 2020, all new buildings are nearly zero-energy buildings and

(b) that after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings

EPBD, Article 9 paragraph 2

Member States shall furthermore, following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, and inform the Commission thereof in their national plans referred to in paragraph 1.

EPBD Annex I: Common general framework for the calculation of energy performance of buildings (referred to in Article 3)

1. The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs.
2. The energy performance of a building shall be expressed in a transparent manner and shall include an energy performance indicator and a numeric indicator of primary energy use, based on primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for on- site production. The methodology for calculating the energy performance of buildings should take into account European standards and shall be consistent with relevant Union legislation, including Directive 2009/28/EC.
3. The methodology shall be laid down taking into consideration at least the following aspects:

   (a) the following actual thermal characteristics of the building including its internal partitions: (i) thermal capacity; (ii) insulation; (iii) passive heating; (iv) cooling elements; and (v) thermal bridges;

   (b) heating installation and hot water supply, including their insulation characteristics;

   (c) air-conditioning installations;

(d) natural and mechanical ventilation which may include air-tightness;

(e) built-in lighting installation (mainly in the non-residential sector);

(f) the design, positioning and orientation of the building, including outdoor climate;

(g) passive solar systems and solar protection;

(h) indoor climatic conditions, including the designed indoor climate;

(i) internal loads.

4. The positive influence of the following aspects shall, where relevant in the calculation, be taken into account:

(a) local solar exposure conditions, active solar systems and other heating and electricity systems based on energy from renewable sources;

(b) electricity produced by cogeneration;

(c) district or block heating and cooling systems;

(d) natural lighting.

EPBD, Recital 15

As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs for heating and cooling are reduced to cost-optimal levels.

EPBD, recital 25

Priority should be given to strategies which enhance the thermal performance of buildings during the summer period. To that end, there should be focus on measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques, primarily those that improve indoor climatic conditions and the micro- climate around buildings.

Annex 2 – National application of the definition of nearly zero-energy buildings

1. General information				
Country			select	
Name of regulation, directive, certification scheme				
Editor of regulation, directive, certification scheme				
Year of introduction of current version			select	
Energy benchmark of current version			select	
Integration and consideration in national directive			select and describe	
2. Field of application	**EPBD / RED requirement**	**EPBD / RED reference**	**Content in Member States national**	**Explanation, comment, source**
2.1 building category	*Member States shall ensure that all new buildings are nearly zero- energy buildings by 31 December 2020 resprecively after 31 December 2018 (occupied and owned by public authorities).*	EPBD article 9.1a/b	select and describe	
▪ single-family houses			select	
▪ apartment blocks			select	
▪ offices			select	
▪ educational buildings			select	
▪ hospitals	*For the purpose of the calculation buildings should be adequately classified into the [...] categories.*	EPBD annex I	select	
▪ hotels and restaurants			select	
▪ sports facilities			select	
▪ wholesale and retail trade service			select	
▪ other types of energy-consuming buildings			select	
2.2 new/retrofit buildings	*New, and existing buildings that are subject to major renovation, should meet minimum energy performance requirements adapted to the local climate.* *Member States shall furthermore [...] stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings*	EPBD preamble recital 15 EPBD article 9.2	select	
2.3 private/public buildings	*Member States shall ensure that by 31 December 2020, all new buildings are nearly zero- energy buildings and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.*	EPBD article 9.1a/b	select	
2.4 In case that a additional or separate definiton(s) exists (e.g. for different building types), please add a new sheet by using the button on the right (to use this option Excel macros need to be activated).			click to add new sheet	
3. Energy Balance / Calculation				
3.1 balance type	*[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources* *Energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand [...]*	EPBD article 2.2 EPBD article 2.4	select and describe right	
3.2 physical boundary	*This directive lays down requirements as regards the common general framework for [...] buildings and building units.* *[...] building' means a roofed construction having walls, for which energy is used to condition the indoor climate.*	EPBD article 1.2a EPBD article 2.1	select and describe right	

3.3 system boundary demand / energy uses included				
▪ space heating, domestic hot water	*[...] energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting.*	EPBD article 2.4	select	
▪ ventilation, cooling, air conditioning			select	
▪ auxiliary energy			select	
▪ lighting			select	
▪ plud loads, appliances, IT			select	
▪ central services			select	
▪ electric vehicles			select	
▪ embodied energy			select	
3.4 system boundary generation / renewable energy sources included				
▪ generation on-site	*[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.* *[...] 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.*	EPBD article 2.2 EPBD article 2.6	select	
▪ generation near by	*[...] minimum levels of energy from renewable sources [...] to be fulfilled, inter alia, through district heating and cooling [...]*	EPBD article 13.4	select	
▪ generation external			select	
▪ crediting			select	
3.5 balance period / calculation step	*[...] The methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance of a building [...]* *[...] requirements should be set with a view to [...] the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building [...]*	EPBD preamble recital 9 EPBD preamble recital 10	select and describe right	
3.6 monthly accounting limitation			select and describe right	
4. Accounting System				
4.1 normalization	*[...] including a numerical indicator of primary energy use expressed in kWh/m² per*	EPBD article 9.3a	select and describe right	
4.2 primary metric	*The energy performance of a building shall be expressed in a transparent manner and shall include an energy performance indicator and a numeric indicator of primary energy use, based on primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for on-site production.* *[...] including a numerical indicator of primary energy use expressed in kWh/m 2 per year.* *[...] primary energy' means energy from renewable and non-renewable sources which has not undergone any conversion or transformation process*	EPBD Annex 1 EPBD 9.3a EPBD article 2.5	select and describe right	
4.3 secondary metric			select and describe right	
4.4 symmetric or asymmetric weighting			select and describe right	
4.5 time dependent weightin	*Primary energy factors [...] may be based on national or regional yearly average values and may take into account [...] European*	EPBD 9.3a	select and describe right	

5. Further requirements				
5.1 fraction of renewables	*Member States shall introduce [...] appropriate measures [...] to increase the share of all kinds of energy from renewable sources in the building sector [...]. By 31 December 2014, Member States shall [...] require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings [...]* *[...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]*	RED article 13.4 EPBD article 2.2	select and describe right	
5.2 temporal performance				
▪ load match			select and describe right	
▪ grid interaction			select and describe right	
5.3 energy performance or rating requirements	*nearly zero-energy building means a building that has a very high energy performance [...]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...]*	EPBD article 2.2	select and describe right	
▪ energy performance indicator				
▪ numeric indicator of primary energy use	*The energy performance [...] shall [...] include an energy performance indicator and a numeric indicator of primary energy use [....]*	EPBD Annex 1		
5.4 general framework / prescriptive requirements	*The methodology shall [...] take into consideration: thermal characteristics (thermal capacity, insulation, passive heating, cooling elements, and thermal bridges), heating installation and hot water supply, air-conditioning installations, natural and mechanical ventilation, built-in lighting, the design, positioning and orientation of the building, outdoor climate, passive solar systems and solar protection, [...] internal loads*	EPBD Annex 1	select and describe right	
5.5 definition of comfort level & IAQ requirements (for winter and summer season, beside other national directives)	*This Directive [...] takes into account [...] indoor climate requirements [...]* *The methodology shall [...] take into consideration: [...] indoor climatic conditions [...]* *That includes [...] indoor air-quality, adequate natural light [...]*	EPBD article 1.1 EPBD Annex 1 EPBD preamble recital 9	select and describe right	
5.6 monitoring procedure	*[...] energy performance of a building means the calculated or measured amount of energy needed [...]* *Member States shall encourage the introduction of intelligent metering systems [...] and the installation of automation, control and monitoring systems [...]*	EPBD article 2.4 EPBD article 8.2	select and describe right	

Annex 3 – Definition of policies and measures

Economic incentives and financing instruments:

This contains schemes of economic support e.g. for the generation of heat or electricity from renewable sources, direct financial stimuli and appropriate tax policies. Such instruments give financial support for investment e.g. through capital grants, low interest loans, tax exemptions or reductions, tax refunds, tender schemes, tradable green certificates, feed-in tariffs, feed-in premiums, voluntary schemes etc.

Supervision (energy advice and audits):

Member States should indicate which responsible authority will monitor, review the effects of specific policies, give advices and assure quality implementation of the programmes.

Information (tools):

Current and future information and awareness raising campaigns and programmes, as well as planned revisions, and expected results should be described. Please indicate how this information is made available and who is responsible for the adequacy and the publishing of this information.

Education and training:

This contains instruments, such as motivational mechanisms, training and education of citizens, installers, project developers, decision makers etc. Please list existing trainings regarding certification and licensing procedures of very efficient technologies or renewable energy installations and explain how guidance for planners and architects is provided to help them to properly consider the optimal combination of renewable energy sources, high efficiency technologies and district heating and cooling when planning, designing, building and renovating buildings.

10.4 Appendix task 3

10.4.1 Nomenclature and glossary

10.4.1.1 Building

Building [EN 15615:2007]

Construction as a whole, including its envelope and all technical building systems, for which energy is used to condition the indoor climate, to provide domestic hot water and illumination and other services related to the use of the building

NOTE The term can refer to the building as a whole or to parts thereof that have been designed or altered to be used separately.

Conditioned area [EN ISO 13790:2008]

Floor area of conditioned spaces excluding non-habitable cellars or non-habitable parts of a space, including the floor area on all storeys if more than one.

NOTE 1 Internal, overall internal or external dimensions can be used. This lead to different areas for the same building.

NOTE 2 Some services, such as lighting or ventilation, might be provided to areas not included in this definition (e.g. a car park).

NOTE 3 The precise definition of the conditioned area is given by national authorities.

NOTE 4 "Conditioned area" can be taken as the useful area mentioned in the Clause 5, 6 and 7 of the EPBD [...] unless it is otherwise defined in national regulations.

Conditioned space [EN 15603:2008]

Heated and/or cooled space.

Conditioned zone [EN ISO 13790:2008]

Part of the conditioned space with a given set-point temperature or set-point temperatures, throughout which the same occupancy pattern is assumed and the internal temperature is assumed to have negligible spatial variations, and which is controlled by a single heating system, cooling system and/or ventilation system, or by different systems with equal energy performance.

Thermal zone of a building [EN ISO 13786:2007]

Part of a building throughout which the internal temperature is assumed to have negligible spatial variations.

Heat recovery unit (sensible and latent)

Mechanical component that recover waste heat from another system and use it to replace heat that would otherwise come from a primary energy source.

Photovoltaic panels (PV)

Photovoltaic devices use semiconductor material to directly convert sunlight into electricity. Power is produced when sunlight strikes the semiconductor material and creates an electric current.

Technical building system [EN 15603:2008]

Technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production

NOTE 1 A technical building system can refer to one or to several building services (e.g. heating system, heating and DHW system).

NOTE 2 A technical building system is composed of different subsystems.

NOTE 3 Electricity production can include cogeneration and photovoltaic systems.

Ventilation system [EN 15615:2007]

Combination of appliances designed to supply interior spaces with outdoor air and to extract polluted indoor air.

10.4.1.2 Building services

Building services [EN 15603:2008]

Services provided by the technical building systems and by appliances to provide the indoor climate condition, illumination and other services related to the use of the building.

Dehumidification [EN 15615:2007; EN 15603:2008]

Process of removing water vapour from air to reduce relative humidity.

Humidification [EN 15615:2007; EN 15603:2008]

Process of adding water vapour to air to increase relative humidity.

Lighting [EN 15603:2008]

Process of supplying the necessary illumination.

Other services [EN 15603:2008]

Services supplied by energy consuming appliances.

Space cooling [EN 15615:2007; EN 15603:2008]

Process of heat extraction for thermal comfort.

Space heating [EN 15615:2007; EN 15603:2008]

Process of heat supply for thermal comfort.

Ventilation [EN 15615:2007; EN 15603:2008]

Process of supplying or removing air by natural or mechanical means to or from any space

NOTE Such air is not required to have been conditioned.

10.4.1.3 Energy and emissions

System boundary [EN 15603:2008]

Boundary that includes within it all areas associated with the building (both inside and outside the building) where energy is consumed or produced

NOTE Inside the system boundary the system losses are taken into account explicitly, outside the system boundary they are taken into account in the conversion factor.

Energy need for heating or cooling [EN 15603:2008]

Heat to be delivered to or extracted from a conditioned space to maintain the intended temperature conditions during a given period of time.

NOTE 1 The energy need is calculated and cannot easily be measured.

NOTE 2 The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing (decreasing) the effective temperature for heating (cooling) and not included in the heat transfer due to the heating (cooling) system.

Energy need for domestic hot water [EN 15603:2008]

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 humidification and dehumidification [EN 15603:2008]

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.

Energy use for lighting [EN 15603:2008]

Electrical energy input to the lighting system.

Energy use for space heating or cooling or domestic hot water [EN 15603:2008]

Energy input to the heating, cooling or hot water system to satisfy the energy need for heating, cooling (including dehumidification) or hot water respectively

NOTE If the technical building system serves several purposes (e.g. heating and domestic hot water) it can be difficult to split the energy use into that used for each purpose. It can be indicated as a combined quantity (e.g. energy need for space heating and domestic hot water).

Energy use for ventilation [EN 15603:2008]

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.

Delivered energy [EN 15603:2008]

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

NOTE 1 For active solar and wind energy systems the incident solar radiation on solar panels or on solar collectors or the kinetic energy of wind is not part of the energy balance of the building. It is decided at national level whether or not renewable energy produced on site is part of the delivered energy.

NOTE 2 Delivered energy can be calculated for defined energy uses or it can be measured.

System thermal loss [EN 15615:2007]

Thermal loss from a technical building system for heating, cooling, domestic hot water, humidification, dehumidification or ventilation that does not contribute to the useful output of the system.

Energy carrier [EN 15615:2007; EN 15603:2008]

Substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes [ISO 13600:1997]

NOTE The energy content of fuels is given by their gross calorific value.

Auxiliary energy [EN 15603:2008]

Electrical energy used by technical building systems for heating, cooling, ventilation and/or domestic water to support energy transformation to satisfy energy needs.

NOTE 1 This includes energy for fans, pumps, electronics, etc. Electrical energy input to the ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation.

NOTE 2 In EN ISO 9488, Solar energy – Vocabulary, the energy used for pumps and valves is called “parasitic energy”.

Exported energy [EN 15603:2008]

Energy, expressed per energy carrier, delivered by the technical building systems through the system boundary and used outside the system boundary

NOTE 1 It can be specified by generation types (e.g. CHP, photovoltaic, etc) in order to apply different weighting factors.

NOTE 2 Exported energy can be calculated or it can be measured.

Net delivered energy [EN 15603:2008]

Delivered minus exported energy, both expressed per energy carrier

NOTE 1 A balance of the delivered and exported energy per energy carrier can be performed only if the same primary energy factors and/or CO2 coefficients apply to the delivered and exported amounts of that energy carrier.

NOTE 2 The term "net" can also be applied to quantities derived from net delivered energy, e.g. primary energy or CO2 emissions.

Primary energy
Energy that has not been subjected to any conversion or transformation process
NOTE 1 Primary energy includes non-renewable energy and renewable energy. If both are taken into account it can be called total primary energy.
NOTE 2 For a building, it is the energy used to produce the energy delivered to the building. It is calculated from the delivered and exported amounts of energy carriers, using conversion factors.

Renewable energy [EN 15615:2007; EN 15603:2008]
Energy from a source that is not depleted by extraction, such as solar energy (thermal and photovoltaic), wind, water power, renewed biomass.
NOTE In ISO 13602-1:2002, renewable resource is defined as “natural resource for which the ratio of the creation of the natural resource to the output of that resource from nature to the technosphere is equal to or greater than one”.

Energy source [EN 15615:2007; EN 15603:2008]
Source from which useful energy can be extracted or recovered either directly or by means of a conversion or transformation process
NOTE Examples include oil or gas fields, coal mines, sun, forests etc.

Carbon dioxide (CO2)
A naturally occurring greenhouse gas in the atmosphere, composed of two oxygen atoms covalently bonded to an individuals carbon atom. Its concentrations have increased from 280 parts per million in preindustrial times to over 350 parts per million today, as a result of anthropogenic activities.

10.4.1.4 Building Costs

Global cost [Regulation (EU) No 244/2012]
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. For the calculation at macroeconomic level, an additional cost category costs of greenhouse gas emissions is introduced.

Initial investment costs [Regulation (EU) No 244/2012]
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.

Energy costs [Regulation (EU) No 244/2012]
annual costs and fixed and peak charges for energy including national taxes.

Operational costs [Regulation (EU) No 244/2012]
all costs linked to the operation of the building including annual costs for insurance, utility charges and other standing charges and taxes.

Maintenance costs [Regulation (EU) No 244/2012]
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.

Running costs [Regulation (EU) No 244/2012]
annual maintenance costs, operational costs and energy costs.

Disposal costs [Regulation (EU) No 244/2012]
the costs for deconstruction at the end- of-life of a building or building element and include deconstruction, removal of building elements that have not yet come to the end of their lifetime, transport and recycling.

Annual cost [Regulation (EU) No 244/2012]
the sum of running costs and periodic costs or replacement costs paid in a certain year.

Replacement cost [Regulation (EU) No 244/2012]
a substitute investment for a building element, according to the estimated economic lifecycle during the calculation period.

Cost of greenhouse gas emissions [Regulation (EU) No 244/2012]
the monetary value of environmental damage caused by CO_2 emissions related to the energy consumption in buildings.

10.4.2 Detailed assumptions for global cost calculations

Table 38. 2010 Full costs for measures (Building envelope)

Envelope variations		Technology (example)		Full investment costs (including material and labour costs, business profits and general expenditure; taxes escluded)							
Measure	Variants	New building	Building refurbishment	New building: costs for IMPLEMENTING the technology on each line				Building REFURBISHMENT: costs for IMPLEMENTING the technology on each line, additional compared to the case of NEW building (including complementary works):			
				West	East	North	South	West	East	North	South
Roof U-value [W/m2K]		**BASE CASE: no insulation layer on the external surface of the slab between the last heated zone and the loft zone (no cost)**									
	0,5	Insulation layer over the slab between last heated zone and loft zone: 5 cm (λ = 0.033 W/mK)					12,2				13,4
	0,3	Insulation layer over the slab between last heated zone and loft zone: 8 cm (λ = 0.033 W/mK)		39,0	30,0	49,0	32,5	42,9	31,1	56,4	39,0
	0,2	Insulation layer over the slab between last heated zone and loft zone: : 15 cm (λ = 0.033 W/mK)		47,0	36,0	60,0	45,8	51,2	37,1	68,4	55,0
	0,1	Insulation layer over the slab between last heated zone and loft zone: 30 cm (λ = 0.033 W/mK)		62,0	53,0	80,0	74,5	67,0	54,0	90,4	89,4
Wall U-value [W/m2K]		**BASE CASE: no insulation, but plaster layer on the external surface of the facade**		25,7	12,1	33,4	20,8	47,4	20,1	63,2	40,8
	0,38	Insulation layer on the external surface of the facade (with light weight finishing and without extra-plaster layer): 5 cm (λ = 0.033 W/mK)					62,4				80,1
	0,32	Insulation layer on the external surface of the facade (with light weight finishing and without extra-plaster layer): 8 cm (λ = 0.033 W/mK)		80,7	38,0	105,0	65,4	96,8	41,0	129,2	83,4
	0,23	Insulation layer on the external surface of the facade (without extra-plaster layer): 12 cm (λ = 0.033 W/mK)		91,2	43,0	112,9	77,4	108,2	46,0	136,6	95,3
	0,14	Insulation layer on the external surface of the facade (without extra-plaster layer): 22 cm (λ = 0.033 W/mK)		105,0	53,0	135,0	87,9	123,9	56,0	160,7	105,9
Basement U-value [W/m2K]		**BASE CASE: no insulation layer above the slab between the first heated zone and the cellar/basement zone (no cost)**									
	0,5	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 5 cm (λ = 0.033 W/mK)					47,7				54,7
	0,32	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 9 cm (λ = 0.033 W/mK)		36,0	23,5	44,5	53,0	41,4	25,5	52,6	60,0
	0,26	Insulation layer above the slab between the first heated zione and the cellar/basement zone: 11 cm (λ = 0.033 W/mK)		39,0	24,8	59,4	55,7	44,5	26,8	69,5	62,7
	0,2	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 15 cm (λ = 0.033 W/mK)		49,0	27,4	74,2	61,1	55,4	29,4	85,4	68,1
Glass U-value [W/m2K]	5,2	**BASE CASE1: single glass 6 mm (U = 5.2 W/m2K)**					37,3				48,6
	3	**BASE CASE2: glass 4-6(air)-4 (U = 3 W/m2K)**		51,0	24,4	63,1	42,7	52,4	25,1	64,8	54,0
	2	Glass: 4(low-e)-12(air)-4 (Ug = 1.8 W/m2K); frame: wood 50 mm (Uf = 2 W/m2K)		58,4	28,0	72,3	48,9	58,4	28,0	72,3	60,2
	1,4	Glass: 4(low-e)-15(krypton)-4 (Ug = 1.3 W/m2K); frame: PVC 60 mm (Uf = 1.6 W/m2K)		50,6	38,0	62,6	56,4	50,6	38,0	62,6	67,7
	0,8	Glass: 4(low-e)-9(krypton)-4(low-e)-9(krypton)-4 (Ug = 0.7 W/m2K); frame: PVC or alluminium PH certified (Uf = 1 W/m2K)		84,0	84,0	103,9	73,4	84,0	84,0	103,9	84,7
Frame U-value [W/m2K] and Air permeability: ach [h-1]	5,2	**BASE CASE1: frame: wood 30 mm (Uf = 5.2 W/m2K); frame air permeability: class 1 EN 12207**					149,0				164,5
	2,2	**BASE CASE2: frame: wood 50 mm (Uf = 2.2 W/m2K); frame air permeability: class 1 EN 12207**		210,2	122,4	225,0	181,2	230,2	133,6	246,4	198,0
	2; 0,5	frame: wood 50 mm (Uf = 2 W/m2K); frame air permeability: class 2 EN 12207		233,6	136,0	250,0	201,3	253,6	147,2	271,4	218,1

Solar shading: g value (total solar transmittance) of the whole window (glass +frame+shading device if present and active)	about 0,6	**BASE CASE condition: no shading**										
	about 0,3	internal solar shade (solar transmittance 45-50%)		59,1	30,6	73,2	49,9	65,1	33,6	80,5	54,9
	about 0,1	external automatised solar shade or blind (solar trasmittance 15-20%)		144,0	119,2	121,3	194,7	151,2	125,2	127,3	204,5
Night natural ventilation: ach [h-1]		**BASE CASE condition: no night natural ventilation**									
	about 2	manual natural ventilation: different internal doors (with vent opening) and we assume that installing them since the beginning has negligible cost	manual natural ventilation: addition of vent openings on the internal doors	24,0	20,3	29,7	20,3	43,8	33,6	54,2	36,7
	about 6	automatised natural ventilation: electrical motors, electrical control for opening, addition of vent opening on the internal doors, outdoor temperature		216,6	182,8	267,9	182,8	238,2	182,8	294,7	199,1
Envelope solar reflectance (we are assuming here an average solar reflectance over the life of the painting, not the initial one when new)		**BASE CASE: painted since the beginning at 0,3 reflectance**									
	0,3	painted since the beginning with color at 0,3 solar reflectance, hence no extra cost	re-Painting of the external surface at 0,3 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5
	0,5	painted since the beginning at color with 0,5 reflectance, hence no extra cost	re-Painting of the external surface at 0,5 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5
	0,7	painted since the beginning at color with 0,7 reflectance, hence no extra cost	re-Painting of the external surface at 0,7 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5

Table 39. 2020 Full for measures (Building envelope)

Envelope variations		Technology (example)		Full investment costs (including material and labour costs, business profits and general expenditure; taxes escluded)							
Measure	Variants	New building	Building refurbishment	New building: costs for IMPLEMENTING the technology on each line				Building REFURBISHMENT: costs for IMPLEMENTING the technology on each line, additional compared to the case of NEW building (including complementary works):			
				West	East	North	South	West	East	North	South
Roof U-value [W/m2K]		**BASE CASE: no insulation layer on the external surface of the slab between the last heated zone and the loft zone (no cost)**									
	0,5	Insulation layer over the slab between last heated zone and loft zone: 5 cm (λ = 0.033 W/mK)					14,7				16,1
	0,3	Insulation layer over the slab between last heated zone and loft zone: 8 cm (λ = 0.033 W/mK)		42,9	30,0	53,9	39,0	47,2	31,1	62,0	46,8
	0,2	Insulation layer over the slab between last heated zone and loft zone: : 15 cm (λ = 0.033 W/mK)		47,0	32,4	60,0	55,0	51,2	33,4	68,4	66,0
	0,1	Insulation layer over the slab between last heated zone and loft zone: 30 cm (λ = 0.033 W/mK)		55,8	42,4	72,0	89,4	60,3	43,2	81,4	107,3
Wall U-value [W/m2K]		**BASE CASE: no insulation, but plaster layer on the external surface of the facade**		28,3	12,1	36,8	25,0	52,1	20,1	69,5	48,8
	0,38	Insulation layer on the external surface of the facade (with light weight finishing and without extra-plaster layer): 5 cm (λ = 0.033 W/mK)					74,9				95,7
	0,32	Insulation layer on the external surface of the facade (with light weight finishing and without extra-plaster layer): 8 cm (λ = 0.033 W/mK)		88,8	38,0	115,5	78,5	106,5	41,0	142,1	99,7
	0,23	Insulation layer on the external surface of the facade (without extra-plaster layer): 12 cm (λ = 0.033 W/mK)		91,2	38,7	112,9	92,9	108,2	41,4	136,6	114,0
	0,14	Insulation layer on the external surface of the facade (without extra-plaster layer): 22 cm (λ = 0.033 W/mK)		94,5	42,4	121,5	105,5	111,5	44,8	144,6	126,7
Basement U-value [W/m2K]		**BASE CASE: no insulation layer above the slab between the first heated zone and the cellar/basement zone (no cost)**									
	0,5	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 5 cm (λ = 0.033 W/mK)					55,1				61,4
	0,32	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 9 cm (λ = 0.033 W/mK)		39,6	23,5	49,0	61,3	45,5	25,5	57,8	67,5
	0,26	Insulation layer above the slab between the first heated zione and the cellar/basement zone: 11 cm (λ = 0.033 W/mK)		39,0	22,3	59,4	64,5	44,5	24,1	69,5	71,0
	0,2	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 15 cm (λ = 0.033 W/mK)		44,1	21,9	66,8	70,8	49,8	23,5	76,8	77,3
Glass U-value [W/m2K]	5,2	**BASE CASE1: single glass 6 mm (U = 5.2 W/m2K)**					41,1				43,4
	3	**BASE CASE2: glass 4-6(air)-4 (U = 3 W/m2K)**		61,2	26,9	75,7	47,0	62,8	27,6	77,8	48,3
	2	Glass: 4(low-e)-12(air)-4 (Ug = 1.8 W/m2K); frame: wood 50 mm (Uf = 2 W/m2K)		70,1	30,8	86,7	53,8	70,1	30,8	86,7	53,8
	1,4	Glass: 4(low-e)-15(krypton)-4 (Ug = 1.3 W/m2K); frame: PVC 60 mm (Uf = 1.6 W/m2K)		50,6	34,2	62,6	50,7	50,6	34,2	62,6	50,7
	0,8	Glass: 4(low-e)-9(krypton)-4(low-e)-9(krypton)-4 (Ug = 0.7 W/m2K); frame: PVC or alluminium PH certified (Uf = 1 W/m2K)		67,2	58,8	83,1	51,4	67,2	58,8	83,1	51,4
Frame U-value [W/m2K] and Air permeability: ach [h-1]	5,2	**BASE CASE1: frame: wood 30 mm (Uf = 5.2 W/m2K); frame air permeability: class 1 EN 12207**					163,9				180,5
	2,2	**BASE CASE2: frame: wood 50 mm (Uf = 2.2 W/m2K); frame air permeability: class 1 EN 12207**		252,3	134,6	270,0	199,3	276,2	147,0	295,6	217,2
	2; 0,5	frame: wood 50 mm (Uf = 2 W/m2K); frame air permeability: class 2 EN 12207		280,3	149,6	300,0	221,4	304,3	161,9	325,7	239,3

Solar shading: g value (total solar transmittance) of the whole window (glass +frame+shading device if present and active)	about 0,6	**BASE CASE condition: no shading**									
	about 0,3	internal solar shade (solar transmittance 45-50%)		59,1	30,6	73,2	49,9	65,1	33,6	80,5	54,9
	about 0,1	external automatised solar shade or blind (solar trasmittance 15-20%)		144,0	119,2	121,3	194,7	151,2	125,2	127,3	204,5
Night natural ventilation: ach [h-1]		**BASE CASE condition: no night natural ventilation**									
	about 2	manual natural ventilation: different internal doors (with vent opening) and we assume that installing them since the beginning has negligible cost	manual natural ventilation: addition of vent openings on the internal doors	24,0	20,3	29,7	20,3	43,8	33,6	54,2	36,7
	about 6	electrical control for opening, addition of vent opening on the internal doors, outdoor temperature sensor		216,6	182,8	267,9	182,8	238,2	182,8	294,7	199,1
Envelope solar reflectance (we are assuming here an average solar reflectance over the life of the painting, not the initial one when new)		**BASE CASE: painted since the beginning at 0,3 reflectance**									
	0,3	painted since the beginning with color at 0,3 solar reflectance, hence no extra cost	re-Painting of the external surface at 0,3 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5
	0,5	painted since the beginning at color with 0,5 reflectance, hence no extra cost	re-Painting of the external surface at 0,5 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5
	0,7	painted since the beginning at color with 0,7 reflectance, hence no extra cost	re-Painting of the external surface at 0,7 reflectance	1,0	1,0	1,0	1,0	13,5	13,5	13,5	13,5

Table 40. 2010 Full costs for measures (Building plants)

Plant	Sub-plant	Variants	Performance factor		Power (kW-thermal)	Description	Investment costs (including labour costs, business profits and general expenditure; taxes escluded)							
							New building				Building refurbishment (including complementary			
			ηHEATING	ηCOOLING			West	East	North	South	West	East	North	South
Heating/ Cooling	Generation	Standard gas boiler	70% - 80%	-	P ≤ 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	4.500	2.895	6.586	4.514	4.860	3.127	7.113	4.628
					35 < P ≤ 100		11.000	2.920	8.895	6.097	11.660	3.095	9.429	6.570
					100 < P ≤ 150		17.000	4.960	10.275	7.043	17.680	5.158	10.686	7.516
		Condensing boiler	95% - 104%	-	P< 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	5.500	3.000	7.421	5.087	5.885	3.210	7.941	5.201
					35<P<100		12.500	5.000	15.608	10.698	13.250	5.300	16.544	11.171
					P>100		18.000	12.160	17.400	11.926	18.900	12.768	18.270	12.400
		Heat pump with medium SPF (and SEER)	150% - 250%	2	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	7.500	6.700	5.863	7.328	7.950	7.102	6.215	7.443
					35 < P ≤ 100		20.250	9.128	12.500	14.233	21.263	9.584	13.125	14.479
					100 < P ≤ 150		28.125	17.579	21.875	27.411	29.250	18.282	22.750	27.680
		Heat pump with high SPF (and SEER)	225% - 350%	3	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	10.000	7.900	14.191	17.739	10.600	8.374	15.043	17.854
					35 < P ≤ 100		27.000	10.700	19.494	24.367	28.350	11.235	20.468	24.613
					100 < P ≤ 150		37.500	16.300	25.526	31.907	39.000	16.952	26.547	32.154
		Cogeneration with gas turbine	0,9	-	P< 35	generator (including burner), fittings, circulation pumps, internal pumps, smoke evacuation system, basements	20.000	19.800	24.745	45.230	20.800	20.592	25.734	45.570
					35<P<100		35.000	38.880	43.303	73.922	36.050	40.046	44.602	74.287
					P>100		50.000	92.400	61.861	98.559	51.000	94.248	63.099	98.925
		Ground source heat pump	400% - 500%	4,5	P< 35	heat pump, internal pumps, condensate tank and evacuation systems, basements, borehole perforation (considering lenghts of 500, 1500, 2500 m), doubleU pipes (considering lenghts of 500, 1500, 2500 m), 2 circulation pumps	25.000	23.000	39.383	49.229	30.000	27.600	47.260	49.343
					35<P<100		74.250	32.000	60.398	75.498	85.388	36.800	69.458	75.744
					P>100		121.875	49.480	110.581	138.226	134.063	54.428	121.639	138.473
		Chiller with medium SEER	-	2	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	6.058	4.240	8.397	5.756	6.663	4.664	9.237	5.867
					35 < P ≤ 100		20.769	8.800	18.042	12.366	22.498	9.533	19.544	12.596
					100 < P ≤ 150		33.654	19.480	27.046	18.538	35.673	20.649	28.669	18.768
		Chiller with high SEER	-	3	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	7.875	8.617	19.604	13.437	8.663	9.479	21.565	13.549
					35 < P ≤ 100		27.000	15.280	25.508	17.483	29.248	16.552	27.631	17.713
					100 < P ≤ 150		43.750	28.480	32.934	22.574	46.375	30.189	34.910	22.804
	Emission	Standard radiant floor	94% - 98%	0,97	-	preformed panel including piping	56	26	78	47	84	39	117	136
		Insulated radiant floor	97% - 99%	0,97	-	preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	75	33	98	61	105	46	137	150
		Insulated radiant ceiling	-	0,98		preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	140	69	207	129	182	90	269	133
		Radiator	92% - 95%	-	-	radiator and valves	355	196	488	305	374	206	515	339
		Fan coil	94% - 96%	0,98	-	fan coil, fixing systems	700	750	1.267	792	736	788	1.331	825
		Air diffuser	94% - 96%	0,97	-	air diffusers, air ducts, air handling units, false ceiling	61	33	83	52	80	43	108	53
		Split	94% - 96%	0,97	-	internal unit and pipe	1.831	1.962	3.315	2.072	1.846	1.978	3.342	2.072
	Distribution	Internal - not insulated	95% - 98%	0,96	-	pipe	5	3	7	4	6	3	8	4
		Internal - a bit insulated	96% - 99%	0,98	-	pipe, 2 cm of insulation material	15	10	24	15	17	11	27	15
		Internal - insulated	97% - 99%	0,99	-	pipe, 4 cm of insulation material	19	13	33	21	21	15	37	21
	Control	climatic	80% - 86%	0,9	-	2 temperature sensors, a 3-way mixing valve with actuator, control system	780	777	1.768	1.212	858	855	1.945	1.212
		indoor thermostatic	91% - 97%	0,95	-	room thermostat, two 2-way valve with servo	540	228	518	355	594	251	570	355
		thermal zone	95% - 98%	0,94	-	zone thermostat, two 2-way valve with servo	550	228	518	355	604	251	570	355
		climatic+indoor thermostatic	95% - 98%	0,98	-	2 temperature sensors, 3-way mixing valve with actuator, control system, room thermostat, 2-way valve with servo	560	400	553	379	616	440	609	379
		climatic+termal zone	94% - 97%	0,97	-	2 temperature sensors, 3-way mixing valve with actuator, control system, zone thermostat, 2-way valve with servo	680	430	607	416	748	473	667	416
	Other	local dehumidifier	-	-	0,25	local dehumidifier, fixing system, condensate tank and evacuation system	3.286	1.779	4.047	2.774	3.779	2.046	4.654	2.892
		local electric hot water boiler	-	-	1	local boiler, fixing system	343	240	422	289	394	276	485	343
		IAQ ventilation system	-	-	-	air diffusers, air ducts, air handling units, false ceiling	55	30	74	46	69	38	94	46
Heat Recovery		absent	0%	0%	-	-	0	0	0	0	0	0	0	0
		medium efficiency	60%	(60%)	0 < Flow [l/s] < 500	heat recovery unit, fixing system	1,52	2,82	1,50	1,81	1,52	2,82	1,50	1,81
					500 < Flow [l/s] < 1500		1,52	2,82	1,50	1,81	1,52	2,82	1,50	1,81
					1500 < Flow [l/s] < 3000		1,09	2,03	1,08	1,30	1,09	2,03	1,08	1,30
		high efficiency	80%	-80%	0 < Flow [l/s] < 500	heat recovery unit, fixing system	1,82	3,38	1,80	2,17	1,82	3,38	1,80	2,17
					500 < Flow [l/s] < 1500		1,82	3,38	1,80	2,17	1,82	3,38	1,80	2,17
					1500 < Flow [l/s] < 3000		1,31	2,43	1,29	1,56	1,31	2,43	1,29	1,56
RES		photovoltaic	-	-	-	panels, support structure, inverter, electricity meter	2.800	3.000	3.600	3.000	3.080	3.300	3.960	3.300
		thermal solar	-	-	-	panels, storage, circulation pumps, expansion vessel	1.000	920	1.226	1.387	1.100	1.012	1.349	1.530

Table 41. 2020 Full costs for measures (Building plants)

Plant	Sub-plant	Variants	Performance factor		Power (kW-thermal)	Description	Investment costs (including labour costs, business profits and general expenditure; taxes escluded)							
							New building				Building refurbishment (including complementary			
			$\eta_{HEATING}$	$\eta_{COOLING}$			West	East	North	South	West	East	North	South
Heating/ Cooling	Generation	Standard gas boiler	70% - 80%	-	P ≤ 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	3.600	2.316	5.269	3.611	3.888	2.501	5.690	3.697
					35 < P ≤ 100		8.800	2.336	7.116	4.878	9.328	2.476	7.543	5.230
					100 < P ≤ 150		13.600	3.968	8.220	5.634	14.144	4.127	8.549	5.835
		Condensing boiler	95% - 104%	-	P< 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	5.500	3.000	7.421	5.087	5.885	3.210	7.941	5.194
					35<P<100		12.500	5.000	15.608	10.698	13.250	5.300	16.544	11.138
					P>100		18.000	12.160	17.400	11.926	18.900	12.768	18.270	12.367
		Heat pump with medium SPF (and SEER)	150% - 250%	2	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	6.000	5.360	4.690	5.863	6.360	5.682	4.972	5.948
					35 < P ≤ 100		16.200	7.302	10.000	11.386	17.010	7.667	10.500	11.558
					100 < P ≤ 150		22.500	14.063	17.500	21.928	23.400	14.626	18.200	22.118
		Heat pump with high SPF (and SEER)	225% - 350%	3	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	9.000	7.110	12.772	15.965	9.540	7.537	13.539	16.062
					35 < P ≤ 100		24.300	9.630	17.544	21.930	25.515	10.112	18.421	22.123
					100 < P ≤ 150		33.750	14.670	22.973	28.717	35.100	15.257	23.892	28.909
		Cogeneration with gas turbine	0,9	-	P< 35	generator (including burner), fittings, circulation pumps, internal pumps, smoke evacuation system, basements	18.000	17.820	22.270	40.707	18.720	18.533	23.161	41.013
					35<P<100		31.500	34.992	38.973	66.529	32.445	36.042	40.142	66.859
					P>100		45.000	83.160	55.675	88.703	45.900	84.823	56.789	89.032
		Ground source heat pump	400% - 500%	4,5	P< 35	heat pump, internal pumps, condensate tank and evacuation systems, basements, borehole perforation (considering lenghts of 500, 1500, 2500 m), doubleU pipes (considering lenghts of 500, 1500, 2500 m), 2 circulation pumps	22.500	20.700	35.445	44.306	27.000	24.840	42.534	44.403
					35<P<100		66.825	28.800	54.359	67.948	76.849	33.120	62.512	68.141
					P>100		109.688	44.532	99.523	124.404	120.656	48.985	109.475	124.596
		Chiller with medium SEER	-	2	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	4.846	3.392	6.718	4.605	5.331	3.731	7.390	4.690
					35 < P ≤ 100		16.615	7.040	14.434	9.893	17.999	7.626	15.635	10.064
					100 < P ≤ 150		26.923	15.584	21.637	14.830	28.538	16.519	22.935	15.001
		Chiller with high SEER	-	3	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	7.088	7.756	17.644	12.093	7.796	8.531	19.408	12.190
					35 < P ≤ 100		24.300	13.752	22.957	15.735	26.323	14.897	24.868	15.928
					100 < P ≤ 150		39.375	25.632	29.641	20.316	41.738	27.170	31.419	20.509
	Emission	Standard radiant floor	94% - 98%	0,97	-	preformed panel including piping	56	26	78	47	84	39	117	133
		Insulated radiant floor	97% - 99%	0,97	-	preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	75	33	98	61	105	46	137	147
		Insulated radiant ceiling	-	0,98		preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	140	69	207	129	182	90	269	133
		Radiator	92% - 95%	-	-	radiator and valves	355	196	488	305	374	206	515	338
		Fan coil	94% - 96%	0,98	-	fan coil, fixing systems	700	750	1.267	792	736	788	1.331	825
		Air diffuser	94% - 96%	0,97	-	air diffusers, air ducts, air handling units, false ceiling	61	33	83	52	80	43	108	53
		Split	94% - 96%	0,97	-	internal unit and pipe	1.831	1.962	3.315	2.072	1.847	1.979	3.344	2.072
	Distribution	Internal - not insulated	95% - 98%	0,96	-	pipe	5	3	7	4	6	3	8	4
		Internal - a bit insulated	96% - 99%	0,98	-	pipe, 2 cm of insulation material	15	10	24	15	17	11	27	15
		Internal - insulated	97% - 99%	0,99	-	pipe, 4 cm of insulation material	19	13	33	21	21	15	37	21
	Control	climatic	80% - 86%	0,9	-	2 temperature sensors, a 3-way mixing valve with actuator, control system	780	777	1.768	1.212	858	855	1.945	1.212
		indoor thermostatic	91% - 97%	0,95	-	room thermostat, two 2-way valve with servo	540	228	518	355	594	251	570	355
		thermal zone	95% - 98%	0,94	-	zone thermostat, two 2-way valve with servo	550	228	518	355	604	251	570	355
		climatic+indoor thermostatic	95% - 98%	0,98	-	2 temperature sensors, 3-way mixing valve with actuator, control system, room thermostat, 2-way valve with servo	560	400	553	379	616	440	609	379
		climatic+termal zone	94% - 97%	0,97	-	2 temperature sensors, 3-way mixing valve with actuator, control system, zone thermostat, 2-way valve with servo	680	430	607	416	748	473	667	416
	Other	local dehumidifier	-	-	0,25	local dehumidifier, fixing system, condensate tank and evacuation system	3.286	1.779	4.047	2.774	3.779	2.046	4.654	2.892
		local electric hot water boiler	-	-	1	local boiler, fixing system	343	240	422	289	394	276	485	343
		IAQ ventilation system	-	-	-	air diffusers, air ducts, air handling units, false ceiling	55	30	74	46	58	31	78	46
Heat Recovery		absent	0%	0%	-	-	0	0	0	0	0	0	0	0
		medium efficiency	60%	(60%)	0 < Flow [l/s] < 500	heat recovery unit, fixing system	1,06	1,98	1,05	1,27	1,06	1,98	1,05	1,27
					500 < Flow [l/s] < 1500		1,06	1,98	1,05	1,27	1,06	1,98	1,05	1,27
					1500 < Flow [l/s] < 3000		0,76	1,42	0,76	0,91	0,76	1,42	0,76	0,91
		high efficiency	80%	-80%	0 < Flow [l/s] < 500	heat recovery unit, fixing system	1,28	2,37	1,26	1,52	1,28	2,37	1,26	1,52
					500 < Flow [l/s] < 1500		1,28	2,37	1,26	1,52	1,28	2,37	1,26	1,52
					1500 < Flow [l/s] < 3000		0,92	1,70	0,91	1,09	0,92	1,70	0,91	1,09
RES		photovoltaic	-	-	-	panels, support structure, inverter, electricity meter	2.240	2.400	2.880	2.400	2.464	2.640	3.168	2.640
		thermal solar	-	-	-	panels, storage, circulation pumps, expansion vessel	800	736	981	1.110	880	809	1.079	1.224

10.5 Appendix task 4

10.5.1 Scenario assumptions on envelope / system cost development

Table 42. Assumed scenario on change in building envelope costs; changes in % decrease (-) or increase (+) per year

Measure	Variants	New building	Building refurbishment	West	East	North	South
Roof U-value [W/m2K]		BASE CASE: no insulation layer on the external surface of the slab between the last heated zone and the loft zone (no cost)					
	0.3	Insulation layer over the slab between last heated zone and loft zone: 8 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.2	Insulation layer over the slab between last heated zone and loft zone: : 15 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.1	Insulation layer over the slab between last heated zone and loft zone: 30 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
Wall U-value [W/m2K]		BASE CASE: no insulation, but plaster layer on the external surface of the facade					
	0.32	Insulation layer on the external surface of the facade (with light weight finishing and without extra-plaster layer): 8 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.23	Insulation layer on the external surface of the facade (without extra-plaster layer): 12 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.14	Insulation layer on the external surface of the facade (without extra-plaster layer): 22 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
Basement U-value [W/m2K]		BASE CASE: no insulation layer above the slab between the first heated zone and the cellar/basement zone (no cost)					
	0.32	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 9 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.26	Insulation layer above the slab between the first heated zione and the cellar/basement zone: 11 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
	0.2	Insulation layer above the slab between the first heated zone and the cellar/basement zone: 15 cm (λ = 0.033 W/mK)		2%	2%	2%	2%
Glass U-value [W/m2K]	3	BASE CASE: glass 4-6(air)-4 (U = 3 W/m2K)					
	2	Glass: 4(low-e)-12(air)-4 (Ug = 1.8 W/m2K); frame: wood 50 mm (Uf = 2 W/m2K)		2%	1%	2%	1%
	1.4	Glass: 4(low-e)-15(krypton)-4 (Ug = 1.3 W/m2K); frame: PVC 60 mm (Uf = 1.6 W/m2K)		0%	-1%	0%	-1%
	0.8	Glass: 4(low-e)-9(krypton)-4(low-e)-9(krypton)-4 (Ug = 0.7 W/m2K); frame: PVC or alluminium PH certified (Uf = 1 W/m2K)		-2%	-3%	-2%	-3%
Frame U-value [W/m2K] and Air permeability: ach [h-1]		BASE CASE: frame: wood 50 mm (Uf = 2.2 W/m2K); frame air permeability: class 1 EN 12207					
	2; 0,5	frame: wood 50 mm (Uf = 2 W/m2K); frame air permeability: class 2 EN 12207		2%	1%	2%	1%

	1.6; 0,3	frame: PVC 60 mm (Uf = 1.6 W/m2K); frame air permeability: class 3 EN 12207		1%	-1%	1%	-1%
	1; 0,1	frame: PVC or alluminium PH certified (Uf = 1 W/m2K); frame air permeability: class 4 EN 12207		-3%	-1%	-3%	-2%
Solar shading: g value (total solar transmittance) of the whole window (glass +frame+shading device if present and active)	about 0,6	BASE CASE condition: no shading					
	about 0,3	internal solar shade (solar transmittance 45-50%)		0%	0%	0%	0%
	about 0,1	external automatised solar shade or blind (solar trasmittance 15-20%)		0%	0%	0%	0%
Night natural ventilation: ach [h-1]		BASE CASE condition: no night natural ventilation					
	about 2	manual natural ventilation: different internal doors (with vent opening) and we assume that installing them since the beginning has negligible cost	manual natural ventilation: addition of vent openings on the internal doors	0%	0%	0%	0%
	about 6	automatised natural ventilation: electrical motors, electrical control for opening, addition of vent opening on the internal doors, outdoor temperature sensor		0%	0%	0%	0%
Envelope solar reflectance (we are assuming here an average solar reflectance over the life of the painting, not the initial one when new)		BASE CASE: painted since the beginning at 0,3 reflectance					
	0.3	painted since the beginning with color at 0,3 solar reflectance, hence no extra cost	re-Painting of the external surface at 0,3 reflectance	0%	0%	0%	0%
	0.5	painted since the beginning at color with 0,5 reflectance, hence no extra cost	re-Painting of the external surface at 0,5 reflectance	0%	0%	0%	0%
	0.7	painted since the beginning at color with 0,7 reflectance, hence no extra cost	re-Painting of the external surface at 0,7 reflectance	0%	0%	0%	0%

Table 43. Assumed scenario on change in system costs; changes in % decrease (-) or increase (+) per year

Plant	Sub-plant	Variants	Performance factor		Power (kW-thermal)	Description	West	East	North	South
			H HEATING	η COOLiNG						
Heating/Cooling	Generation	Standard gas boiler	70% - 80%	-	P ≤ 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	-2%	-2%	-2%	-2%
					35 < P ≤ 100		-2%	-2%	-2%	-2%
					100 < P ≤ 150		-2%	-2%	-2%	-2%
		Condensing boiler	95% - 104%	-	P< 35	heat generator (including burner), fittings, circulation, internal pumps, smoke evacuation system, basements	0%	0%	0%	0%
					35<P<100		0%	0%	0%	0%
					P>100		0%	0%	0%	0%
		Heat pump with medium SPF (and SEER)	150% - 250%	2	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	-2%	-2%	-2%	-2%
					35 < P ≤ 100		-2%	-2%	-2%	-2%
					100 < P ≤ 150		-2%	-2%	-2%	-2%
		Heat pump with high SPF (and SEER)	225% - 350%	3	P ≤ 35	heat pump, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	-1%	-1%	-1%	-1%
					35 < P ≤ 100		-1%	-1%	-1%	-1%
					100 < P ≤ 150		-1%	-1%	-1%	-1%
		Cogeneration with gas turbine	90%	-	P< 35	generator (including burner), fittings, circulation pumps, internal pumps, smoke evacuation system, basements	-1%	-1%	-1%	-1%
					35<P<100		-1%	-1%	-1%	-1%
					P>100		-1%	-1%	-1%	-1%
		Ground source heat pump	400% - 500%	4,5	P< 35	heat pump, internal pumps, condensate tank and evacuation systems, basements, borehole perforation (considering lenghts of 500, 1500, 2500 m), doubleU pipes (considering lenghts of 500, 1500, 2500 m), 2 circulation pumps	-1%	-1%	-1%	-1%
					35<P<100		-1%	-1%	-1%	-1%
					P>100		-1%	-1%	-1%	-1%
		Chiller with medium SEER	-	2	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate tank and evacuation systems, basements	-2%	-2%	-2%	-2%
					35 < P ≤ 100		-2%	-2%	-2%	-2%
					100 < P ≤ 150		-2%	-2%	-2%	-2%
		Chiller with high SEER	-	3	P ≤ 35	Chiller, circulation pumps, internal pumps, condensate	-1%	-1%	-1%	-1%
					35 < P ≤ 100		-1%	-1%	-1%	-1%

					100 < P ≤ 150	tank and evacuation systems, basements	-1%	-1%	-1%	-1%
Heating/Cooling	Emission	Standard radiant floor	94% - 98%	0,97	-	preformed panel including piping	0%	0%	0%	0%
		Insulated radiant floor	97% - 99%	0,97	-	preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	0%	0%	0%	0%
		Insulated radiant ceiling	-	0,98		preformed panel including piping, insulation material (2-4 cm) for slabs facing to unheated rooms	0%	0%	0%	0%
		Radiator	92% - 95%	-	-	radiator and valves	0%	0%	0%	0%
		Fan coil	94% - 96%	0,98	-	fan coil, fixing systems	0%	0%	0%	0%
		Air diffuser	94% - 96%	0,97	-	air diffusers, air ducts, air handling units, false ceiling	0%	0%	0%	0%
	Distribution	Internal - not insulated	95% - 98%	0,96	-	pipe	0%	0%	0%	0%
		Internal - a bit insulated	96% - 99%	0,98	-	pipe, 2 cm of insulation material	0%	0%	0%	0%
		Internal - insulated	97% - 99%	0,99	-	pipe, 4 cm of insulation material	0%	0%	0%	0%
	Control	climatic	80% - 86%	0,90	-	2 temperature sensors, a 3-way mixing valve with actuator, control system	0%	0%	0%	0%
		indoor thermostatic	91% - 97%	0,95	-	room thermostat, two 2-way valve with servo	0%	0%	0%	0%
		thermal zone	95% - 98%	0,94	-	zone thermostat, two 2-way valve with servo	0%	0%	0%	0%
		climatic+indoor thermostatic	95% - 98%	0,98	-	2 temperature sensors, 3-way mixing valve with actuator, control system, room thermostat, 2-way valve with servo	0%	0%	0%	0%
		climatic+termal zone	94% - 97%	0,97	-	2 temperature sensors, 3-way mixing valve with actuator, control system, zone thermostat, 2-way valve with servo	0%	0%	0%	0%
	Other	local dehumidifier	-	-	0,25	local dehumidifier, fixing system, condensate tank and evacuation system	0%	0%	0%	0%

		local electric hot water boiler	-	-	1	local boiler, fixing system	0%	0%	0%	0%
Heat Recovery		absent	0%	0%	-	-	0	0%	0%	0%
		medium efficiency	60%	(60%)	0 < Flow [l/s] < 500	heat recovery unit, fixing system	-3%	-3%	-3%	-3%
					500 < Flow [l/s] < 1500		-3%	-3%	-3%	-3%
					1500 < Flow [l/s] < 3000		-3%	-3%	-3%	-3%
		high efficiency	80%	-80%	0 < Flow [l/s] < 500	heat recovery unit, fixing system	-2%	-2%	-2%	-2%
					500 < Flow [l/s] < 1500		-2%	-2%	-2%	-2%
					1500 < Flow [l/s] < 3000		-2%	-2%	-2%	-2%
RES		photovoltaic	-	-	-	panels, support structure, inverter, electricity meter	-2%	-2%	-2%	-2%
		thermal solar	-	-	-	panels, storage, circulation pumps, expansion vessel	-2%	-2%	-2%	-2%

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