Inclusion of New Buildings in Residential Building Typologies

Steps Towards NZEBs
Exemplified for Different European Countries

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1 Introduction

Building typologies have proved to be a useful instrument for an in-depth understanding of the energy performance of certain building types and categories. In the framework of the IEE project TABULA, residential building typologies have been developed for 13 European countries following a common methodological structure. Each national typology consists of a classification scheme grouping buildings according to their size, age and further energy-relevant parameters, and a set of exemplary buildings representing the respective building types [IWU 2012a].

In the course of the IEE project EPISCOPE, 10 of these typologies have been further developed[1] and new typologies for 6 more countries[2] have been elaborated. In this context, the common typology scheme has been extended to additionally include showcase examples of new buildings meeting the national requirements or, as an alternative, more ambitious standards up to nearly zero-energy building (NZEB) level.

The recast of the Energy Performance of Buildings Directive in 2010 [EPBD 2010] stipulates that all new buildings constructed within the European Union after 2020 should reach nearly zero-energy levels. Thereby, a *'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 produced on-site or nearby;* (Article 2, No. 2.)

This ambitious commitment supports the radical cuts in greenhouse gas emissions highlighted by the IPCC's Fifth Assessment Report [IPCC 2014] as well as the long term targets of the European Union. With its "Roadmap for moving to a competitive low carbon economy in 2050" [COM 2011], the European Commission has looked beyond its short term objectives and set out a pathway for achieving deep emission cuts by the middle of the century. The Roadmap suggests that the European Union should prepare to cut its domestic emissions to 80 % below 1990 levels. Thereby, the 80 % reduction is just the minimum aim — the roadmap lays out plans to cut greenhouse gas emissions by up to 95 %. Energy efficiency is identified to be a key driver of the transition, and the built environment is supposed to provide low-cost and short term opportunities to reduce emissions — first and foremost through improvement of the energy performance of buildings.

It is expected that more than one quarter of the European 2050s building stock is still to be built [BPIE 2011]. Consequently, the effective implementation of nearly zero-energy buildings needs to be supported by providing guidance, common principles and quality checks of the concepts.

The inclusion of this standard in national residential building typologies aims to make a corresponding contribution by disseminating information and showcase examples in national "Building Typology Brochures" and online through the TABULA WebTool[3]. Referring to the appearance and details of actual existing buildings proves the feasibility of the concepts. Apart from being a source of information for house owners, the showcase examples can also be used in energy advice or energy certificate software as pre-defined datasets in order to show possible combinations of constructions and supply systems. Furthermore, they may be used by key actors to present the impact of policies and measures in an illustrative manner.

This report presents an overview of the current national minimum requirements, related national calculation methods, the status of the national NZEB definitions as well as information

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[1] For the countries Austria, Belgium, Czech Republic, Denmark, Germany, France, Greece, Ireland, Italy, Slovenia have been developed further. This applies also to the associated EPISCOPE partner country Serbia.

[2] For the countries Cyprus, Spain, Great Britain/England, Hungary, The Netherlands, and Norway new residential typologies have been elaborated.

[3] www.episcope.eu/communication/download/

on how these new built concepts were integrated in the national residential building typologies for the 17 participating countries. The overall objective is to enable an understanding of diverse energy-related approaches and requirements for new buildings in the residential sector in different countries and to learn from each other on how to develop successful energy saving strategies. A focus is placed on the energy consumption for space heating and domestic hot water.

In most countries official NZEB definitions are not yet available. In the following chapters appropriate concepts were considered, which as far as possible refer to supposed future national approaches.

From a European point of view the harmonised approach provides a framework for cross-country comparisons of residential NZEB concepts.

Table 1: Sources / References Introduction

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[BPIE 2011]	BPIE (ed.) (2011): Principles for Nearly Zero Energy Buildings. Paving the way for effective implementation of policy requirements. Online available: http://www.bpie.eu/documents/BPIE/publications/HR_NZEB%20study.pdf [2014-05-12]	Study with the objective to contribute to a common and cross-national understanding on EU-wide NZEB definitions, the need for principles of sustainable, realistic nearly Zero-Energy Buildings as well as possible technical solutions and their implications.
[EPBD 2010]	Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). Online available: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0031 [2014-05-15]	
[COM 2011]	Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2011): A Roadmap for moving to a competitive low carbon economy in 2050. Brussels. Online available: http://eur-lex.europa.eu/resource.html?uri=cellar:5db26ecc-ba4e-4de2-ae08-dba649109d18.0002.03/DOC_1&format=PDF	The Roadmap is supposed to describe a cost-effective pathway to reach the EU's objective of cutting greenhouse gas emissions by 2050. It is meant to give direction to sectoral policies, national and regional low-carbon strategies and long-term investments.
[IPCC 2014]	Intergovernmental Panel on Climate Change (ed.) (2014): Climate Change 2014: Mitigation of Climate Change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Final Draft online available: http://mitigation2014.org/report/final-draft/background [2014-05-15]	The Working Group III contribution to the IPCC Fifth Assessment Report (WGIII AR5) provides a comprehensive assessment of relevant options for mitigating climate change through limiting or preventing greenhouse gas emissions, as well as activities that remove them from the atmosphere.
[IWU 2012a]	Loga, T./Diefenbach, N./Stein, B. (2012): Typology Approach for Building Stock Energy Assessment. Main Results of the TABULA project. Online available: http://episcope.eu/fileadmin/tabula/public/docs/report/TABULA_FinalReport.pdf [2014-04-08]	Final report of the IEE project TABULA

2 Principles and Benchmarks for Nearly Zero-Energy Buildings

(by EPISCOPE partners BPIE & POLITO)

2.1 European Legislation

Europe's building stock accounts for approximately 40 % of the total primary energy consumption and 36 % of GHG emissions[4]. More than one quarter of the 2050s building stock is still to be built. To exploit the significant savings potential attributed to the building stock and fulfil the EU targets[5], the energy consumption and related GHG emissions of those new buildings need to be close to zero.

During the last decades significant steps have been made towards improving the energy performance of the European building stock. The cornerstone was set in 2002 with the Energy Performance of Buildings Directive (EBPD), which introduced stipulations regarding the application of minimum requirements on new and existing buildings as well as the energy certification of buildings. As a next step and in order to *"lay down more concrete actions with a view to achieving the great unrealised potential for energy savings in buildings",* in 2010 in the recast of the EPBD the term "nearly zero energy building" (nZEB) was introduced [EPBD 2010].

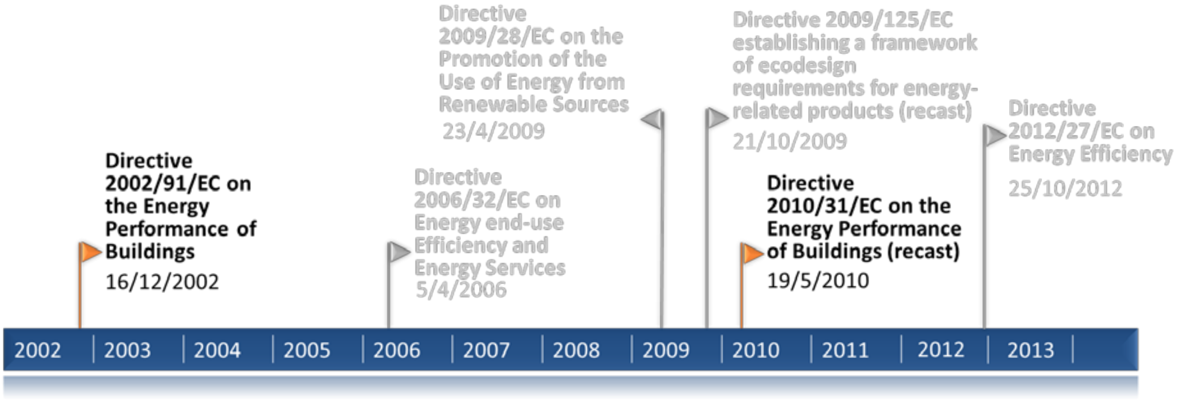

Figure 1: Key Directives related to buildings.

The Directive 2010/31/EC foresees that after 31 December 2020 all new buildings will be nZEB, while for public buildings the date is set on 31 December 2018 [ibidem]. Furthermore, the Member States (MS) shall draw up national plans for increasing the number of nZEBs. The national plans, which are the roadmaps for implementation of the national goals, introduce measures and financial incentives for the promotion of nZEBs. Moreover, the national plans shall include, inter alia, intermediate targets for improving the energy performance of new buildings by 2015. The EC shall by 31 December 2012 and every three years thereafter evaluate the MSs' progress in increasing the number of nZEBs and if necessary to propose measures towards this direction (see Figure 2).

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[4] Estimations based on Eurostat data, tsdpc320, tsdcc210

[5] The European Union (EU) aims to reduce domestic greenhouse gas (GHG) emissions by 40 % by 2030 and 80 % by 2050 (compared to 1990 levels); A non-binding target for energy savings, proposed by the European Commission [COM (2014) 520], is 30 % by 2030.

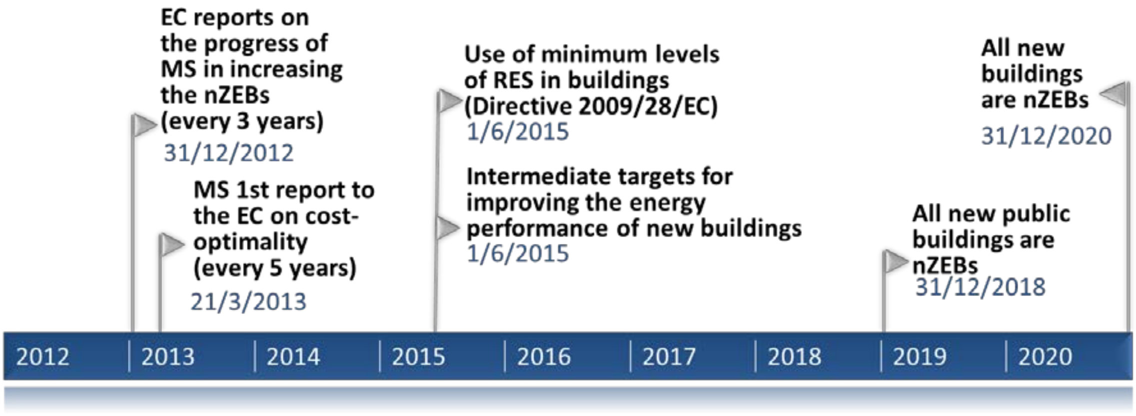

Figure 2: Key years for nearly zero energy buildings (Directive 2010/31/EC).

The EPBD recast (Art 9.6) specifies the extraordinary condition in which Member States may decide not to apply the nZEB requirements (i.e. the obligation to have all new buildings nearly Zero-Energy Buildings as from 2019/2021); This can only be justified for specific cases where the cost-benefit analysis over the economic lifecycle of the building in question is negative[6].

The cost optimal levels

According to the EPBD Directive (2010/31/EC) Member States are required to “assure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost optimal levels” (Art 4, EPBD). The MS need to also establish a comparative methodology framework for calculation cost-optimal levels (Art. 5 and Annex III). Besides the EPBD directive, the Commission provided additional legal documents on the cost optimality methodology. Those are the Commission’s Cost-Optimal Delegated Regulation [COM 2012a] and the Guidelines [COM 2012b].

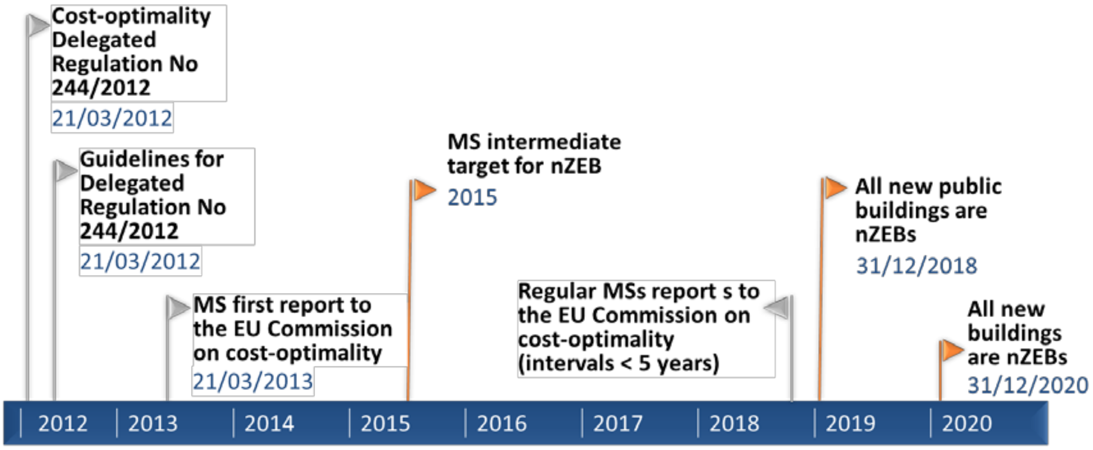

Figure 3: Timeline for implementation of the cost-optimal levels and nZEB requirements (Directive 2010/31/EC) [BPIE 2011].

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[6] However the cost-benefit analysis mentioned does not equal the cost-optimal requirements (Article 5, EPBD).

The EPBD requires MS to report on the comparison the existing minimum energy performance requirements with the calculated cost-optimal levels[7]. Additionally, Member States need to:

- define reference buildings (i.e. new and existing buildings; residential and non-residential) that are representative in terms of functionality and climate conditions.
- define energy efficiency measures and assess the final and primary energy need for the reference buildings.
- calculate the costs of the energy efficiency measures during the expected economic life-cycle[8] of the reference buildings.

The deadline for submission of the first report on cost optimality to the Commission was set for March 21, 2013; MS need to report their level of energy requirements at regular intervals of maximum five years.

The cost optimal methodology is a suitable tool to facilitate a smooth transition towards nZEB[9] (see: Figure 3). It could be used in the context of the definition of nearly Zero-Energy Building, but also to estimate the necessary support (subsidies) and market developments for the nZEB [BPIE 2011] (see also section 2.3).

Renewable Energy Systems - RES

Additional requirements, related to nearly zero-energy buildings, were established within the Renewable Energy Directive [RED 2009]:

By 31 December 2014 Member States shall, in their building regulations 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, through district heating and cooling produced using a significant proportion of renewable energy sources. In establishing such measures, 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 (Art 13.4).

Definition of nZEBs according to EPBD

Nearly zero energy *buildings "have very high energy performance while 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"*. This aforementioned definition of nZEBs, which is given in the recast of the [EPBD 2010] sets only a general description of the term. Despite this fact, the Directive clearly states that it is each MS's responsibility to define the term in national level taking into consideration their national, regional or local conditions. Additionally, each of the national definitions should include, inter alia, a numerical indicator of primary energy use expressed in kWh/m^2 per year, and energy needs for heating, cooling, ventilation and domestic hot water should be taken into account.

Based on the recast of the EPBD (Art.9) the national application of the definition of nZEB should be accompanied by national plans for increasing the number of nZEBs. By the end of

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[7] According to recital 14, EPBD, The discrepancy between the calculated cost-optimal level of national minimum energy performance requirements and the minimum energy performance requirements in force should not exceed 15 %.

[8] Investment costs, maintenance and operating costs, earnings from energy produced and disposal costs (if applicable) need to be taken into consideration.

[9] The energy performance of NZEB should, in principle, be better or equal to cost-optimal levels.

2012 (as stated in the first progress EC's report [EC 2013]) there were only 4 Member States with an official nZEB definition that contained both a numerical indicator of the primary energy and a share for renewable energy sources. To date the EC has received national plans[10] for nZEBs from 18 MS[11], while in total for 24 MS the EC has published consolidated information[10] on nZEBs (information coming from nZEBs national plans, NEEAP etc.). From the aforementioned countries only few of them assumed officially national approaches and nZEB national definitions (e.g. BE-Brx Region, DK, LT, SK). In most of the EU MS, the nZEB definitions are still under debate, while, on the other hand, there are 10 EU MS out of 28 which didn't report yet their nZEB plans and national definitions to the EU Commission (e.g. Czech Republic, Greece, Slovenia, Spain)".

Need for harmonisation at the EU level

Even though each MS has the flexibility to describe in its own way the nZEB, it would be very helpful if they followed a common approach for reporting the national definition and for drawing up the national plan for increasing the number of nZEBs. A harmonized European definition would facilitate not only the exchange of information and best practices among the MS but also the EC's evaluation progress. Towards this direction the EC asked CEN (Mandate M/480) to support the application of recast EPBD in the MS by developing standards.

The first mandate to CEN to develop a set of CEN EPBD standards (M 343) resulted in the successful publication of all EPBD related CEN standards in 2007-2008 (31 EN and 11 EN ISO standards).

The new mandate (M 480) came to review the mandate M 343 as the recast of the EPBD raises the need to revisit the standards and reformulate and add standards so that they become on the one hand unambiguous and compatible, and on the other hand a clear and explicit overview of the choices, boundary conditions and input data that need to be defined at national or regional level. Such national or regional choices remain necessary, due to differences in climate, culture & building tradition, policy and legal frameworks.

By 2016 a total revised and updated set will become available.

The first phase of the activity yielded the following products:

- FprEN 15603:2014 Over-Arching Standard + its Technical Report (FprCEN TR 15615);
- Fpr CEN /TS 16628: Technical Specification on Basic Principles + FprCEN/TS 16629 TS on Detailed Technical Rules;
- a software tool to support the checking of the calculation procedures given in the various standards and their interconnection.

Updating the standards to the needs of the EPBD recast included the following issues:

- more focus on models and input data which are suited to existing buildings;
- more focus on passive cooling techniques and for the assessment of the energy performance of cooling systems;
- expansion of the procedures to nearly zero energy buildings by way of renewable sources of energy, and procedures for energy producing buildings;
- more consideration given to alternative systems;
- integrated approach for calculating minimum performance requirements for technical building systems and building envelope taking into account all energy uses.

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[10] National nZEB reports to the EU Commission as well as Consolidated information from the Member States on Nearly Zero Energy Buildings are available at: http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm

[11] BE, BG, CY, DE, DK, FI, FR, HR, HU, IE, IT, LI, LU, NL, RO, SE, SK, UK

The assessment of the overall energy performance of a building is based on the holistic approach, that assumes integration and aggregation of all elements and energy services (see Figure 4).

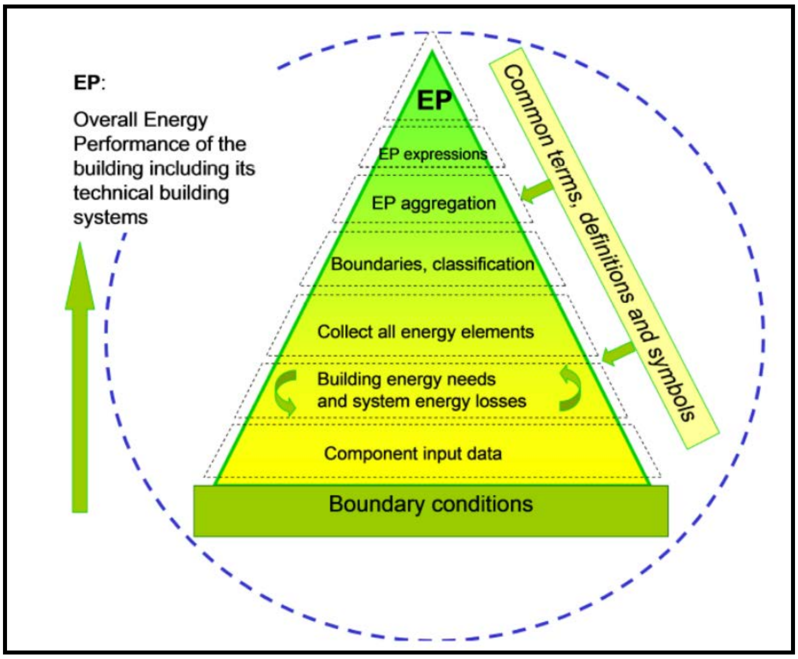

Figure 4: Holistic approach of the set of EPB-standards (source FprCEN/TS 16628:2014).

The overall energy balance of the building is defined by means of the assessment boundary, through which the energy can be imported or exported. The assessment boundary defines where the delivered and exported energy are evaluated.

Some of these energy flows can be quantified based on the meters (e.g. gas, electricity, district heating). For active solar, wind or water energy systems the incident solar radiation on solar panels or the kinetic energy of wind or water is not part of the energy balance of the building. Only the energy delivered by the generation devices, the auxiliary energy needed to supply the energy from the source (e.g. solar collector) to the building, and the thermal losses are taken into account in the energy balance.

The overall energy performance assessment of a building includes the following steps:

1) Specification of the building or building part for the energy performance assessment.
2) Categorization of spaces, including assessment of thermal envelope and simplifications.
3) Specification of the building services (e.g. heating, cooling, lighting, etc.) included in the energy performance.
4) Specification of the assessment boundaries.
5) Calculation or measurement of the energy flows at the assessment boundary.
6) Weighting of the energy flows according to primary energy factors or other metric (e.g. CO_2 emission). This is performed with controlling factors to allow including or excluding from the energy performance the effect of exported energy and of any compensation between energy carriers.
7) Aggregation to the energy performance and the renewable energy contribution

As shown in Figure 5, the delivered and exported energies can be classified according to the following perimeters: on-site; nearby; distant.

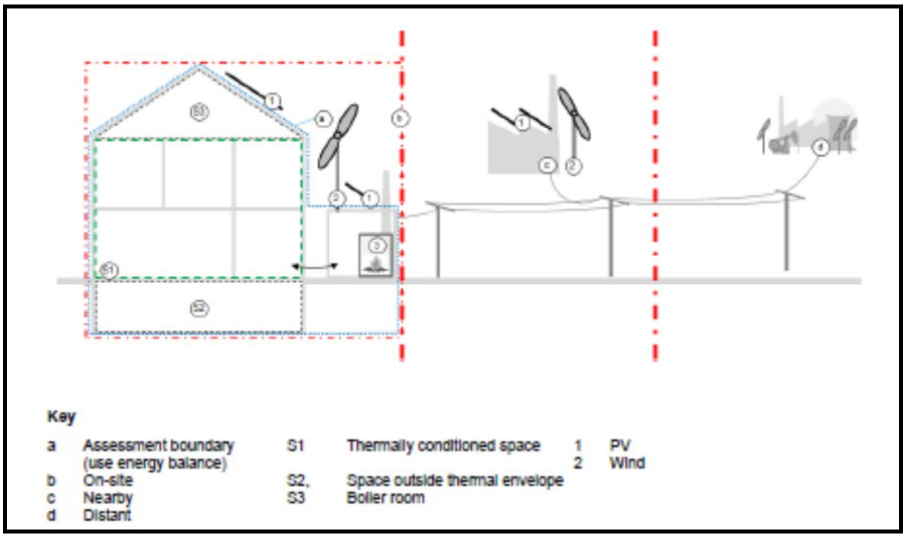

Figure 5: Perimeters and assessment boundaries (source FprEN 15603:2014).

Information on nearly Zero-Energy Building (nZEB) is given in annex G of FprEN 15603:2014, in which the following different requirements are combined to a coherent assessment of an nZEB:

- the building fabric (energy needs)
- the total primary energy use
- non-renewable primary energy use without compensation between energy carriers

Final nZEB rating is then based on a numerical indicator of non-renewable primary energy use with compensation.

2.2 nZEB Principles

The flexibility given to the MSs to define in their own way the nZEB requirements makes it difficult to find a common and harmonized nZEB definition across the EU. For that reason several studies and approaches have been published on this topic, i.e. [REHVA 2011], [REHVA 2013], [BPIE 2013a], [BPIE 2013b].

Technical definition – REHVA

A benchmarking study conducted in 2010 by REHVA revealed large variations in the technical regulations in different MSs [Seppänen/Goeders 2010], [REHVA 2011]. Realizing that these differences negatively affect the building industry and in an attempt to defining the nZEB in a uniform way, REHVA experts proposed a general definition format for the term nZEB. Hence, a nZEB is defined by *“technically and reasonably achievable national energy use of > 0 kWh/(m^2a) but no more than a national limit value of non-renewable primary energy, achieved with a combination of best practice energy efficiency measures and renewable energy technologies which may or may not be cost optimal”.* [REHVA 2013]

In the aforementioned definition the cost-effectiveness of the renewable energy technologies depends on the available national financial incentives, while the “reasonably achievable energy use” is defined in comparison with the national energy use benchmarks appropriate to the activities served by the buildings. For the definition it is necessary to clarify how on-site and nearby renewable energy production is included in the energy performance assessment and how primary energy factors should be used for the primary energy indicator calculation. Nevertheless, this definition takes into account local conditions and at the same time introduces a uniform methodology in all MSs.

nZEB Principles – BPIE

A study published by BPIE introduces a set of principles that support MSs in setting a sustainable nZEB definition [BPIE 2011]. After analysing the financial, legal, environmental and technical challenges, the three basic principles set the basis for setting up a proper nZEB definition.

The first nZEB principle is related to the energy consumption of the buildings and how this is assessed. It is based on an assumption that *"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"*. Therefore, it is recommended that in the nZEB definition a threshold for the maximum allowable energy need should be defined. This threshold should be between an upper limit which is defined by the cost optimal levels (Art. 5 EPBD) and a lower limit which can be determined considering the best available technology (BAT). Each MS should have the flexibility in elaborating the nZEB definition and in setting its own threshold within the aforementioned margins.

There are some good reasons for including electricity use for appliances (plug load) within the regulated energy demand (e.g. provision of indication on environmental impact). Thus, the definition should consist the electricity (energy) consumption of appliances for information purposes) including lighting for residential buildings.

The second nZEB principle results from the general definition set in the EPBD which foresees **that in an nZEB the energy required should be covered to a very significant extent by renewable sources.** Therefore, it has been concluded that *"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".* Consequently, a threshold for the minimum share of renewable energy demand should be part of the nZEB definition. According to the nZEB definition from EPBD which stipulates that onsite and nearby renewables should cover 'to a significant extend' the remaining energy needs of the buildings, BPIE study concluded that this share should gradually increase from 2020 to 2050, with a reasonable corridor between 50 % and 90 %.

The third nZEB principle is related to the CO_2 emissions. Due to the fact that the other two principles don't necessarily ensure sufficient CO_2 savings *"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"*. Consequently, in the nZEB definition a threshold for the overarching primary energy demand and CO_2 emission should be included. In the study the proposed range for CO_2 is between 0-3 kg/m^2 yr[12].

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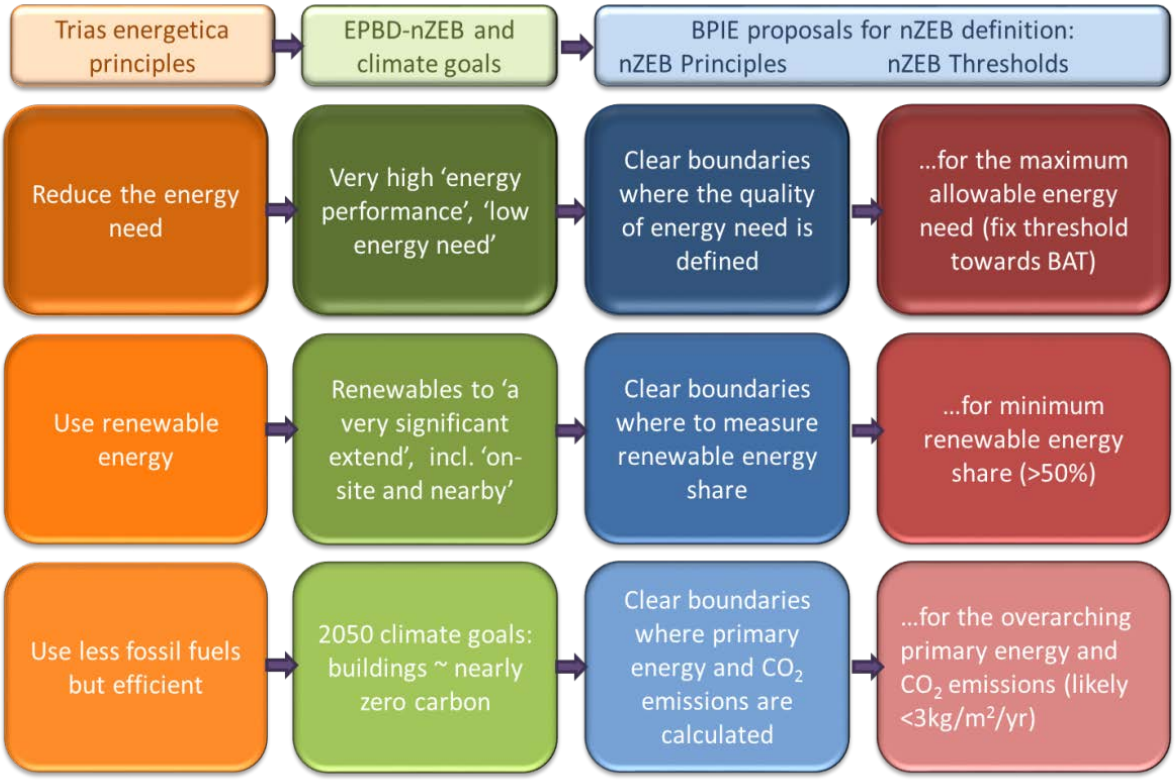
[12] Considering the proposed 90 % CO2 reduction in residential and services sectors from EU 2050 roadmap for a competitive and low-carbon economy and based on the following cacluation: a CO2 -emissions for the building sector of approximately 1.100 MtCO2 in 1990 (direct and indirect emissions for heating, domestic hot water and cooling purposes) and an estimated useful floor area evolution by 2050 up to 38 billion m² in 2050, the 90 % decrease of CO2 emissions would require an average CO2 -emissions of maximum 3 kgCO2/(m²yr).: 1,100MtCO2 x (100 %-90 %) / 38 billion m² = 2.89 kg/(m²yr).



Trias energetica principles	EPBD-nZEB and climate goals	BPIE proposals for nZEB definition: nZEB Principles	nZEB Thresholds
Reduce the energy need	Very high 'energy performance', 'low energy need'	Clear boundaries where the quality of energy need is defined	...for the maximum allowable energy need (fix threshold towards BAT)
Use renewable energy	Renewables to 'a very significant extend', incl. 'on-site and nearby'	Clear boundaries where to measure renewable energy share	...for minimum renewable energy share (>50%)
Use less fossil fuels but efficient	2050 climate goals: buildings ~ nearly zero carbon	Clear boundaries where primary energy and CO_2 emissions are calculated	...for the overarching primary energy and CO_2 emissions (likely <3kg/m²/yr)

Figure 6: Towards a sustainable nZEB definition. [BPIE 2011]

2.3 Relation between cost optimality & nZEB

As previously mentioned there are significant relations between the cost optimal methodology and nZEB requirements. While the cost optimality is the scope of current framework of the building policy (both for renovation of existing and new buildings), the nZEB will be playing a significant role after 2020 (2018 for public buildings).

Relations between cost-optimally and nZEB requirements were analysed in number of studies, e. g. [BPIE 2013a], [Ecofys et al. 2013], [Madonna and Ravasio 2013]. Implementation of the cost optimal methodology nowadays allows identifying the gaps that need to be addressed for the successful implementation of the nZEB after 2020. The BPIE report highlights three types of potential gaps, as following (see also Figure 7):

- Financial gap, due to the difference of the actual cost;
- Energy performance gap, due to the difference in primary energy need;
- Environmental gap, due to the difference between associated CO_2 emissions to primary energy need of cost-optimal and nZEB levels, the latter aiming to nearly zero-carbon emissions (or <3kg CO_2/m^2/yr) in order to be consistent with the 2050 decarbonisation goals of the EU.

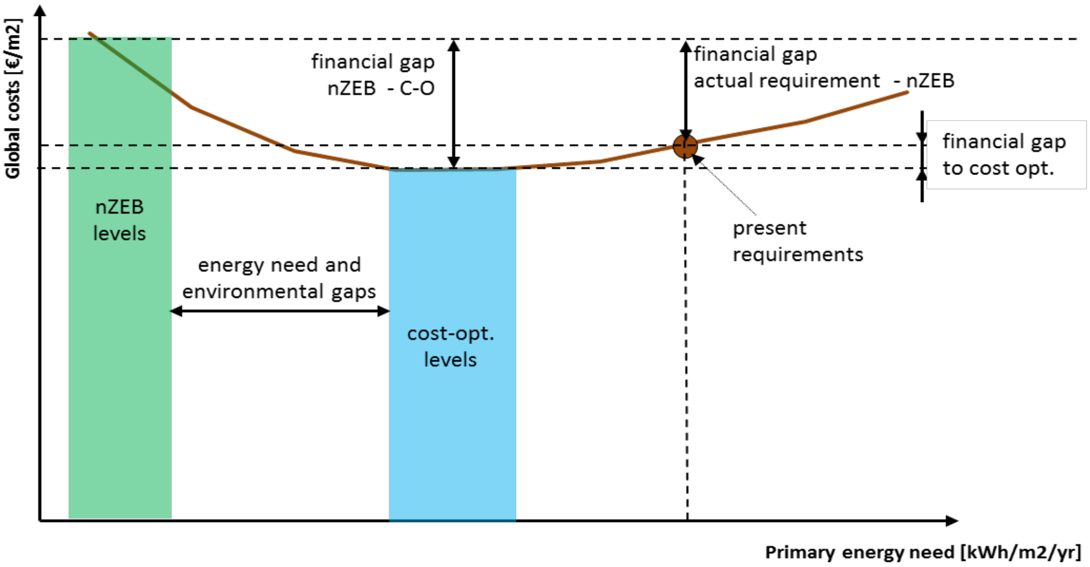


Figure 7: **Example of financial, energy and environmental gaps between current and cost-optimal requirements and nZEB levels [BPIE 2013a]**

This can be achieved by addressing the technology and installation costs. The market development of more energy efficient and renewable technologies and materials should be stimulated as this could lead to lowering the costs by 2020 [BPIE 2013a].

2.4 Sources / References

Table 2: Sources / References Principles and Benchmarks for Nearly Zero-Energy Buildings

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[BPIE 2011]	BPIE (ed.) (2011): Principles for Nearly Zero Energy Buildings. Paving the way for effective implementation of policy requirements. Online available: http://www.bpie.eu/documents/BPIE/publications/HR_NZEB%20study.pdf [2014-05-12]	Study with the objective to contribute to a common and cross-national understanding on EU-wide NZEB definitions, the need for principles of sustainable, realistic nearly Zero-Energy Buildings as well as possible technical solutions and their implications.
[BPIE 2013a]	BPIE (ed.) (2013): Implementing the Cost-Optimal Methodology in EU Countries. Lessons learned from three case studies. Online available: http://bpie.eu/documents/BPIE/publications/cost_optimal_methodology/BPIE_Implementing_Cost_Optimality.pdf	The study provides guidance on how to effectively implement the cost-optimal methodology at national level. It evaluates the implications of different critical parameters, as well as to share the good practices across EU countries. In addition three practical case studies (i.e. Austria, Germany and Poland) were delivered.
[BPIE 2013b]	Atanasiu, B./ Kunkel, S./Kouloumpi, I. (ed.) (2013): nZEB criteria for typical single-family home renovations in various countries. Online available: http://www.cohereno.eu/fileadmin/media/Dateien/Cohereno_Report_nZEB_Criteria.pdf	COHERENO project deliverable The report introduces nZEB criteria for typical single family house renovation.
[COM (2014) 520]	Communication from the Commission to the European Parliament and the Council. Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy 23.07.2014. Online available: http://ec.europa.eu/energy/efficiency/events/doc/2014_eec_communication_adopted.pdf [2014-08-05]	EC Communication
[COM 2012a]	Commission delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements. Online available: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0018:0036:EN:PDF [2014-08-05]	EC Regulation
[COM 2012b]	European Commission guidelines accompanying Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU) on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements. Online available at: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52012XC0419(02)&from=EN	EC guidelines
[EC 2013]	Report from the Commission to the European Parliament and the Council: Progress by Member States towards Nearly Zero-Energy Buildings. 2013. On line available: http://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=xh0nT22LfLgcbqT7VMthVXyzyB0QJJQ23Ryt29nhZkKmGpBhQTGQ!1575695567?uri=CELEX:52013DC0483R(01)	Report introduces an overview on MS practical definition of NZEBs within the scope of EPBD. The analysis was based on the results of MS progress reports on nZEBs.

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Ecofys et al. 2013]	Ecofys/Politecnico die Milano/University of Wuppertal (2013): Towards nearly zero-energy buildings: Definition of common principles under the EPBD, by order of the European Commission http://ec.europa.eu/energy/efficiency/buildings/doc/nzeb_full_report.pdf [2014-08-05]	The study gives guidance to the MSs on how to interpret the requirements for nearly zero energy buildings. It evaluates the adequacy of measures and activities reported by MS in their national plans on nearly zero energy buildings. Moreover it links cost optimality and the nearly zero energy buildings principle in a consistent way and facilitate their convergence until 2021.
[EPBD 2010]	Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). Online available: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0031 [2014-05-15]	
[Madonna and Ravasio 2013]	Madonna F. and Ravasio F. (2013) Definition of nearly zero energy building and cost-optimal energy performance in 2020, ECEEE Summer Study Proceedings 2013 (5b-315-13).	In the article presents the methodological framework to derive the cost-optimality levels, i.e. the energy performance, in terms of primary energy, leading to minimum life cycle cost. The levels are benchmarks for nZEB definition.
[RED 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 (Text with EEA relevance) http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0028 [2014-08-05]	
[REHVA 2011]	Kurtnitski, J. (ed.) (2011): How to define nearly net zero energy buildings nZEB – REHVA proposal for uniformed national implementation of EPBD recast. Available at: http://www.rehva.eu/publications-and-resources/hvac-journal/2011/032011/how-to-define-nearly-net-zero-energy-buildings-nzeb/	Report proposes the technical definitions and energy calculation principles for nearly zero energy buildings. The intention of the report was to help the experts in the Member States define the nearly zero energy buildings in a uniform way.
[REHVA 2013]	REHVA 2013: Technical definition for nearly zero energy buildings. Online available: http://www.rehva.eu/fileadmin/REHVA_Journal/REHVA_Journal_2013/RJ_issue_3/22-28_nZEB_RJ1303_web.pdf	This report is a revised version of 2011 report. It was prepared in cooperation with European standardization organization CEN. Report presents the technical definitions and energy calculation principles for nearly zero energy buildings.
[Seppänen/ Goeders 2010]	Seppänen O, Goeders G (2010): Benchmarking regulations on energy efficiency of buildings. Executive summary. REHVA Federation of European Heating, Ventilation and Air-conditioning Associations, 5 May 2010	Executive summary of the benchmarking study conducted on the technical regulations for building in different MSs.

3 Inclusion of Different Energy Performance Levels for New Buildings in National Residential Building Typologies

In the following subchapters, the inclusion of different energy performance levels for new buildings in national residential building typologies is described for each of the participating countries. Apart from the current national requirements for new buildings, the status of the national NZEB definition and the calculation method to comply with the building regulations are explained.

Furthermore, the classification schemes of national building typologies are displayed, and the integration of example buildings to demonstrate current national requirements for new buildings, an improved and the (assumed[13]) NZEB standard is discussed and illustrated by the description of one example building from each country. For this example also the national building display sheet is shown which is included in the respective national typology brochures the project partners have elaborated.[14]

Results of energy balance calculations are shown with regards to the national calculation procedures as well as to the TABULA scheme. This commonly used calculation method has been evolved in the framework of the IEE funded project TABULA in order to make energy performance data comparable between different countries. It has been further developed in the framework of the EPISCOPE project and is now e.g. including the assessment of on-site electricity production by CHP and PV systems.

A focus is placed on the energy consumption for space heating and hot water. Moreover, the present report considers calculated energy demands only, since the building variants are case studies and have not necessarily been exactly constructed in the way displayed here. In general, these values may differ from actual consumptions in a greater or lesser extent.

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[13] For several countries no official definitions of nearly zero-energy buildings have been published so far. In these cases, the considerations are based on an energy performance level that is assumed to comply with the NZEB approach.

[14] Example display sheets as well as the national building typology brochures can be downloaded from the project website: http://episcope.eu

3.1 <AT> Austria

(by EPISCOPE partner AEA)

In Austria the reduction of the energy consumption in the building sector is one of the important goals of the energy strategy. There has been considerable number of measures implemented for space heating reduction since 1990 [AEA, 2013]. The implemented U-values for the construction elements (envelope insulation and windows) defined in the building regulations for example reflect these efforts.

In 1996 the first Passive-single family house was already built in Vorarlberg (Austria). This was followed by multifamily buildings, apartment buildings, schools and office buildings. During the period of 2005-07 the first renovation of a public building with Passive house components was completed. In 2009, Austria is the country with the most built Passive houses density [Lang, 2010].

There are subsidy programmes on regional and national level for both new buildings and renovation activities [KPC, 2014] relating to energy saving measures also for the use of renewable energy and changing the heating system into an ecological system.

In 2004, the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) initiated a special programme for new buildings and renovation (klimaaktiv: Bauen & Sanieren) to promote the reduction of energy consumption in the building sector. In 2012, 312,000 m² of dwelling area built, were declared according to the criteria of klimaaktiv which is more than double than the area in 2011 [klimaaktiv, 2014]. The criterion for the klimaaktiv certification is more stringent than the criterion for nearly zero-energy buildings (nZEBs), defined in the national plan for the year 2020 and are in three certification categories: Gold, Silber and Bronze (Minimum).

Nearly zero-energy buildings (nZEBs) have been defined in the national plan 2020 (tightened in two year steps: 2014, 2016, 2018 and 2020) and the negotiations with the Austrian Provinces (Länder) are completed [OIB, 2014a]. The implementation in the building regulations in the Provinces (Länder) are expected in 2015.

3.1.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Austria

There is no central (national) building regulation in Austria. Each Austrian province (Land) has its own building regulation but in 2008 the fundamental technical regulations in most of the provinces “Länder” were revised and harmonized.

Since the energy crisis in 1973, there has been a gradual implementation of technical regulations on thermal specifications. In Vienna, for example, in 1976 the first thermal regulation on the building envelope was executed.

For the time being, the regulations on thermal aspects of the building according to the OIB[15] (Austrian Institute of Construction Engineering)-directive 2011 have been accepted by all of the Austrian provinces [OIB, 2014a]. The current thermal and energy requirements are for both new and major renovation.

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[15] OIB stands for „Österreichisches Institut für Bautechnik“: Austrian Institute of Construction Engineering

Minimum requirements for new residential buildings in Austria

The OIB-2011 guidelines 6 on energy saving and thermal insulation, includes the complete description of minimum requirements on building components and parameters such as U-values and supply system type and quality. It also includes the requirements of space heating demand, final and primary energy demand and CO_2-emissions.The layout of energy performance certificate is also specified in this guideline [OIB, 2011].

The energy performance requirements of the buildings are planned to be tightened step by step. The requirements define maximum limit of the primary energy demand, of CO_2-emissions and total energy efficiency factor. This can be reached either by improving the thermal envelope or improvement of the heating and domestic hot water supply (See picture in the next section).

In the revised version of OIB guidelines [OIB 2014b], at least 15 % of the primary energy demand should be provided by renewable sources.

Austrian calculation method to comply with new building regulations for residential buildings

As already mentioned, the layout of the EPC for residential and non-residential buildings is described in the OIB guidelines ([OIB, 2011] and revised in [OIB, 2014b]). The calculation method of the EPC is defined in an attachment to the guidelines in form of a handbook on energy performance of buildings. The calculations are based on the different ÖNORMs (Austrian standards and regulations):

Wärmeschutz im Hochbau - Niedrig- und Niedrigstenergie-Gebäude - Teil 5: Anforderungen und Nachweisverfahren Thermal protection in building construction - Low and lowest energy buildings - Part 5: Requirements and reference methods	ÖNORM 8110-5	B
Wärmeschutz im Hochbau - Teil 6: Grundlagen und Nachweisverfahren - Heizwärmebedarf und Kühlbedarf Thermal insulation in building construction - Part 6: Principles and verification methods - Heating demand and cooling demand	ÖNORM 8110-6[16]	B
Gesamtenergieeffizienz von Gebäuden - Begleitende Dokumente zum Energieausweis - Befund, Gutachten, Ratschläge und Empfehlungen Energy performance of buildings - Documents relating to the energy certificate - Findings, expertise, advice and recommendations	ÖNORM 5055	H
Gesamtenergieeffizienz von Gebäuden - Heiztechnik-Energiebedarf Energy performance of buildings - Energy use for heating systems	ÖNORM 505616	H
Gesamtenergieeffizienz von Gebäuden - Raumlufttechnik-Energiebedarf für Wohn- und Nichtwohngebäude Energy performance of buildings - Energy use for ventilation systems of residential and non-residential buildings	ÖNORM 5057	H
Gesamtenergieeffizienz von Gebäuden - Kühltechnik-Energiebedarf Energy performance of buildings - Energy use for cooling systems	ÖNORM 5058	H
Gesamtenergieeffizienz von Gebäuden - Beleuchtungsenergiebedarf Energy performance of buildings — Energy use for lighting	ÖNORM 5059	H

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[16] In August 2014, updated versions of the 2 ÖNORMs have been published: ÖNORM B 8110-6 and ÖNORM H 5056.

Status of NZEB definition for residential buildings in Austria

The concept of the Nearly Zero-Energy Building (nZEB) in the national plan is composed in a document by the OIB- Austrian Institute of Construction Engineering [OIB, 2014a]. The concept is based on article 9 of the Energy Performance of Buildings Directive (EPBD) 2010 (2010/31/EU) and defines the minimum requirements of the complete energy efficiency of the buildings.

The requirements of the nZEB 2020 are defined in four indicators:

- Heating energy demand: Heizwärmebedarf (HWB)
- Primary energy demand: Primärenergiebedarf (PEB)
- CO_2 emissions: CO_2-Emissionen (CO_2)
- Total energy efficiency factor called 'Gesamtenergieeffizienz-Faktor (f_{GEE})'

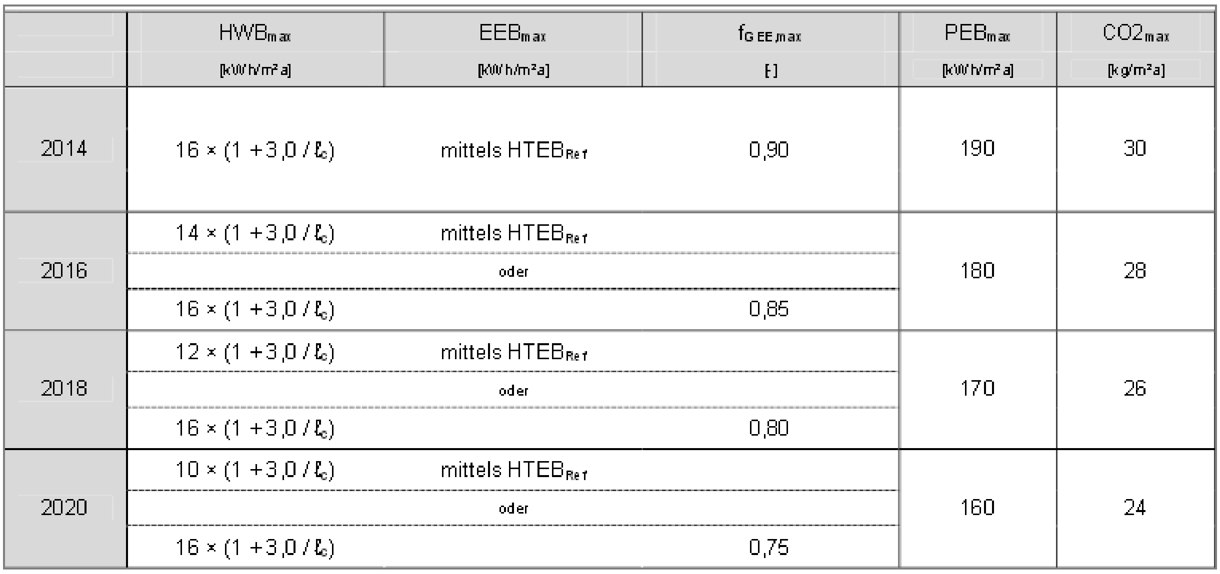
It has to be mentioned that the electricity demand for both residential and non-residential buildings is being considered in the primary energy demand including the electricity for lightning, heating, cooling, ventilation and domestic hot water (Haushaltstrombedarf HHSB or household electricity demand is included in final energy demand).

In the table below, the maximum space heating demand (HWB), final energy demand (EEB), total energy efficiency factor (f_{GEE}), primary energy demand (PEB) and CO_2-emissions (CO_2) are defined for new buildings.

HTEB in the tables below stands for Heiztechnik-Energiebedarf or energy use for heating systems. The abbreviation l_c stands for 'charakteristische Gebäudelänge' or characteristic length of the building (the relation of the volume of the building to its envelope: V/A).[17]

The current calculation method for new residential buildings, according to the building regulations requirements and special aspects of nZEB definition in Austria can be seen in the table below:

Table 3: Extract from the Austrian national plan for new buildings [OIB, 2014a]



	HWB_{max} [kWh/m²a]	EEB_{max} [kWh/m²a]	$f_{GEE,max}$ [-]	PEB_{max} [kWh/m²a]	$CO2_{max}$ [kg/m²a]
2014	$16 \times (1 + 3{,}0 / \ell_c)$	mittels $HTEB_{Ref}$	0,90	190	30
2016	$14 \times (1 + 3{,}0 / \ell_c)$	mittels $HTEB_{Ref}$		180	28
		oder			
	$16 \times (1 + 3{,}0 / \ell_c)$		0,85		
2018	$12 \times (1 + 3{,}0 / \ell_c)$	mittels $HTEB_{Ref}$		170	26
		oder			
	$16 \times (1 + 3{,}0 / \ell_c)$		0,80		
2020	$10 \times (1 + 3{,}0 / \ell_c)$	mittels $HTEB_{Ref}$		160	24
		oder			
	$16 \times (1 + 3{,}0 / \ell_c)$		0,75		

In the table, there are two variations defined per year: one variation through improvement of the building envelope (top row) with a standard energy system and the second one through more energy efficient heating system (lower row) and lower requirements for the building envelope.

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[17] For example: if the relation of the envelope of a building to its volume is 2, the space heating demand for the nZEB 2020 would be for the first version 10 x (1 + 3/2) = 25 kWh/m²a and for the second version 16 x (1+3/2) = 40kWh/m²a. For the second version the f_{GEE} needs to be under 0.75.

Table 4: **Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the NZEB definition in Austria**

Calculation Method New Building Regulations – (part 1)

Country	AT	Austria	Status	06/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the Austrian NZEB Definition

Legislation / Standards

Provincial or governmental building codes based on OIB (Austrian Institute of Construction Engineering)-directive 2011 [OIB, 2011]

Calculation method based on Austrian standards

Heating demand and cooling demand (Heizwärmebedarf und Kühlbedarf) : ÖNORM B 8110-6

Energy use for ventilation systems of residential and non-residential buildings (Raumlufttechnik-Energiebedarf für Wohn- und Nichtwohngebäude): ÖNORM H 5057

Energy use for heating systems (Heiztechnik-Energiebedarf): ÖNORM H 5056

Energy use for cooling systems (Kühltechnik-Energiebedarf): ÖNORM H 5058

Energy use for lighting (Beleuchtungsenergiebedarf): ÖNORM H 5059

Requirements and reference methods (Anforderungen und Nachweisverfahren): ÖNORM B 8110-5

Explanation / Comments

The calculation method is described in handbook on energy performance of the buildings (OIB) December 2011 as a basis for the calculations of the provinces of Austria.

Special Aspects with regard to the Austrian NZEB Definition:

The building regulation is not central. The Austrian Federal Governments (Länder) have each its own regulation.

A draft of revised OIB Guidelines 6 has been published in June 2014 [OIB, 2014b].

Energy Services

x	Heating	x	DHW	x	Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation	x	Lighting			

Explanation / Comments

Installing cooling systems are rare in Austria but installing ventilation systems are gaining (e.g. passive or low energy houses)

Special Aspects with regard to the Austrian NZEB Definition:

No deviations.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	month/year
x	Calculation of delivered energy (system)	month

Explanation / Comments

Special Aspects with regard to the Austrian NZEB Definition:

No deviations.

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
	On-site CHP				
x	On-site PV	x	x	month	HE
	Other energy generation systems:				

[1] "self-use" = parts of the electricity demand of the building is directly covered by the produced electricity; self-use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Special Aspects with regard to the Austrian NZEB Definition:

On-site electricity produced by PV has been added to EPC recently in the draft of June 2014 [OIB, 2014b].

Table 4 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>**Country**</td><td>**AT**</td><td colspan="3">Austria</td><td>Status</td><td>06/2014</td></tr>
<tr><td colspan="5">**National Requirements for New Residential Buildings**</td><td colspan="2">**Special Aspects with regard to the National NZEB Definition**</td></tr>
<tr><td colspan="5">**Type of Requirements (new buildings)**</td><td colspan="2" rowspan="6">According to the draft of the OIB guideline 6 from June 2014 [OIB, 2014b], apart from a fixed maximum value for the primary energy demand a minimum 15% of the primary energy demand should be renewable.
Also fixed value requirements for CO_2 emissions and the complete energy efficiency factor (f$_{GEE)}$) are foreseen.
f$_{GEE}$ is considered in nZEB in combination with other features [OIB, 2014b].</td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2"></td><td rowspan="2">Primary energy</td><td rowspan="2"></td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td>x</td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td>x</td><td>Delivered energy</td><td></td><td>Other:</td><td></td></tr>
<tr><td colspan="5">**Explanation / Comments**
In some provinces, a tenant behaviour factor is used as a default value in the calculation of the EPCs.</td></tr>
</table>

Assessment of energy carriers in Austria

In the Austrian energy performance certificate, the primary energy demand for energy derived from renewable and non-renewable energy sources are indicated. The primary energy demand is calculated according to the Austrian standards (see previous chapter) considering the auxiliary energy demand of the lightning, heating/cooling system, ventilation system, and domestic hot water. The primary energy factors are foreseen in the Austrian standards concerning the energy carriers in the table below.

Table 5: Austrian primary energy factors

Label / type of factor	**Total Primary Energy Factor**	**Non-Renewable Primary Energy Factor**
used for EPC rating	x	x
used for building regulations requirements	*	*
Label (national language)	Primärenergiebedarf	Primärenergiebedarf nicht erneuerbar
Description / type of weighting factor	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary
Reference	[OIB, 2011]**	[OIB, 2011]**
Factor is multiplied by delivered energy based on the	net calorific value*	net calorific value
Natural gas	1.17	1.17
Heating oil	1.23	1.23
Biomass	1.08	0.06
Electricity	2.62	2.15
District heating	1.52	1.38
District heating with 100 % CHP	0.92	0.20

*) According to [OIB, 2011] the primary energy demand is only used for EPC rating. In June 2014 a draft of the new OIB guideline 6 has been published in which requirements of the primary energy demand are included and which defines a minimum share of renewable primary energy of 15 % with regards to the total primary energy demand.

**) ÖNORM EN 15603, 2008

Methodological points for discussion in Austria

As mentioned before, there are two variations defined to reach the Austrian nZEB requirements:

a) improvement of the building envelope (minimum space heating demand formula)
b) more energy efficient heating system (a combination of the minimum space heating demand (formula) and the minimum total energy efficiency factor)

In both cases the minimum value for the primary energy demand and CO_2-emission are indicated.

The energy produced by the photovoltaic is exported mainly into the electricity grid (there are exceptions). It will be stated in the EPC of the building in the energy balance (a draft was published in June 2014 [OIB, 2014b]).

3.1.2 Integration of National Requirements for New Buildings and NZEB Standards in the Austrian Residential Building Typology

The building typology developed in the TABULA/EPISCOPE project is the first comprehensive typology concerning all type of residential buildings starting with single family home to apartment buildings. The first building typology developed in the TABULA project has been used by research institutions and universities. It has supported some of Austrian provinces (Länder) to adapt their climate protection strategies accordingly.

Classification scheme for the Austrian residential building stock (“Building Type Matrix”)

During the IEE Project EPISCOPE, the building type matrix developed in TABULA project was extended towards new buildings, reflecting the current legal requirements [OIB, 2011]. The picture below shows the respective matrix. Four further examples buildings have been identified which are now used for show calculations reflecting possible practical implementations of new buildings requirements according to the national minimum requirements, klimaaktiv certification and future nZEB standards.

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Gesamt-Österreich)	… 1919	generic (Standard / allgemein typisch)	 AT.N.SFH.01.Gen	 AT.N.TH.01.Gen	 AT.N.MFH.01.Gen	 AT.N.AB.01.Gen
2	national (Gesamt-Österreich)	1919 … 1944	generic (Standard / allgemein typisch)	 AT.N.SFH.02.Gen	 AT.N.TH.02.Gen	 AT.N.MFH.02.Gen	 AT.N.AB.02.Gen
3	national (Gesamt-Österreich)	1945 … 1960	generic (Standard / allgemein typisch)	 AT.N.SFH.03.Gen	 AT.N.TH.03.Gen	 AT.N.MFH.03.Gen	 AT.N.AB.03.Gen
4	national (Gesamt-Österreich)	1961 … 1980	generic (Standard / allgemein typisch)	 AT.N.SFH.04.Gen	 AT.N.TH.04.Gen	 AT.N.MFH.04.Gen	 AT.N.AB.04.Gen
5	national (Gesamt-Österreich)	1981 … 1990	generic (Standard / allgemein typisch)	 AT.N.SFH.05.Gen	 AT.N.TH.05.Gen	 AT.N.MFH.05.Gen	 AT.N.AB.05.Gen
6	national (Gesamt-Österreich)	1991 … 2000	generic (Standard / allgemein typisch)	 AT.N.SFH.06.Gen	 AT.N.TH.06.Gen	 AT.N.MFH.06.Gen	 AT.N.AB.06.Gen
7	national (Gesamt-Österreich)	2001 … 2009	generic (Standard / allgemein typisch)	 AT.N.SFH.07.Gen	 AT.N.TH.07.Gen	 AT.N.MFH.07.Gen	 AT.N.AB.07.Gen
8	national (Gesamt-Österreich)	2010 …	generic (Standard / allgemein typisch)	 AT.N.SFH.08.Gen	 AT.N.TH.08.Gen	 AT.N.MFH.08.Gen	 AT.N.AB.08.Gen

Figure 8: **Classification scheme ("Building Type Matrix") of the Austrian residential building typology [AEA, 2014], now extended towards new buildings**

Table 6: **Exemplary new buildings representing the latest construction year classes (2010 …)**

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 AT.N.SFH.08.Gen	 AT.N.TH.08.Gen	 AT.N.MFH.08.Gen	 AT.N.AB.08.Gen
Number of dwellings		1	1	4	25
Number of full storeys (conditioned)		2	2	4	4
Number of directly attached neighbour buildings		0	2	0	0
National reference area (Buttogrundfläche / gross floor area based on EPC)	m²	192	142	274	1133
TABULA reference area (conditioned floor area, internal dimensions)	m²	153	113	219	906

Building example: variants meeting three energy performance levels for new buildings

For all four categories of new buildings three different standards beside the current standard have been compared: klimaaktiv [klimaaktiv, 2013] basic standard (Bronze), and two variations of the national plan standards. A multifamily house has been chosen to show the different model cases. The table below shows the building features for these energy performance levels.

Energy Performance levels

- **“OIB-guidelines 6, 2011”** (Mindestanforderung OIB-Richtlinie 6, 2011)

  Combination of building and supply system that exactly complies with the current minimum requirements Building VII: current standard

- **“klimaaktiv minimum criteria”** (according to the minimum criteria for the certification as klimaaktiv building 2013)

  Combination of building’s thermal insulation, construction material and supply system: Building VIII (in table below has been shown as ka). For the gold certification of klimaaktiv, a short indication of heating demand has been also presented on the sheets.

- **National Plan on Nearly Zero-Energy Buildings**
  - **“10 x (1 + 3.0 / l_c)”** OIB-Document on national plan with better thermal insulation (in table below has been shown as 10)
  - **“16 x (1 + 3.0 / l_c)”** OIB-Document on national plan with supply system with less CO_2-emissions (in table below has been shown as 16)

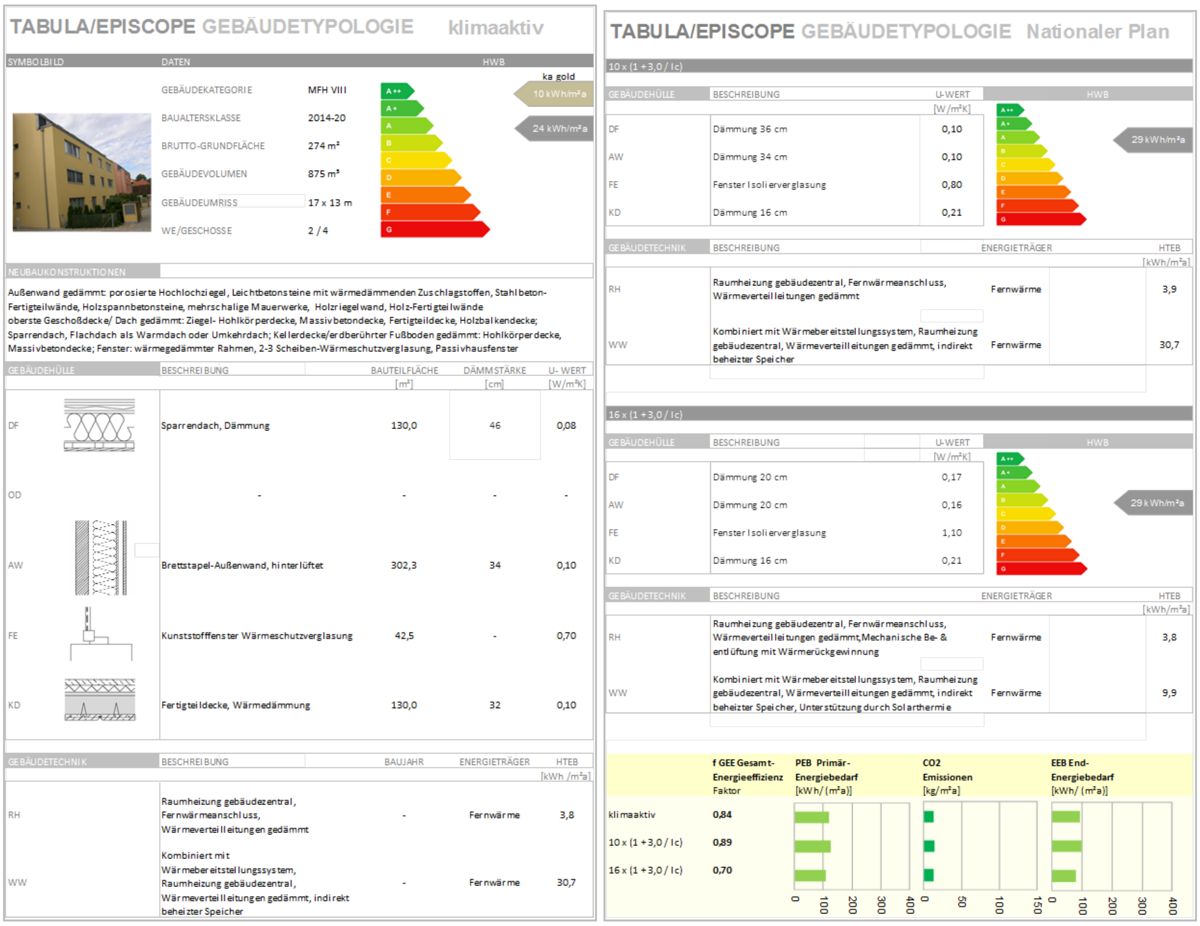
Table 7: Exemplary single-family house (MFH) – definition of variants

 AT. N.MFH.08.Gen **Variant N° 8**		**OIB RL6, 2011**	**ka**	**10**	**16**
Energy Performance Level		Current Minimum Requirement	Minimum standard	Improved thermal envelope/ NZEB	Improved supply system / NZEB
U-values					
Roof	W/(m^{2}K)	0.2*	0.08	0.1	0.17
Wall	W/(m^{2}K)	0.35*	0.1	0.1	0.16
Window	W/(m^{2}K)	1.4*	0.7	0.8	1.1
Door	W/(m^{2}K)	1.7*	0.7	0.8	1.1
Floor	W/(m^{2}K)	0.4*	0.1	0.2	0.2
Thermal bridging supplement (whole envelope)	W/(K)	10.57	6.98	8.29	10.37
CO$_2$ emissions **kg/(m^{2}a)		< 30	< 12	< 24	< 24
Primary energy **W/(m^{2}K)		< 160	< 135	< 160	< 160
Heat Supply System					
Heat generator		District Heating	District Heating	District Heating	District Heating Ventilation system with heat recovery
Thermal solar system		-	-	-	DHW

*These U-values are the minimum requirements of the OIB-guidelines

** The type of heating system is reflected in primary energy and CO$_2$-emission balance and these is the parameter considered in the NZEB Buildings

In the new version of the Austrian “Building Typology Brochure” [AEA, 2014] the three variants of the new buildings are displayed next to each other on a double page: left the klimaaktiv minimum criteria and right top the nZEB 10 x (1 + 3.0 / l_c) (better thermal insulation) and right bottom nZEB 16 x (1 + 3.0 / l_c) (better energy efficient supply system). These “Building Display Sheets” have been developed during the IEE project TABULA and have been modified to represent the three variations of new buildings as explained above.



TABULA/EPISCOPE GEBÄUDETYPOLOGIE klimaaktiv

SYMBOLBILD DATEN HWB

GEBÄUDEKATEGORIE	MFH VIII
BAUALTERSKLASSE	2014-20
BRUTTO-GRUNDFLÄCHE	274 m²
GEBÄUDEVOLUMEN	875 m³
GEBÄUDEUMRISS	17 x 13 m
WE/GESCHOSSE	2 / 4

ka gold
10 kWh/m²a
24 kWh/m²a

NEUBAUKONSTRUKTIONEN

Außenwand gedämmt: porosierte Hochlochziegel, Leichtbetonsteine mit wärmedämmenden Zuschlagstoffen, Stahlbeton-Fertigteilwände, Holzspannbetonsteine, mehrschalige Mauerwerke, Holzriegelwand, Holz-Fertigteilwände
oberste Geschoßdecke/ Dach gedämmt: Ziegel- Hohlkörperdecke, Massivbetondecke, Fertigteildecke, Holzbalkendecke; Sparrendach, Flachdach als Warmdach oder Umkehrdach; Kellerdecke/erdberührter Fußboden gedämmt: Hohlkörperdecke, Massivbetondecke; Fenster: wärmegedämmter Rahmen, 2-3 Scheiben-Wärmeschutzverglasung, Passivhausfenster

GEBÄUDEHÜLLE	BESCHREIBUNG	BAUTEILFLÄCHE [m²]	DÄMMSTÄRKE [cm]	U- WERT [W/m²K]
DF	Sparrendach, Dämmung	130,0	46	0,08
OD	-	-	-	-
AW	Brettstapel-Außenwand, hinterlüftet	302,3	34	0,10
FE	Kunststofffenster Wärmeschutzverglasung	42,5	-	0,70
KD	Fertigteildecke, Wärmedämmung	130,0	32	0,10

GEBÄUDETECHNIK	BESCHREIBUNG	BAUJAHR	ENERGIETRÄGER	HTEB [kWh /m²a]
RH	Raumheizung gebäudezentral, Fernwärmeanschluss, Wärmeverteilleitungen gedämmt	-	Fernwärme	3,8
WW	Kombiniert mit Wärmebereitstellungssystem, Raumheizung gebäudezentral, Wärmeverteilleitungen gedämmt, indirekt beheizter Speicher	-	Fernwärme	30,7

TABULA/EPISCOPE GEBÄUDETYPOLOGIE Nationaler Plan

10 x (1 +3,0 / lc)

GEBÄUDEHÜLLE	BESCHREIBUNG	U-WERT [W/m²K]
DF	Dämmung 36 cm	0,10
AW	Dämmung 34 cm	0,10
FE	Fenster Isolierverglasung	0,80
KD	Dämmung 16 cm	0,21

HWB
29 kWh/m²a

GEBÄUDETECHNIK	BESCHREIBUNG	ENERGIETRÄGER	HTEB [kWh/m²a]
RH	Raumheizung gebäudezentral, Fernwärmeanschluss, Wärmeverteilleitungen gedämmt	Fernwärme	3,9
WW	Kombiniert mit Wärmebereitstellungssystem, Raumheizung gebäudezentral, Wärmeverteilleitungen gedämmt, indirekt beheizter Speicher	Fernwärme	30,7

16 x (1 +3,0 / lc)

GEBÄUDEHÜLLE	BESCHREIBUNG	U-WERT [W/m²K]
DF	Dämmung 20 cm	0,17
AW	Dämmung 20 cm	0,16
FE	Fenster Isolierverglasung	1,10
KD	Dämmung 16 cm	0,21

HWB
29 kWh/m²a

GEBÄUDETECHNIK	BESCHREIBUNG	ENERGIETRÄGER	HTEB [kWh/m²a]
RH	Raumheizung gebäudezentral, Fernwärmeanschluss, Wärmeverteilleitungen gedämmt,Mechanische Be- & entlüftung mit Wärmerückgewinnung	Fernwärme	3,8
WW	Kombiniert mit Wärmebereitstellungssystem, Raumheizung gebäudezentral, Wärmeverteilleitungen gedämmt, indirekt beheizter Speicher, Unterstützung durch Solarthermie	Fernwärme	9,9

	f GEE Gesamt-Energieeffizienz Faktor	PEB Primär-Energiebedarf [kWh/ (m²a)]	CO2 Emissionen [kg/m²a]	EEB End-Energiebedarf [kWh/ (m²a)]
klimaaktiv	0,84			
10 x (1 +3,0 / lc)	0,89			
16 x (1 +3,0 / lc)	0,70			

Figure 9: “Building Display Sheet” of the exemplary MFH <AT> [AEA, 2014]

Table 8: Exemplary MFH – Results of the energy balance calculation; Procedure: OIB Guidelines 6, 2011

Variant N°  A T.N.MFH.08.Gen					
Label of the variant		OIB RL6, 2011	klimaaktiv	NZEB	NZEB
Variation level		Minimum Requirement	minimum	VAR 10	VAR 16
Energy standard		2011	2013	2020	2020
Calculation method					
Total energy efficiency factor f_{GEE}		1.01	0.84	0.89	0.7
Energy need for heating	kWh/(m²a)	41	24	29	30
Delivered energy		DH	DH	DH	DH
Fossil fuels	kWh/(m²a)	61.5	56.7	58.1	55.8
Renewable fuels	kWh/(m²a)	76.7	61.9	66.3	51.6
Electricity	kWh/(m²a)	16.4	16.4	16.4	16.4
CO2-Emissions	kg/(m²a)	15.1	13.5	14	12.8
End energy demand	kWh/(m²a)	113.4	92.8	98.9	78.7
Primary energy demand	kWh/(m²a)	138.2	118.6	124.4	107.3

TABULA calculation results for all exemplary buildings

Table 9 shows the results of the TABULA/EPISCOPE calculation procedure (standard calculation, not adapted) for all four exemplary building categories.

The minimum requirements in the table are the requirements of the buildings according to the OIB 2011 guidelines 6 for the buildings build in 2014. The improved standard in the table shows the values according to the klimaaktiv minimum standards. For ambitious standard in the table the requirements of nZEB national plan 2020 variant 10 (with better thermal insulation) has been chosen.

Table 9: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  AT.N.SFH.08.Gen ReEx.001	01	Minimum Requirement	1.39	135	29	106	114	10	27	0	0	0	164	4	0	0	0
	02	Improved Standard / ka	0.56	67	0	67	70	10	27	0	0	0	0	1	83	0	0
	03	Ambitious Standard / NZEB (10)	0.68	81	0	81	84	10	27	0	0	0	0	1	97	0	0
TH  AT.N.TH.08.Gen ReEx.001	01	Minimum Requirement	1.09	114	29	85	93	10	27	0	0	0	136	4	0	0	0
	02	Improved Standard / ka	0.52	70	0	70	73	10	27	0	0	0	0	1	86	0	0
	03	Ambitious Standard / NZEB (10)	0.52	72	0	72	76	10	27	0	0	0	0	1	88	0	0
MFH  AT.N.MFH.08.Gen ReEx.001	01	Minimum Requirement	1.31	142	0	142	145	15	32	0	0	0	0	1	162	0	0
	02	Improved Standard / ka	0.55	72	0	72	75	15	32	0	0	0	0	1	90	0	0
	03	Ambitious Standard / NZEB (10)	0.64	84	0	84	87	15	32	0	0	0	0	1	102	0	0
AB  AT.N.AB.08.Gen ReEx.001	01	Minimum Requirement	1.04	112	0	112	116	15	32	0	0	0	0	1	131	0	0
	02	Improved Standard / ka	0.52	64	0	64	67	15	32	0	0	0	0	1	82	0	0
	03	Ambitious Standard / NZEB (10)	0.59	75	0	75	79	15	32	0	0	0	0	1	93	0	0

Explanation of Quantities (TABULA Data fields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.1.3 Sources / References Austria

Table 10: Sources / References Austria

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[AEA, 2013]	Kratena, Kurt/ Angela Holzmann, Angela/ Barreto-Gomez, Leonardo/Baumann, Martin/ Bürbaumer, Heimo/Thenius,Gregor/Tretter, Herbert (2013): Bestimmungsgrößen für Energieeffizienz und –verbrauch in Österrreichs Haushalten – Eine Komponentenzerlegung. Influence factors on energy efficiency and energy use in private household in Austria – A decomposition analysis. Publisher: Österreichische Energieagentur – Austrian Energy Agency (AEA), Vienna. Online available: http://www.energyagency.at/fileadmin/dam/pdf/projekte/klimapolitik/BEEHOUSE-Endbericht_2013.pdf [2014-08-05]	Final report on. Influence factors on energy efficiency and energy use in private households in Austria – A decomposition analysis
[AEA, 2014]	Amtmann, Maria/Altmann-Mavaddat, Naghmeh (2014): Eine Typologie österreichischer Wohngebäude, published by the Austrian Energy Agency, Vienna. Online available. http://episcope.eu/fileadmin/tabula/public/docs/brochure/AT_TABULA_TypologyBrochure_AEA.pdf [2014-08-05]	Austrian Typology Brochure 2014
[Lang, 2010]	Lang, Günter (2010): 1000 Passivhäuser in Österreich. Passivhaus Objektdatenbak: Interaktives Dokumentations-Netzwerk Passivhaus.3. Dokumentationsperiode 2006-2009. Wien, Berichte aus der Enerige- und Umweltforschung 85/2010, Online available: http://www.hausderzukunft.at/hdz_pdf/endbericht_1085_1000_passivhaeuser_oesterreich.pdf [2014-08-05]	Final report on documenting the first 1000 passiv houses in Austria
[klimaaktiv, 2013]	klima:aktiv Bauen und Sanieren ÖGUT GmbH (2013): klima:aktiv Bauen und Sanieren. Basiskriterien 2013 für Wohngebäude und Dienstleistungsgebäude Neubau/Sanierung. Version 1.0, Juni 2013, Publisher: Bundesministeirum für Land- und Fortwirtschaft, Umwelt und Wasserwirtaschaft. Online available: http://www.klimaaktiv.at/bauen-sanieren/gebaeudedeklaration/basiskriterien2013.html [2014-08-05]	Klimaaktiv certification programme for new buildings and major retrofits
[klimaaktiv, 2014]	klimaaktiv Bauen und sanieren (ed.) (2014): Gebäudereport. Online available: http://www.klimaaktiv.at/bauen-sanieren/bestpractice/gebaeude-report.html	Report on overview on buildings built or renovated according to klimaaktiv criterion
[KPC, 2014]	Kommunalkredit Public Consulting GmbH (ed.) (2014): Sanierungsscheck für Private 2014. Vienna. Online available: http://www.umweltfoerderung.at/kpc/de/home/umwelt-frderung/fr_private/energiesparen/sanierungsscheck_2014/ [2014-08-05]	Subsidy for private building sector for retrofit activities
[OIB, 2011]	OiB – Richtlinie 6. Energieeinsparung und Wärmeschutz. Ausgabe: Oktober 2011.Online availabe. http://www.oib.or.at/sites/default/files/rl6_061011_2.pdf [2014-08-05]	OIB guidelines on energy savings and thermal requirements of the buildings
[OIB, 2014a]	OIB – Dokument zur Definition des Niedrigstenergiegebäudes und zur Festlegung von Zwischenzielen in einem “Nationalen Plan” gemäß Artikel 9 (3) zu 2010/31/EU. 28. March 2014. Online available: http://www.oib.or.at/sites/default/files/nationaler_plan.pdf [2014-08-05]	Definition of the NZEB according to Article 9 (3) of 2010/31/EU

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[OIB, 2014b]	OIB – Richtline 6. Energieeinsparung und Wärmeschutz. Entwurf: Juni 2014 www.wien.arching.at/getdownload.php?id=1842 [2014-08-15]	Draft of revised OIB Guidelines 6, published in June 2014

3.2 <BE> Belgium

(by EPISCOPE partner VITO)

In the Federal State of Belgium the transposition of the EPBD is a matter of the regions, the Flemish Region, Brussels Capital Region and the Walloon Region. In the following, the definitions and specifications are focused primarily on the Flemish system. The other two have been added for illustrative reasons. The systems are comparable but especially the way the directive is transposed in each of the Regions deserves some attention, especially the Brussels' NZEB definition ("nearly passive") and the transposition of the Directive with NZEB as the required standard from 2015 on.

3.2.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Belgium

Flanders

In the Region of Flanders with approximately 58 % of the Belgian building stock The Flemish Energy Agency (VEA) is charged with the implementation of the Energy Performance Regulation of residential buildings. All information on the current legal requirements and the NZEB definition can be found on their website www.energiesparen.be.

Central to the requirements used in Flanders is the dimensionless E-level representing the primary energy demand which includes heating, cooling, ventilation, DHW and auxiliary energy in a monthly balancing period. The E-level requirement is accompanied by more detailed specifications and required insulation values of the building envelope as a whole (K-value) and of its composing elements (U- or R-values). The package of measures also includes requirements for summer comfort, minimal ventilation and a minimum share of renewable energy. If the requirement for renewable energy is not met, the overall energy performance needs to be 10 % lower than the requirements.

- **Current legal requirements**

  The Energy Performance Regulation in Flanders is in place since 2006 and has to be respected for every construction for which an application is required, from new constructions to extensions. From 2006 on a stepwise approach to tightening the rules up to 2021 has been chosen (see table below).

Table 11: E-level requirements from 2006-2021 in the Flemish Region (Belgium)

Year	2006-2009	2010-2011	2012-2013	2014-2015	2016-2017	2018-2019	2020	2021
E-level	100	80	70	60	50	40	35	30

Current (2014) legal requirements for new buildings are:

Table 12: General legal requirements for 2014 in the Flemish Region (Belgium)

Requirement	Indicator	
Thermal insulation	K-value[18]	Max 40
	U_{max}-value	Specific max values per construction element (see table below)
Energy Performance	E-level	Max 60
Net energy need for heating	Max (100-25*compactness) kWh/m² or 70kWh/m²	
Interior Climate	Minimal ventilation and overheating risk reduction	
Renewable energies	Minimum amount (either by thermal solar, PV, biomass boiler, DH, heat pump or participation in renewable energy projects	

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[18] A compactness-corrected mean U-value for the whole building envelope

- **NZEB definition**

  On November 29 2013 the Flemish Government[19] determined the E-level to correspond with the definition of NZEB (BEN[20]) at lower or equal to 30.

Table 13: General requirements to comply with NZEB in the Flemish Region (Belgium)

Requirement	**Indicator**	
Thermal insulation	K-value	Max 40
	U_{max}-value	Specific max values per construction element (see table below)
Energy Performance	E-level	Max 30
Net energy need for heating	Max 70kWh/m²	
Interior Climate	Ventilation system has to comply with a list of specifications and norms	
	Overheating	max 6500 Kh per dwelling
Renewable energies	One of the following measures has to be applied in the dwelling: Solar boiler with a collector with aperture value of min 0.02 m² per m² of usable floor area, oriented in between E and W and with an inclination of 0-70° PV panels producing 7 kWh per m² of usable floor area, oriented in between E and W and with an inclination of 0-70° A Heat pump applied as primary heating source and with a minimum SPF of 4 A biomass boiler with an efficiency of min 85 %, which does not exceed certain CO and fine particle emission levels and which is applied as primary heating source A connection to a district heating or cooling network with an energy mix of min 45 % or renewables A participation in a renewable energy project within the province (min € 20 per m² of usable floor area) Another possibility to comply with the rules is to produce 10 kWh of renewable energy per m² of usable floor area by a combination of the measures listed above. In that case the underlined conditions are cancelled.	

The list of demands to qualify as an NZEB dwelling will be evaluated every 2 years. Such an evaluation – the first one due in 2015 – can lead to an adaptation of the list of demands and a consequential refinement of the NZEB definition.

Table 14: Required thermal insulation values for current legal requirements and NZEB in the Flemish Region (Belgium)

	U_{max} (W/m²K)	
Element	Current (2014)	NZEB
Roof and ceiling	0.24	
Exterior wall	0.24	
Floor	0.30	0.24
Windows	1.80	1.50
Glazing	1.10	
Doors and gates	2.00	

- **Calculation method to comply with new building regulations for residential buildings**

  The EPC calculation in Flanders is a characteristic annual primary energy use calculation, with characteristic meaning with the assumption of a specific climate and a fixed constant room temperature of 18 °C and fixed internal heat gains. The first steps of the calculation are based upon monthly totals and the method concludes with an annual value or E-level. EPC calculations have to be performed with a free downloadable software package from VEA's website.

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[19] http://www.energiesparen.be/BEN/eisen

[20] In Dutch 'Bijna Energie Neutraal'

The calculation is composed of the following steps:

1. Heat loss calculation (transmission, ventilation and thermal bridges);
2. Useful heat gains calculation (solar and fixed from appliances and occupants);
3. Net energy need calculation (thermal mass of the construction);
4. Gross energy need calculation through system performance calculation of the heating installation (delivery, distribution, storage);
5. **Energy need for space heating** through heat generation performance calculation (technical specifications of the heat generator);
6. System performance for DHW installation calculation (see step 4);
7. Solar thermal contribution calculation (technical specifications);
8. **Energy need for DHW** (technical specifications of generator and storage);
9. **Energy need for auxiliary functions** of the technical installations (pumps, electronics, ventilation etc.)
10. **Energy need for cooling**;
11. **Energy gains through PV or CHP**.

For the calculation of thermal bridges ($H^{Tjunctions}$) one can choose in between 3 options from a very detailed measurement up to a fixed allowance.

Brussels

The highly urbanised Brussels Capital Region makes up for 10 % of the Belgian building stock. In order to prepare the implementation of the EPB Directive’s 2020 target the Brussels Capital Region decided on February 21 2013 to tighten its insulation requirements in 2014 to bring them at the same level as the other two regions [IBGE-BIM, 2013]. At the same time it decided to put in place its “EPB-Passive Requirements 2015” which is the transposition of the NZEB definition, based on the Passive House Standard and already to be implemented from 2015 on (with a slight increased stringency from 2018 on) [IBGE-BIM, 2014]. The latter interpretation of the Passive Standard was discussed with the sector and adapted to the Brussels context.

- **Current legal requirements**

Current (2014) requirements are:

Table 15: General legal requirements for 2014 in the Brussels Capital Region (Belgium)

Requirement	Indicator	
Thermal insulation	K-value	Max 40
	U_{max}-value	Specific max values per construction element (see table below)
Energy Performance	E-level	Max 70
Interior Climate	Ventilation system has to comply with a list of specifications and norms	
	Overheating	max 17500 Kh (The temperature can only exceed 26°C for a maximum of 10% of the time (annually)

Table 16: Required thermal insulation values for current legal requirements in the Brussels Capital Region (Belgium)

	U_{max} (W/m²K)
Element	Current (2014), also from 2015 on
Roof and ceiling	0.24
Exterior wall	0.24
Floor	0.30
Windows	1.80
Glazing	1.10

- **EPB-Passive Requirements 2015** (as a more stringent standard than NZEB)

  As of 2015 – with the implementation of the “EPB-Passive Requirements 2015“ [IBGE-BIM, 2014] some of the requirements (or their indicators) change. For example the E-level is completely substituted by a maximum requirement of total primary energy use. The K-value is completely replaced by the U-values of the building elements:

Table 17: General legal requirements for 2015 (and NZEB) in the Brussels Capital Region (Belgium)

Requirement	Indicator	
Thermal insulation	U_{max}-value	Specific max values per construction element (see table above)
Airtightness	n_{50}	Max 0.6
Total primary energy consumption	45 kWh/m² *	
Net energy need for Heating	15 kWh/m² *	
Interior Climate	Ventilation system has to comply with a list of specifications and norms	
	Overheating	The temperature can only exceed 25°C for a maximum of 5% of the time (annually)

* always calculated with a ventilation D-assumption to put the emphasis on the quality of the building envelope instead of promoting either of the available systems. Some exceptions exist when, due to a bad configuration or a bad orientation of a building, the energy demand can’t be reached. In those cases, the requirement for net energy need for heating and primary energy consumption is recalculated taking into account the specific urban characteristics such as a poor compactness and/or less solar gains. This calculation uses thermal insulation values of the building envelope (average U-value 0.85 W/m²K for transparent parts; average U-value 0.12 W/m²K for non-transparent parts). As such, the legislation avoids ‘unfortunate’ building owners to do excessive investments.

Wallonia

The Walloon Region counts approximately 32 % of the Belgian building stock. The region’s NZEB Action Plan [SPW, 2012] provides for a roadmap with progressively more stringent requirements.

- **Current legal requirements**

  Current (2014) requirements [SPW, 2013] are:

Table 18: General legal requirements for 2014 in the Walloon Region (Belgium)

Requirement	Indicator	
Thermal insulation	K-value	Max 35
	U_{max}-value	Specific max values per construction element (see table below)
Energy Performance	E-level	Max 80
Net energy need for heating	Max 130 kWh/m²	
Interior Climate	Ventilation system has to comply with a list of specifications and norms	
	Overheating	max 6500 Kh per dwelling

Table 19: Required thermal insulation values for current legal requirements in the Walloon Region (Belgium)

	U_{max} (W/m²K)
Element	Current (2014)
Roof and ceiling	0.24
Exterior wall	0.24
Floor	0.30
Windows	1.80
Glazing	1.10
Doors and gates	2.00

- **NZEB definition**

  A Walloon NZEB doesn’t exist yet, though the NZEB Action Plan mentions that it will be close to the Passive Standard, but without the heaviest restrictions. “A Nearly Zero energy Building is characterised on the one hand in the conception stage by its energy performance close to or equivalent to the Passive Standard when the building envelope is concerned, and on the other hand by renewable energy production.”

Table 20: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the NZEB definition in Belgium (Flanders)

Calculation Method New Building Regulations – (part 1)

Country	**BE**	Belgium - Flanders	Status	07/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the NZEB Definition
Legislation / Standards Energy Decision (Energiebesluit van 19 november 2010) [VR, 2010] **Explanation / Comments**	Flemish NZEB definition as of 23/11/2013. [VEA, 2014]

Energy Services

x	Heating	x	DHW		Appliances
x	Cooling	x	Auxiliary		Other:
x	Ventilation		Lighting		

Explanation / Comments

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Year / Month

Explanation / Comments

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery
x*	Thermal solar system
	Other special systems:

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP		x	Month	H-C-W
x	On-site PV		x	Month	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

*only for DHW

Type of Requirements (new buildings)

x	U-values of building elements	x*	Primary energy	Agreed weighting factors
x	Heat transfer coefficient by transmission			
X	Energy need for heating		Carbon dioxide emissions	
x*	Delivered energy	x	Other:	Share of renewables**

Explanation / Comments

*A minimum share of renewable energy is necessary. If the requirement for renewable energy is not met, the overall energy performance needs to be 10 % lower than the requirements.

** Fixed share of renewables depending on technology (see Table 13).

Assessment of energy carriers in Belgium (Flanders)

The assessment of energy carriers in Flanders is determined in the EPB calculation procedure [VEA, 2013b].

Table 21: Belgian primary energy factors (Flanders)

Label / type of factor	**Primary Energy factor EPW calculation method**
used for EPC rating	x
used for building regulations requirements	x
Label (national language)	Omrekenfactor naar primaire energie van de brandstof
Description / type of weighting factor	Factor applied in the compulsory calculation method
Factor is multiplied by delivered energy based on the	gross calorific value
Reference	[VEA, 2013b]
Natural gas	1
Heating oil	1
Electricity	2.5
Electricity production CHP	1.79
District heating	1.49

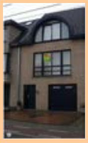
Methodological points for discussion in Belgium (Flanders)

The EPB method is evaluated bi-annually together with the many stakeholders involved in the process. Points of improvement are gathered among them and priorities for improvement are determined. The latest evaluation focused specifically on “which improvements of the method are crucial to ensure an adequate and refined energy performance calculation of low and very low energy buildings.” A variety of issues for discussion comes out of this procedure. Many of them are related to the inclusion of specific (improved) product values which are not available in the current product library of the software package, or requests for review of methods for currently less applied techniques for which the applied calculation method is not yet well-adapted. Collective heating or DHW systems, thermal solar panels for auxiliary heating, refinement of the integration of micro-CHP etc. are some of the most recent issues raised. The relevant issues are then prioritised on the basis of 5 principles in order of importance: 1) magnitude of proven energy reduction; 2) number of buildings where this could be applicable; 3) amount of E-level points to gain; 4) presence of argumentation; and 5) increased accuracy.

3.2.2 Integration of National Requirements for New Buildings and NZEB Standards in the Belgian Residential Building Typology

Until the first TABULA typology (matrix year and type) was published in 2011 no real Belgian typology existed. The first TABULA typology with its 5 construction year classes (pre 1945, 1946-1970, 1971-1990, 1991-2005 and 2006-2011) and 6 building/dwelling types (single-family house, semi-detached house, terraced house, small multi-family house, multi-family house and apartment block) have now been extended with these 6 new types for the year class post 2011. Note that the typology in Belgium doesn't consider small MFH, MFH and AB as such, but rather uses exposed and enclosed apartments as it considers dwellings ("living units") instead of buildings while the common TABULA systematic refers to whole buildings.

Classification scheme for the Belgian residential building stock ("Building Type Matrix")

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	national (Belgie)	… 1945	generic	 BE.N.SFH.01.Gen	 BE.N.TH.01.Gen	 BE.N.MFH.01.Gen	
2	national (Belgie)	1946 … 1970	generic	 BE.N.SFH.02.Gen	 BE.N.TH.02.Gen	 BE.N.MFH.02.Gen	 BE.N.AB.02.Gen
3	national (Belgie)	1971 … 1990	generic	 BE.N.SFH.03.Gen	 BE.N.TH.03.Gen	 BE.N.MFH.03.Gen	 BE.N.AB.03.Gen
4	national (Belgie)	1991 … 2005	generic	 BE.N.SFH.04.Gen	 BE.N.TH.04.Gen	 BE.N.MFH.04.Gen	 BE.N.AB.04.Gen
5	national (Belgie)	2006 … 2011	generic	 BE.N.SFH.05.Gen	 BE.N.TH.05.Gen	 BE.N.MFH.05.Gen	 BE.N.AB.05.Gen
6	national (Belgie)	2012 …	generic	 BE.N.SFH.06.Gen	 BE.N.TH.06.Gen	 BE.N.MFH.06.Gen	 BE.N.AB.06.Gen

7	national (Belgie)	… 1945	semi detached sfh		 BE.N.TH.01.Semi		
8	national (Belgie)	… 1945	small mfh			 BE.N.MFH.01.Small	
9	national (Belgie)	1946 … 1970	semi detached sfh		 BE.N.TH.02.Semi		
10	national (Belgie)	1946 … 1970	small mfh			 BE.N.MFH.02.Small	
11	national (Belgie)	1971 … 1990	semi detached sfh		 BE.N.TH.03.Semi		
12	national (Belgie)	1971 … 1990	small mfh			 BE.N.MFH.03.Small	
13	national (Belgie)	1991 … 2005	semi detached sfh		 BE.N.TH.04.Semi		
14	national (Belgie)	1991 … 2005	small mfh			 BE.N.MFH.04.Small	
15	national (Belgie)	2006 … 2011	semi detached sfh		 BE.N.TH.05.Semi		
16	national (Belgie)	2006 … 2011	small mfh			 BE.N.MFH.05.Small	
17	national (Belgie)	2012 …	semi detached sfh		 BE.N.TH.06.Semi		
18	national (Belgie)	2012 …	small mfh			 BE.N.MFH.06.Small	

Figure 10: Classification scheme ("Building Type Matrix") of the Belgian residential building typology [VITO, 2014], now extended towards new buildings

Table 22: Exemplary new buildings representing the latest construction year classes (2012 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
Picture		 BE.N.SFH.06.Gen	 BE.N.TH.06.Gen	 BE.N.MFH.06.Gen	 BE.N.AB.06.Gen
Number of dwellings		1	1	33	20
Number of full storeys (conditioned)		2	2	5	11
Number of directly attached neighbour buildings		0	2	0	0
National reference area (conditioned gross floor area)	m²	270	200	2530	3960
TABULA reference area (conditioned floor area, internal dimensions)	m²	229	170	2151	3366

Building example: variants meeting three energy performance levels for new buildings

In the following the exemplary multi-family house is demonstrated in more detail. Comparable information for the other buildings can be found in the updated national typology brochure [VITO, 2014].

Table 23 shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels

1. **Minimum requirements (common practice)**
   This energy performance level refers to the legal requirements in Flanders in 2012-2013, but as common practice outperforms the minimum legal requirements, the levels ‘as applied’ were revised slightly. The data from the VEA EPB report 2006-2012 [VEA, 2013a] were used to determine the actual performance levels.
2. **Improved Standard (Low Energy)**
   The Low Energy Standard is based upon a package of tightened requirements for the building envelope and technical installations resulting in an E-level of max 50 for houses and max 40 for apartments. This standard always includes solar thermal panels. It could be compared to the legal requirements in 2016.
3. **Ambitious Standard (NZEB)**
   The NZEB standard refers to the actual definition outlined above. The standard includes both thermal solar panels and PV panels.

Table 23: Exemplary multi-family house (MFH) – definition of variants

 BE.N.MFH.06.Gen		**“Natural Gas”**		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values				
Roof	W/(m²K)	0.21	0.15	0.10
Wall	W/(m²K)	0.23	0.23	0.23
Window	W/(m²K)	1.70	1.70	1.50
Door	W/(m²K)	1.70	1.70	1.70
Floor	W/(m²K)	0.22	0.22	0.22
Heat Supply System				
Heat generator		Condensing boiler		
Specification / Supplemental system				
Ventilation system		C+	D heat recovery	D heat recovery
Thermal solar system		DHW	DHW	DHW
Further system			PV	PV (larger surface)

As an example, a “Building Type Display Sheet” for one supply system type is shown in Figure 11; it consists of three pages. The first page shows the situation for the building with minimum requirements; the second page shows the adaptations to the minimum requirement situation to result into the Low Energy and the NZEB situations. The third page is a summary of results from an energy, comfort and investment point of view.

30. Type 30 - Blootgesteld appartement vanaf 2012

30.1 Beschrijving

Deze woningfiche heeft betrekking op blootgestelde appartementen daterend uit de periode vanaf 2012. Als buitenschil voor blootgestelde appartementen veronderstellen we een voor- en achtergevel, dakvlak en 1 zijgevel. Het vloervlak en de 2de zijgevel grenzen aan naburige appartementen.

30.2 Details

Woningtype: Appartement blootgesteld
Bouwperiode: Vanaf 2012
Bruto vloeroppervlakte (m²): 100 m²
Beschermd volume (m³): 320 m³
Totale verliesoppervlakte (m²): 191 m²

30.3 Huidige situatie

(1) Bouwkundige kenmerken (HS)

Component	Beschrijving	U-waarde (W/m²K)
Dak	Geisoleerde dakconstructie vanaf 2012 - dakisolatie tussen kepers	0,21
Gevel	Geventileerde spouwmuur vanaf 2012 - spouwisolatie	0,23
Raam	Geïsoleerde raamprofielen - verbeterde isolerende beglazing Ug minstens 1,1 – vanaf 2012	1,7

(2) Systeemeigenschappen (HS)

Component	Beschrijving
Verwarming	Centrale verwarming - condenserende combiketel op gas - rendement 1,06
Warm water	Condenserende combiketel op gas - leidinglengtes > 5 m
Ventilatie	Ventilatiesysteem C+ - natuurlijke toevoer en mechanische afvoer, vraaggestuurd

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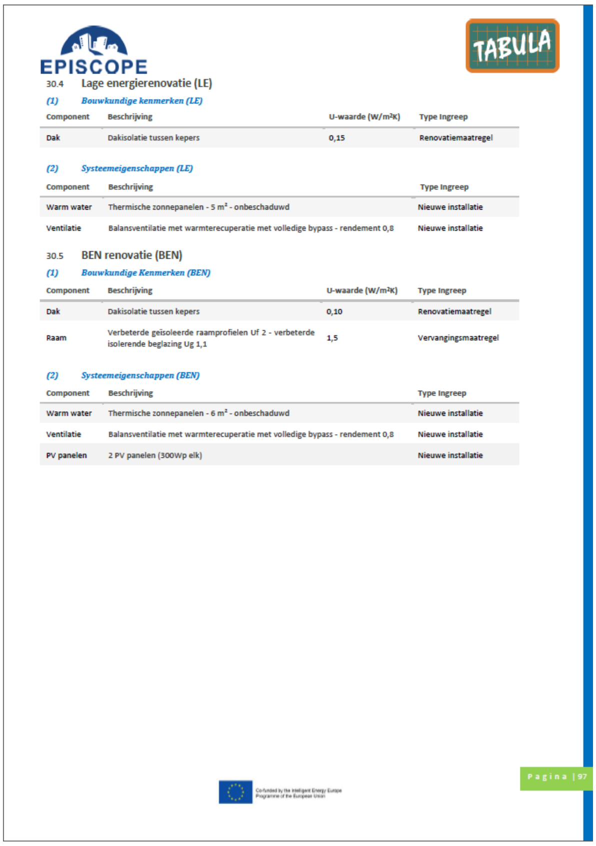

30.4 Lage energierenovatie (LE)

(1) Bouwkundige kenmerken (LE)

Component	Beschrijving	U-waarde (W/m²K)	Type Ingreep
Dak	Dakisolatie tussen kepers	0,15	Renovatiemaatregel

(2) Systeemeigenschappen (LE)

Component	Beschrijving	Type Ingreep
Warm water	Thermische zonnepanelen - 5 m² - onbeschaduwd	Nieuwe installatie
Ventilatie	Balansventilatie met warmterecuperatie met volledige bypass - rendement 0,8	Nieuwe installatie

30.5 BEN renovatie (BEN)

(1) Bouwkundige Kenmerken (BEN)

Component	Beschrijving	U-waarde (W/m²K)	Type Ingreep
Dak	Dakisolatie tussen kepers	0,10	Renovatiemaatregel
Raam	Verbeterde geïsoleerde raamprofielen Uf 2 - verbeterde isolerende beglazing Ug 1,1	1,5	Vervangingsmaatregel

(2) Systeemeigenschappen (BEN)

Component	Beschrijving	Type Ingreep
Warm water	Thermische zonnepanelen - 6 m² - onbeschaduwd	Nieuwe installatie
Ventilatie	Balansventilatie met warmterecuperatie met volledige bypass - rendement 0,8	Nieuwe installatie
PV panelen	2 PV panelen (300Wp elk)	Nieuwe installatie

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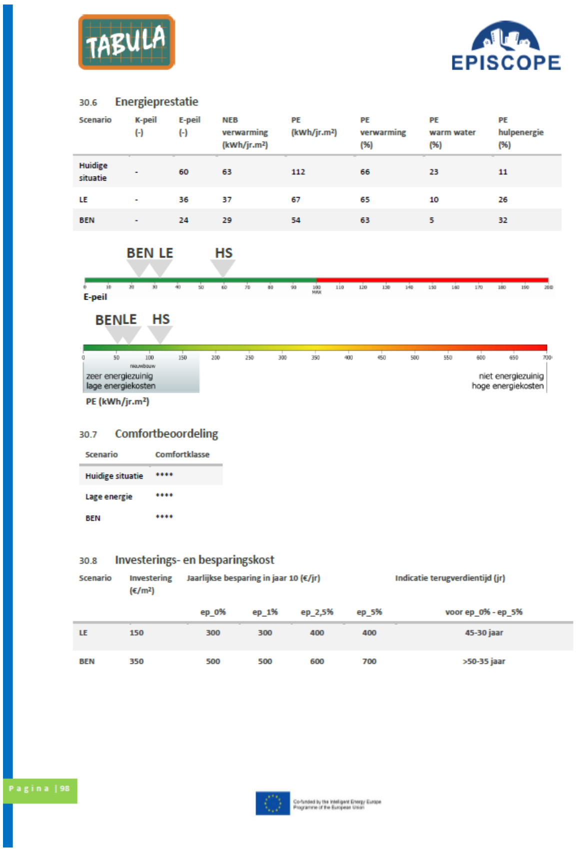

30.6 Energieprestatie

Scenario	K-peil (-)	E-peil (-)	NEB verwarming (kWh/jr.m²)	PE (kWh/jr.m²)	PE verwarming (%)	PE warm water (%)	PE hulpenergie (%)
Huidige situatie	-	60	63	112	66	23	11
LE	-	36	37	67	65	10	26
BEN	-	24	29	54	63	5	32

30.7 Comfortbeoordeling

Scenario	Comfortklasse
Huidige situatie	****
Lage energie	****
BEN	****

30.8 Investerings- en besparingskost

Scenario	Investering (€/m²)	Jaarlijkse besparing in jaar 10 (€/jr)				Indicatie terugverdientijd (jr)
		ep_0%	ep_1%	ep_2,5%	ep_5%	voor ep_0% - ep_5%
LE	150	300	300	400	400	45-30 jaar
BEN	350	500	500	600	700	>50-35 jaar

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Figure 11: “Building Display Sheet” of the exemplary MFH <BE> [VITO, 2014]

In Table 24 the results of the national EPB calculation procedure for the exemplary MFH are given. Note that the Belgian method considers dwellings or living units instead of buildings. For Belgian single-family houses the dwelling and building calculations will be the same. For MFH (including AB) only dwelling calculations can be made. These are not to be compared with the MFH calculations resulting from the TABULA calculation procedure. The National Typology Brochure contains both enclosed and exposed apartments in those MFH or AB. The example given below is for an exposed apartment. Energy performance of the enclosed apartment (total exposed area of 45m²) is –logically– better.

Table 24: Exemplary MFH – Results of the energy balance calculation; Procedure: Belgian (Flemish) EPB calculation procedure

Variant N°		**001**	**002**	**003**
Label of the variant triplet		"Natural Gas"		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard
Energy standard		Common practice	Low Energy	NZEB
Calculation method		EPW calculation procedure		
Gross Floor Area	m²	100	100	100
Protected Volume	m³	320	320	320
Total exposed area	m²	191	191	191
E-level		60	36	24
K-value		35	32	28
Thermal transfer coefficient by transmission related to envelope area	W/(m²K)	0.43	0.40	0.34
Primary energy demand	kWh/(m²a)	112	67	54
Energy need for heating	kWh/(m²a)	63	37	29
Energy need for heating	%	66	65	63
Energy need for DHW	%	23	10	5
Energy need for auxiliary	%	11	26	32

TABULA calculation results for all exemplary buildings

Table 25 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all six exemplary buildings. The table contains the generic building types SFH, TH, MFH and AB. Additionally it includes the building types TH (semi) and MFH (small) for respectively semi-detached houses and small multi-family buildings.

Table 25: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  BE.N.SFH.06.Gen	01	Minimum Requirement	1.18	89	0	89	93	10	11	110	0	0	0	4	0	0	0
	02	Improved Standard	1.12	70	19	51	54	10	13	62	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	1.00	64	19	45	49	10	13	55	0	0	0	8	0	0	0
TH  BE.N.TH.06.Gen	01	Minimum Requirement	0.85	64	0	64	69	10	11	85	0	0	0	4	0	0	0
	02	Improved Standard	0.80	57	20	37	40	10	13	48	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	0.72	54	20	34	37	10	13	43	0	0	0	8	0	0	0
MFH  BE.N.MFH.06.Gen	01	Minimum Requirement	0.93	68	0	68	73	15	16	94	0	0	0	4	0	0	0
	02	Improved Standard	0.90	61	20	41	44	15	18	54	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	0.83	58	20	38	42	15	18	50	0	0	0	8	0	0	0
AB  BE.N.AB.06.Gen	01	Minimum Requirement	0.98	64	0	64	69	15	16	90	0	0	0	4	0	0	0
	02	Improved Standard	0.97	58	20	38	42	15	18	52	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	0.87	55	20	35	39	15	18	47	0	0	0	8	0	0	0
TH (semi)  BE.N.TH.06.Semi	01	Minimum Requirement	1.03	82	0	82	86	10	11	103	0	0	0	4	0	0	0
	02	Improved Standard	0.97	63	19	44	47	10	13	55	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	0.86	60	20	40	44	10	13	50	0	0	0	8	0	0	0
MFH (small)  BE.N.MFH.06.Small	01	Minimum Requirement	0.85	65	0	65	70	15	16	91	0	0	0	4	0	0	0
	02	Improved Standard	0.82	57	20	37	41	15	18	51	0	0	0	8	0	0	0
	03	Ambitious Standard / NZEB	0.76	56	20	35	39	15	18	47	0	0	0	8	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.2.3 Sources / References Belgium

Table 26: Sources / References Belgium

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[IBGE-BIM, 2013]	IBGE-BIM (2013): Les exigences PEB 2014 et 2015. Available from URL: http://documentation.bruxellesenvironnement.be/documents/IF_ENERGIE_NvlleExigencesPEB_FR.PDF	Brussels' EPB requirements for 2014 and 2015
[IBGE-BIM, 2014]	IBGE-BIM (2014): Les exigences PEB à partir de 2015. Available from URL: http://documentation.bruxellesenvironnement.be/documents/IF_NRJ_ExigencesPeb2015FR.PDF	Brussels' EPB requirements as of 2015 = NZEB requirements
[SPW, 2012]	Service Public de Wallonie (2012): Plan d'action NEZB en vue de la transposition de l'article 9 du recast de la directive europeenne relative a la performance energetique des batiments (directive 2010/31/CE du 19 Mai 2010) Available from URL: http://energie.wallonie.be/fr/plan-d-action-nzeb.html?IDD=89872&highlighttext=nzeb+&IDC=8011	Walloon NZEB Plan
[SPW, 2013]	Service Public de Wallonie (2013): Reglementation PEB. Available from URL: http://energie.wallonie.be/fr/la-reglementation-peb.html?IDC=6232	Walloon EPB requirements
[VEA, 2013a]	VEA (2013): Cijferrapport energieprestatietregelgeving. Procedures, resultaten en energetische karakteristieken van het Vlaamse gebouwenbestand - periode 2006-2012. Available from URL: http://www2.vlaanderen.be/economie/energiesparen/epb/doc/EPBincijfers-2006-2012.pdf	VEA report on the performance of new buildings based on EPB data from 2006-2012.
[VEA, 2013b]	VEA (2013): Methodologie. Available from URL: http://www.energiesparen.be/node/3476	VEA webpage with the EPB methodology and formula structure.
[VEA, 2014]	VEA (2014). Wat is een BEN woning? Available from URL: http://www2.vlaanderen.be/economie/energiesparen/epb/doc/watiseenbenwoning.pdf	VEA publication on NZEB definition.
[VITO, 2014]	Cuypers, Dieter/Vandevelde, Birgit/Van Holm, Marlies/Verbeke, Stijn (2014): Belgische Woningtypologie. Nationale brochure over de TABULA woningtypologie. Versie 2, published by VITO.Available from URL: http://episcope.eu/fileadmin/tabula/public/docs/brochure/BE_TABULA_TypologyBrochure_VITO.pdf	Belgian Building typology brochure from EPISCOPE. Updated version with new buildings.
[VR, 2010]	Vlaamse Regering (2010). Besluit van de Vlaamse Regering houdende algemene bepalingen over het energiebeleid [citeeropschrift "het Energiebesluit van 19 november 2010". Available from URL: http://codex.vandenbroele.be/Zoeken/Document.aspx?DID=1019755&param=inhoud	Decision of the Flemish Government on its energy policy.

3.3 <CY> Cyprus

(by EPISCOPE partner CUT)

The first attempt in Cyprus to introduce energy conservation in buildings was the preparation of a voluntary CYS98:1999 Standard for the Insulation and Rational Use of Energy in Dwellings [MCIT, 2012a]. The Law for the Regulation of the Energy Performance of Buildings of 2006 took effect as of 21/12/2007 by enacting the legislation concerning the minimum requirements for the energy performance of buildings. The issuance of Certificates for the Energy Performance for Buildings (EPB) was implemented as of 1st of January 2010 for residential buildings [MCIT, 2009a]. Currently there is an updated legislation the 2012, N.210 (I)/2012 on the 28/12/2012 and the latest revision of the minimum requirements for the energy performance of buildings (Κ.Δ.Π.432/2013) was enacted as of 13/12/2013. As a next step towards nearly zero-energy buildings, it includes a tightening of the requirements for new buildings [ECOFYS, 2013].

For the purpose of setting the definition of the NZEB in Cyprus the Energy Service (ES) of the Ministry of Energy, Commerce, Industry and Tourism (MECIT) has carried out the in depth study [MCIT, 2013] of the potential of energy saving in the identified as most commonly used 3 categories of residential buildings:

i) Detached 2 storey house

ii) Terraced houses

iii) Apartments on building blocks.

These are located in the 4 climatic zones: Coastal areas, lowlands, low mountainous areas (from 300m up to 600m from sea level) and high mountainous area; of the country as defined in the national methodology for the energy performance of buildings.

The action plan presents the essential measurements that will enable Cyprus to harmonise with the Directive 2010/31/EU and enforce the NZEB on new public buildings by 2018 and all new buildings by 2020.

The report’s findings regarding the preliminary minimum energy requirements, definitions and methodology are under revision and an appropriate benchmark is yet to be defined.

3.3.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Cyprus

The first attempt to introduce energy conservation in buildings was the preparation of a voluntary CYS98:1999 Standard for the Insulation and Rational Use of Energy in Dwellings.

This standard became a legal requirement in 2006 and was implemented in 2007. Later in January 2010 the Energy Performance Certificates along with the Methodology for Assessing the Energy Performance of Buildings (MAEPB), were made an integral part of the regulatory system. The latest revision of the minimum requirements for the energy performance of buildings was employed on the 13/12/2013.

In 2012 the first action plan regarding NZEB was published, in 2013 a revision of this was issued [ECOFYS, 2013]. As a next step towards NZEB, in 2014, the minimum requirements for NZEB were announced and are now under consultation.

The national plan for increasing the number of nearly zero-energy buildings introduce policies and measures towards achieving NZEB by 2020 in three stages [ECOFYS, 2013]:

1. Design and announcement of a linear tightening of the minimum energy performance requirements leading to the 2020 NZEB (2012-2015)
2. Second and third revision of the minimum energy performance requirements (2015-2018)
3. Implementation of the Third Revision of the Minimum Energy Performance Requirements (2018-2020)

The NZEB has been described as a very energy efficient building. The nearly zero or the very low amount of energy required should consist heavily on energy from renewable sources, including sources locally produced or near the building. Currently the Energy Service is working towards finalising the benchmark for minimum requirements of the building envelope, the methodology, the definition of the actual energy levels and percentage of Renewable energy sources required on a building to be classified as a NZEB. For this the building must have an Energy Performance Certificate class A according to the preliminary national methodology for energy performance of buildings [MECIT, 2014a].

Minimum requirements for new residential buildings in Cyprus

The current minimum requirements for the energy performance of new buildings were enforced in 13/12/2013, under the Amendment of the Law for the Regulation of the Energy Performance of the Buildings of 2012, N.210 (I)/2012 [MCIT, 2012b]. As a result a new class (B+) has been introduced to the Energy Performance Certificates (EPC) [Republic of Cyprus, 2013].

The National Methodology for Calculating the Energy Performance of Buildings [MCIT, 2009b] uses the simulation software SBEMcy, which calculates the energy demands of each space in the building according to the activity within it. Different activities may have different temperatures, operating periods, lighting levels, etc. SBEMcy calculates the heating and cooling energy demands by carrying out an energy balance based on monthly average weather conditions. This is combined with information about system efficiencies in order to determine the energy consumption. The energy used for lighting and domestic hot water is also calculated. Therefore, the energy saving ordinance includes a complete description of parameters (U-values, supply system type and quality), which is applied to calculate a building-related primary energy requirement.

Cyprus calculation method to comply with new building regulations for residential buildings

The National Methodology for Assessing the Energy Performance of Buildings is also used to issue Energy Performance Certificates by utilizing the SBEMcy simulation software. The National Methodology defines set point temperatures, typical outdoor climatic condition, typical functionality, and primary energy conversion factors [MCIT, 2009b].

Finally reports are prepared to the standard format to provide

1. Comparison of Primary Energy between the actual and Reference Building
2. Confirmation of the elemental and data compliance check

According to the Methodology for Assessing the Energy Performance of Buildings (MAEPB) each building is divided into a series of zones (following the zoning rules), each of which may have different internal conditions or durations of operation (U-Values, lighting, Heating Ventilation and Air-conditioning system and Domestic Hot Water). The approach of setting up multiple activity areas allows buildings to be defined more correctly. The software also allows for the input of the energy produced by Renewable Energy Sources mainly Photovoltaic Systems and wind generators.

Status of NZEB definition for residential buildings in Cyprus

The current definition (MCIT, 2013; MECIT, 2014a):

NZEB: building with very high energy efficiency, determined according to the methodology for calculating the energy performance of a building and whose almost zero or very low amount of energy required is covered largely with energy from renewable sources, including locally produced or close to the building;

For Residential Buildings [MCIT, 2013]:

As previously mentioned the NZEB methodology and process is undergoing changes therefore existing and preliminary values are presented below.

Primary Energy Use: 180 kWh/m^2/yr (existing), 100 kWh/m^2/year (preliminary value)

The numerical indication above includes primary energy use for heating, cooling, lighting and domestic hot water.

At least 25 % of the 180 kWh/m2/yr of the Primary Energy must be covered by RES.

The NZEB defined in terms of primary energy use index and percentage of energy from renewable sources. Reference building is used for calculations.

For this the building must have an Energy Performance Certificate class A according to the preliminary national methodology for energy performance of buildings.

The NZEB's definition, the current minimum requirements and the primary energy use were published and are now under revision.

Under consultation [MECIT, 2014b]: The reduction of Primary Energy Use from 180 kWh/m2/yr to 100 kWh/m2/yr

Table 27: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (preliminary) NZEB definition in Cyprus

Calculation Method New Building Regulations – (part 1)				
Country	**CY**	Cyprus	Status	08/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the (preliminary) National NZEB Definition
Legislation / Standards Law for the Regulation of the Energy Performance of the Buildings of 2012, N.210 (I)/2012 [MCIT, 2012b] **Explanation / Comments**	Legislation in preparation, MECIT, 2014 [MECIT, 2014b]

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation	x	Lighting			

Explanation / Comments

Special Aspects (NZEB):

Methodology and software for the Energy Performance Certification of the NZEB (1st Stage 2012-2015)

Further upgrading of the software for the Certification of the NZEB. (2nd Stage 2015-2018)

Identified final software for the Certification of the NZEB. (3rd Stage 2018-2020)

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	year
x	Calculation of delivered energy (system)	year

Explanation / Comments :
single energy carrier EAC

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

On-Site Electricity Production		Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
	On-site CHP				
	On-site PV				
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Type of Requirements (new buildings)

x	U-values of building elements	x	Primary energy	non-renewable
	Heat transfer coefficient by transmission			
x	Energy need for heating		Carbon dioxide emissions	
	Delivered energy		Other	

Explanation / Comments

Special Aspects (NZEB):

A revision to the definition of NZEB's suggests the reduction of Primary Energy Use from 180 kWh/m2/yr to 100 kWh/m2/yr and is now under public consultation

EPC CLASS A

At least 25 % of the Primary Energy must be covered by RES

Assessment of energy carriers in Cyprus

There is a single energy carrier in Cyprus for Electricity the Electricity Authority of Cyprus.

Table 28: Cyprus primary energy factors

Label / type of factor	**Primary Energy Factor of the Cyprus Calculation Methodology (MAEPB)**
used for EPC rating	x
used for building regulations requirements	x
Label (national language)	**Παράγοντες μετατροπής πρωτογενούς ενέργειας (ΜΥΕΑΚ)**
Description / type of weighting factor	kWh of primary energy per kWh of the building's delivered energy.
Factor is multiplied by delivered energy based on the	gross calorific value (H_s)*
Reference	[MCIT, 2009b]
Natural gas	1.1
Heating oil	1.1
Firewood	1.1
Wood pellets	2.7
Electricity	2.7
Electricity production CHP	2.7
Electricity production PV system	1
District heating	1

* The primary energy is considered to include the delivered energy, plus an allowance for the energy "overhead" incurred in extracting, processing, and transporting a fuel or other energy carrier to the building. Hence, the primary energy factors in the table above denote kWh of primary energy per kWh of the building's delivered energy.

Methodological points for discussion in Cyprus

Interesting discussion points:

- Regulation changes are happening according the national plan, there is no reference building, example strategy or a standard software tool for simulating the NZEB. Lack of reasoning, method and process.
- The EPC methodology allows for Photovoltaic systems, wind turbines and combined heat and power (CHP) systems. However wind turbines are not allowed to be used in densely populated areas.
- Electricity production is to the grid directly
- The current applicability and industry knowledge on new technologies
- The regulations focus on heating period and u-values, not thermal mass and cooling period/ shading devices, natural ventilations systems etc.

3.3.2 Integration of National Requirements for New Buildings and NZEB Standards in the Cyprus Residential Building Typology

In 2009 the Statistical Service of Cyprus contacted a census that paved the way towards the national residential typologies. This was developed in order to collect data regarding the energy consumption in households [Cyprus Statistical Service, 2009]. In 2010 researches [Panayiotou, et al., 2010] elaborated on the relationship of building typologies and year of construction in relation with the software for the issuance of EPCs the SBEMCy. Later in 2012 the Cyprus Energy Agency under the framework of Intelligent Energy Europe published a detailed report regarding Building Typologies in Cyprus and information related to energy consumption, population, funding systems and more [Cyprus Energy Agency, 2012]. However the national residential building typology was utilized by the study the Energy Service (ES) of Ministry of Energy, Commerce, Industry and Tourism (MECIT) contacted via Exergia in order to define the NZEB [Exergia, 2012]. The integration of the residential building typology with national minimum requirements is being further developed by CUT during the IEE EPISCOPE Project.

The latest revision of the minimum requirements for the energy performance of buildings was employed on the 13/12/2013, hence representative exemplary buildings for this construction year (after 2014) and not yet available. According to an agreement between the EPISCOPE partners the same exemplary buildings as for the preceding construction year class can be used for a transition period in such a case. To indicate this the appearance of the building pictures are changed.

Classification scheme for the Cyprus residential building stock ("Building Type Matrix")

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Cyprus)	… 1980	generic	 CY.N.SFH.01.Gen	 CY.N.TH.01.Gen	 CY.N.MFH.01.Gen	
2	national (Cyprus)	1981 … 2006	generic	 CY.N.SFH.02.Gen	 CY.N.TH.02.Gen	 CY.N.MFH.02.Gen	
3	national (Cyprus)	2007 … 2013	generic	 CY.N.SFH.03.Gen	 CY.N.TH.03.Gen	 CY.N.MFH.03.Gen	
4	national (Cyprus)	2014 …	generic	 CY.N.SFH.04.Gen	 CY.N.TH.04.Gen	 CY.N.MFH.04.Gen	

Figure 12: Classification scheme ("Building Type Matrix") of the Cyprus residential building typology

Table 29: **Exemplary new buildings representing the latest construction year classes (2014 …)**

Building Size Class		**SFH**	**TH**	**MFH**
		Single-Family House	Terraced House	Multi-Family House
Picture		 CY.N.SFH.03.Gen CY.N.SFH.04.Gen	 CY.N.TH.03.Gen CY.N.TH.04.Gen	 CY.N.MFH.03.Gen CY.N.MFH.04.Gen
Number of dwellings		1	1	1
Number of full storeys (conditioned)		2	2	4
Number of directly attached neighbour buildings		0	1	0
National reference area (conditioned floor area, internal dimensions)	m²	170	125	1350
TABULA reference area (conditioned floor area, internal dimensions)	m²	170	125	1350

Building example: variants meeting three energy performance levels for new buildings

In the following the exemplary multi-family house is demonstrated in more detail. Comparable information for the other buildings can be found in the updated national typology brochure [CUT, 2014].

Table 30 shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels

1. **“Minimum Requirements”** (“Ελάχιστες Απαιτήσεις Ενεργειακής Απόδοσης Κτιρίων Κ.Δ.Π 423/2013”)
   Combination of building construction elements and supply system that exactly complies with the current minimum requirements (Κ.Δ.Π 423/2013)
2. **“Improved Standard”** (“Αυστηρότερες τιμές U-Value στο κτιριακό κέλυφος”)
   Increasing the level of thermal insulation of the building envelope.
3. **“Ambitious Standard / NZEB”** (“Παράμετροι Σχεδιασμού Κατοικιών με Σχεδόν Μηδενική Ενεργειακή Κατανάλωση”)
   Increasing the level of thermal insulation of the building envelope to match the minimum requirement values for the preliminary NZEB standards. Integrating Renewable Energy Sources (RES) to the building’s electromechanical systems to offset the primary energy demand by at least 25 %.

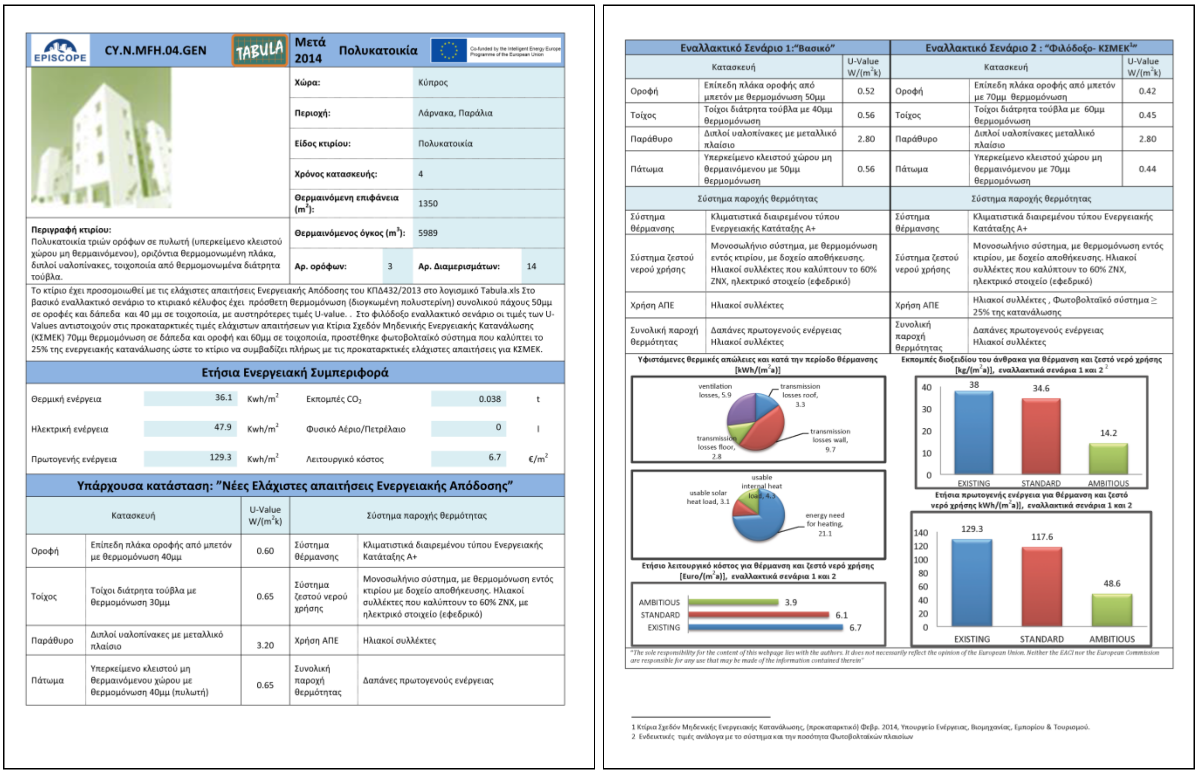
One basic of heat supply systems has been defined that also provides cooling:

"Electricity" (Variants 01, 02, 03):

- **Variant 01** is predefined by the EPC national minimum requirements that the building is class B or higher: The U-values as well as the description of the heating system (air conditioning split unit + thermal solar system for DHW) have been directly taken from the regulation.
- **Variant 02** consists of the same system but the U-values are considerably lower, these are 86.5 % lower than the current national minimum requirements of variant 01. The heat supply system remains the same.
- For **Variant 03** U-values that meet the preliminary NZEB minimum requirements, these are 68 % lower than the current national minimum requirements of variant 01. For the electromechanical systems a class A++ air conditioning split unit was selected with PV to offset minimum 25 % of the electricity production. The heat supply system remains the same.

Table 30: Exemplary multi-family house (MFH) – definition of variants [MCIT, 2009b]

Label of the variant triplet		**"04"**		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values				
Roof	W/(m²K)	0.60	0.52	0.42
Wall	W/(m²K)	0.65	0.56	0.45
Window	W/(m²K)	3.20	2.80	2.80
Floor	W/(m²K)	0.65	0.56	0.44
Thermal bridging supplement (whole envelope)	W/(m²K)	Average 0.32	Average 0.32	Average 0.32
Heat Supply System				
Heat generator		air conditioning split unIts class A+	air conditioning split units class A+	{ air conditioning split units class A+
Specification / Supplemental system				
Ventilation system		ext. air	ext. air	ext. air
Thermal solar system		DHW	DHW	DHW
Further system			PV	PV



CY.N.MFH.04.GEN | **Μετά 2014** | **Πολυκατοικία**

Co-funded by the Intelligent Energy Europe Programme of the European Union

Χώρα:	Κύπρος
Περιοχή:	Λάρνακα, Παράλια
Είδος κτιρίου:	Πολυκατοικία
Χρόνος κατασκευής:	4
Θερμαινόμενη επιφάνεια (m²):	1350
Θερμαινόμενος όγκος (m³):	5989
Αρ. ορόφων:	3
Αρ. Διαμερισμάτων:	14

Περιγραφή κτιρίου:
Πολυκατοικία τριών ορόφων σε πυλωτή (υπερκείμενο κλειστού χώρου μη θερμαινόμενου), οριζόντια θερμομονωμένη πλάκα, διπλοί υαλοπίνακες, τοιχοποιία από θερμομονωμένα διάτρητα τούβλα.

Το κτίριο έχει προσομοιωθεί με τις ελάχιστες απαιτήσεις Ενεργειακής Απόδοσης του ΚΠΔ432/2013 στο λογισμικό Tabula.xls Στο βασικό εναλλακτικό σενάριο το κτιριακό κέλυφος έχει πρόσθετη θερμομόνωση (διογκωμένη πολυστερίνη) συνολικού πάχους 50μμ σε οροφές και δάπεδα και 40 μμ σε τοιχοποιία, με αυστηρότερες τιμές U-value. . Στο φιλόδοξο εναλλακτικό σενάριο οι τιμές των U-Values αντιστοιχούν στις προκαταρκτικές τιμές ελάχιστων απαιτήσεων για Κτίρια Σχεδόν Μηδενικής Ενεργειακής Κατανάλωσης (ΚΣΜΕΚ) 70μμ θερμομόνωση σε δάπεδα και οροφή και 60μμ σε τοιχοποιία, προστέθηκε φωτοβολταϊκό σύστημα που καλύπτει το 25% της ενεργειακής κατανάλωσης ώστε το κτίριο να συμβαδίζει πλήρως με τις προκαταρκτικές ελάχιστες απαιτήσεις για ΚΣΜΕΚ.

Ετήσια Ενεργειακή Συμπεριφορά

Θερμική ενέργεια	36.1	Kwh/m²	Εκπομπές CO_2	0.038	t
Ηλεκτρική ενέργεια	47.9	Kwh/m²	Φυσικό Αέριο/Πετρέλαιο	0	l
Πρωτογενής ενέργεια	129.3	Kwh/m²	Λειτουργικό κόστος	6.7	€/m²

Υπάρχουσα κατάσταση: ”Νέες Ελάχιστες απαιτήσεις Ενεργειακής Απόδοσης”

Κατασκευή		U-Value W/(m²k)	Σύστημα παροχής θερμότητας	
Οροφή	Επίπεδη πλάκα οροφής από μπετόν με θερμομόνωση 40μμ	0.60	Σύστημα θέρμανσης	Κλιματιστικά διαιρεμένου τύπου Ενεργειακής Κατάταξης Α+
Τοίχος	Τοίχοι διάτρητα τούβλα με θερμομόνωση 30μμ	0.65	Σύστημα ζεστού νερού χρήσης	Μονοσωλήνιο σύστημα, με θερμομόνωση εντός κτιρίου με δοχείο αποθήκευσης. Ηλιακοί συλλέκτες που καλύπτουν το 60% ΖΝΧ, με ηλεκτρικό στοιχείο (εφεδρικό)
Παράθυρο	Διπλοί υαλοπίνακες με μεταλλικό πλαίσιο	3.20	Χρήση ΑΠΕ	Ηλιακοί συλλέκτες
Πάτωμα	Υπερκείμενο κλειστού μη θερμαινόμενου χώρου με θερμομόνωση 40μμ (πυλωτή)	0.65	Συνολική παροχή θερμότητας	Δαπάνες πρωτογενούς ενέργειας

Εναλλακτικό Σενάριο 1:“Βασικό”			Εναλλακτικό Σενάριο 2 : “Φιλόδοξο- ΚΣΜΕΚ[1]”		
Κατασκευή		U-Value W/(m²k)	Κατασκευή		U-Value W/(m²k)
Οροφή	Επίπεδη πλάκα οροφής από μπετόν με θερμομόνωση 50μμ	0.52	Οροφή	Επίπεδη πλάκα οροφής από μπετόν με 70μμ θερμομόνωση	0.42
Τοίχος	Τοίχοι διάτρητα τούβλα με 40μμ θερμομόνωση	0.56	Τοίχος	Τοίχοι διάτρητα τούβλα με 60μμ θερμομόνωση	0.45
Παράθυρο	Διπλοί υαλοπίνακες με μεταλλικό πλαίσιο	2.80	Παράθυρο	Διπλοί υαλοπίνακες μεταλλικό πλαίσιο	2.80
Πάτωμα	Υπερκείμενο κλειστού χώρου μη θερμαινόμενου με 50μμ θερμομόνωση	0.56	Πάτωμα	Υπερκείμενο κλειστού χώρου μη θερμαινόμενου με 70μμ θερμομόνωση	0.44
Σύστημα παροχής θερμότητας			Σύστημα παροχής θερμότητας		
Σύστημα θέρμανσης	Κλιματιστικά διαιρεμένου τύπου Ενεργειακής Κατάταξης Α+		Σύστημα θέρμανσης	Κλιματιστικά διαιρεμένου τύπου Ενεργειακής Κατάταξης Α+	
Σύστημα ζεστού νερού χρήσης	Μονοσωλήνιο σύστημα, με θερμομόνωση εντός κτιρίου, με δοχείο αποθήκευσης. Ηλιακοί συλλέκτες που καλύπτουν το 60% ΖΝΧ, ηλεκτρικό στοιχείο (εφεδρικό)		Σύστημα ζεστού νερού χρήσης	Μονοσωλήνιο σύστημα, με θερμομόνωση εντός κτιρίου, με δοχείο αποθήκευσης. Ηλιακοί συλλέκτες που καλύπτουν το 60% ΖΝΧ, ηλεκτρικό στοιχείο (εφεδρικό)	
Χρήση ΑΠΕ	Ηλιακοί συλλέκτες		Χρήση ΑΠΕ	Ηλιακοί συλλέκτες , Φωτοβολταϊκό σύστημα ≥ 25% της κατανάλωσης	
Συνολική παροχή θερμότητας	Δαπάνες πρωτογενούς ενέργειας Ηλιακοί συλλέκτες		Συνολική παροχή θερμότητας	Δαπάνες πρωτογενούς ενέργειας Ηλιακοί συλλέκτες	

Υφιστάμενες θερμικές απώλειες και κατά την περίοδο θέρμανσης [kWh/(m²a)]

Ετήσιο λειτουργικό κόστος για θέρμανση και ζεστό νερό χρήσης [Euro/(m²a)], εναλλακτικά σενάρια 1 και 2

Εκπομπές διοξειδίου του άνθρακα για θέρμανση και ζεστό νερό χρήσης [kg/(m²a)], εναλλακτικά σενάρια 1 και 2 [2]

Ετήσια πρωτογενής ενέργεια για θέρμανση και ζεστό νερό χρήσης kWh/(m²a)], εναλλακτικά σενάρια 1 και 2

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1 Κτίρια Σχεδόν Μηδενικής Ενεργειακής Κατανάλωσης, (προκαταρκτικό) Φεβρ. 2014, Υπουργείο Ενέργειας, Βιομηχανίας, Εμπορίου & Τουρισμού.
2 Ενδεικτικές τιμές ανάλογα με το σύστημα και την ποσότητα Φωτοβολταϊκών πλαισίων

Figure 13: “Building Display Sheet” of the exemplary MFH.04 <CY> [CUT, 2014]

Table 31: Exemplary MFH.04 – Results of the energy balance calculation; Procedure: TABULA method

Variant N°		**001**	**002**	**003**
Label of the variant triplet		“Electricity”		
Variation level		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
Calculation method		EPC, ΜΑΕΡΒ Κ.Δ.Π432/2013- NZEB prelim. values		
National reference area*	m²	1350	1350	1350
Thermal transfer coefficient by transmission related to envelope area	W/(m²K)	0.63	0.55	0.41
Energy need for heating	kWh/(m²a)	21.1	16.8	14.3
Delivered energy				
Fossil fuels	kWh/(m²a)	0	0	0
Renewable fuels	kWh/(m²a)	0	0	0
Electricity	kWh/(m²a)	47.9	43.5	28.1
Auxiliary energy demand	kWh/(m²a)	3.6	3.6	3.6

*) gross reference area

**) The improved standard does not follow a national calculation method, just are tighter U-values.

***) Requirement is for class B and above, the Primary Energy Demand as calculated by Tabula.xls is within the expectable Demand for an EPC class B.

****) Primary Energy Demand includes 25 % of energy produced by RES, NZEB Requirements, Primary Energy Demand 100 kWh/(m²a), of which a minimum 25 % has to be covered by RES

TABULA calculation results for all exemplary buildings

The following table shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 32: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m^{2}K)	q_h_nd kWh/(m^{2}a)	q_ve_rec_h_usable kWh/(m^{2}a)	q_h_nd_net kWh/(m^{2}a)	q_g_h_out kWh/(m^{2}a)	q_w_nd kWh/(m^{2}a)	q_g_w_out kWh/(m^{2}a)	q_del_sum_gas kWh/(m^{2}a)	q_del_sum_oil kWh/(m^{2}a)	q_del_sum_coal kWh/(m^{2}a)	q_del_sum_bio kWh/(m^{2}a)	q_del_sum_el kWh/(m^{2}a)	q_del_sum_dh kWh/(m^{2}a)	q_del_sum_other kWh/(m^{2}a)	q_exp_sum_el kWh/(m^{2}a)
SFH  CY.N.SFH.04.Gen	01	Minimum Requirement	3.38	34	0	34	32	10	16	0	0	0	0	55	0	0	0
	02	Improved Standard	2,86	29	0	29	26	10	16	0	0	0	0	49	0	0	0
	03	Ambitious Standard / NZEB	2.28	22	0	22	20	10	29	0	0	0	0	35	0	0	0
TH  CY.N.TH.04.Gen	01	Minimum Requirement	3.43	33	0	33	31	10	16	0	0	0	0	54	0	0	0
	02	Improved Standard	2.87	27	0	27	24	10	16	0	0	0	0	48	0	0	0
	03	Ambitious Standard / NZEB	2.44	22	0	22	20	10	29	0	0	0	0	35	0	0	0
MFH  CY.N.MFH.04.Gen	01	Minimum Requirement	1.52	20	0	20	17	15	21	0	0	0	0	47	0	0	0
	02	Improved Standard	1.33	17	0	17	14	15	21	0	0	0	0	44	0	0	0
	03	Ambitious Standard / NZEB	1.01	13	0	13	10	15	34	0	0	0	0	26	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m^{2}K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m^{2}a)	energy need for heating
q_ve_rec_h_usable	kWh/(m^{2}a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m^{2}a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m^{2}a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m^{2}a)	net energy need domestic hot water
q_g_w_out	kWh/(m^{2}a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m^{2}a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m^{2}a)	sum produced electricity (negative value)

3.3.3 Sources / References Cyprus

Table 33: Sources / References Cyprus

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[CUT, 2014]	CUT (2014): Typology brochures for Cyprus,	
[Cyprus Energy Agency, 2012]	Ενεργειακό Γραφείο Κυπρίων Πόλιτών (2012): Τυπολογία Κτιριακού Αποθέματος στην Κύπρο http://www.cea.org.cy/TOPICS/Buildings/BuildingstypologyCyprus.pdf Accessed: 30/07/2014	Census of the Building stock Typology in Cyprus, published by the Cyprus Energy Agency
[Cyprus Statistical Service, 2009]	Στατιστική Υπηρεσία Κύπρου (2009): Έρευνα για την τελική κατανάλωση ενέργειας στα νοικοκυρία http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/4D81522FDBE27569C225779F003B8677/$file/HH_Energy_Consumption-2009-EL-150910.pdf?OpenElement	Research on the Final Energy Consumption of Households, Questionnaires, published by the Cypriot Statistical Service
[ECOFYS, 2013]	ECOFYS (ed.) (2013): National plan for increasing the number of nearly zero-energy buildings in Cyprus ECOFYS 15 May 2013 European Commission, Publisher: MECIT	Includes targets differentiated according to the category of building and the steps needed to meet the dates of 2018 and 2020 that will support the implementation of nZEB and including national measures and requirements concerning the use of RES in new and existing buildings undergoing major renovation.
[Exergia, 2012]	Exergia (ed.) (2012): Provision of consulting services for the definition of the NZEB (residential) in Cyprus http://www.mcit.gov.cy/mcit/mcit.nsf/All/44D2917DF3B1EDCCC2257A390035FEB6/$file/CY-NZERB_results.pdf Accessed: 30/07/2014	Presentation of the results
[MCIT, 2009a]	Κ.Δ.Π.446/2009 Ο περί ρύθμισης Ενεργειακής Απόδοσης κτιρίων Νόμος, Δίαταγμα. http://www.mcit.gov.cy/mcit/mcit.nsf/All/DF8E187B6AF21A89C22575AD002C6160/$file/KDP446_2009%20peri%20Rythmisis%20Energeiakis%20Apodosis%20Ktirion(Apaitiseis%20Elaxistis%20Energeiakis%20Apodosis%20Ktiriou)%20Diatagma.pdf Accessed: 30/07/2014	National Minimum requirements and terminology explaination
[MCIT, 2009b]	Infogrend Innovations/BRE (2009): Methodology for Assessing the Energy Performance of Buildings. August 2009 for the Ministry of Energy, Commerce, Industry and Tourism (MECIT) http://www.mcit.gov.cy/mcit/mcit.nsf/0/E074577C58AD9EFCC22575B60047BEA8/$file/Methodology%20for%20Assesing%20the%20Energy%20Performance%20of%20Buildings.pdf.pdf Accessed: 30/07/2014	Overview on the Methodology for Assessing the Energy Performance of Buildings.
[MCIT, 2012a]	REPUBLIC OF CYPRUS (MCIT) (ed.) (2012): Nearly Zero Energy Buildings Action Plan CYPRUS September 2012 Available at: http://ec.europa.eu/energy/efficiency/buildings/doc/ms_nzeb_national_plans.zip	The action plan containing all the essential information to enable Cyprus to harmonise with the Directive 2010/31/EU and enforce the NZEB on new public buildings by 2018 and all new buildings by 2020.
[MCIT, 2012b]	MECIT / N.210(I)/2012 Ο περί ρύθμισης Ενεργειακής Απόδοσης κτιρίων Τροποποιητικός Νόμος, Κυπριακή Δημοκρατία, 28.12.2012 http://www.mcit.gov.cy/mcit/mcit.nsf/All/DF8E187B6AF21A89C22575AD002C6160/$file/N210(i)_2012%20peri%20Rithmisis%20Energiakis%20Apodosis%20Ktirion%20Tropoiitikos%20Nomos.pdf Accessed: 30/07/2014, Publisher The Republic of Cyprus	Regulation regarding the adjustment/control of Energy Perfomance of buldings

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[MCIT, 2013]	Republic of Cyprus (MCIT) (2013): Calculation for Setting the Minimum Energy Performance Requirement at Cost Optimal Levels According ton Article 5 of the Directive 2010/31/EE for the Energy Performance of Buidlings (recast) http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm National Report	Energy Efficiency – Implementation National reports on calculation of cost-optimal levels of minimum energy performance requirements CYPRUS
[MECIT, 2014a]	Νίκος Χ"Νικολάου, για το Υπουργείο Ενέργειας, Εμπορίου, Βιομηχανίας και Τουρισμού (2014): Κτίρια με Σχεδόν Μηδενική Κατανάλωση Ενέργειας, (MECIT) 16/05/2014 http://www.mcit.gov.cy/mcit/mcit.nsf/All/44D2917DF3B1EDCCC2257A390035FEB6/$file/DIABOYLEYSH_KSMKE_16APRIL14.pdf	Presentation of public consultation for NZEB in Cyprus
[MECIT, 2014b]	Παραμέτροι Σχεδιασμού κατοικιών με σχεδόν μηδενική ενεργειακή κατανάλωση Υπουργείο Ενέργειας, Εμπορίου, Βιομηχανίας και Τουρισμού, 24/02/2014 http://www.mcit.gov.cy/mcit/mcit.nsf/All/44D2917DF3B1EDCCC2257A390035FEB6/$file/KATOIKIES%20SXEDON%20MHDENIKHS%20KATANALVSHS%20ENERGEIAS_PARAMETROI%20SXEDIASMOU.pdf	Parametres for nearly zero energy houses and minimum requirements. NZEB regulations in preparation for public consultation.
[Panayiotou, et al., 2010]	Panayiotou, G.P./Kalogirou, S.A./Florides, G.A./Maxoulis, C.N./Papadopoulos, A.M./Neophytou, M./Fokaides, P./Georgiou, G./Symeou, A./ Georgakis, G. (2010): The characteristics and the energy behaviour of the residential building stock of Cyprus in view of Directive 2002/91/EC. In: Energy and Buildings, Issue 42 p.p: 1083-2089	This scientific paper presents the outline, goals and methodology of a research project and the findings regarding the energy behaviour and other characteristics of the residential building stock of Cyprus.
[Republic of Cyprus, 2013]	Κ.Δ.Π.433/2013 Κυπριακή Δημοκρατία (2013): Ο περί ρύθμισης Ενεργειακής Απόδοσης κτιρίων Τροποποιητικό Διάταγμα, 11/12/2013	Revised regulation regarding the adjustment/control of Energy Perfomance of bulding s

3.4 <CZ> Czech Republic

(by EPISCOPE partner STU-K)

The reduction of final energy consumption in the Czech housing sector is one of the most crucial tasks for the Czech Republic in the upcoming years and decades. The national energy strategic planning is following the EU political targets.

In the past decades Czech Republic followed the concepts for lowering energy demand and consumption in buildings developed in Austria and Germany.

The real interest in design and construction of low energy buildings raised considerably in the 90s of previous century.

Up to now several thousands of low energy buildings were built on the territory of the Czech Republic out of which around 800 comply with the passive house definition. The first Czech passive house was built in 2004. In 2008 there were only several dozens of passive houses built; the most famous project from this pioneer period is a set of 13 houses in Koberovy u Trutnova.

Current requirements for new and refurbished buildings are defined by the new Czech legislation; these criterions will become gradually stricter in order to meet the targets of 2020.

Renovations to highly efficient (nZEB) level are still not clearly defined. Once the process comes to an end the corresponding requirements will be tightened in the national building codes.

In order to support energy efficiency projects following subsidy programmes addressing the building sector were launched:

- State program for energy savings and RES;
- Operation program environment;
- Operation program enterprise and innovations;
- Green investment scheme;
- New panel program;
- Regional programs.

3.4.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Czech Republic

In 2010 the EPBD recast Directive [EPBD 2010] was adopted by the Czech legislation. In 2012 and 2013 the Czech Parliament approved the implementing regulations, especially the amendment to the Energy Management Act No. 406/2000 Coll. [CZ LAW 406] and the Decree No. 78/2013 Coll. on the Energy Performance of Buildings [CZ DEC 78].

The latter defines:

- Cost optimum requirements for the energy efficiency of new buildings, refurbishments and NZEB;
- Energy efficiency calculation methodology using “reference building”;
- Model for technical, economic and ecological feasibility of alternative energy supply system;
- Model for definition of recommended measures to reduce energy efficiency of buildings;
- Energy performance certificate template;
- Display Energy certificate rules.

Minimum requirements for new residential buildings in Czech Republic

Following energy performance parameters are taken into account for the evaluation of energy efficiency of new residential buildings:

a) total annual primary energy;
b) non-renewable primary energy;
c) total delivered annual energy
d) partial delivered energies for technical systems (heating, cooling, ventilation);
e) air conditioning, DHW and lighting;
f) average U value of the building envelope;
g) U-values of building elements on the “system borders”;
h) efficiency of technical systems.

Table 34: Required energy performance indicators for new buildings and refurbishments

Energy performance indicator	**Fulfilment of energy performance indicator required (compulsory)**				
	Newly built and extensions ≥ 25% of existing floor area	Refurbishments			
		Option 1	Option 2	Option 3	Option 4
Non-renewable primary energy (max. quantity allowed)	x	x			
Total delivered energy	x		x		
Mean U-value of building envelope	x	x	x		
Efficiency of HVAC components				x	
Partial U-value of replaced elements					x

In the coming years the value of non-renewable primary energy demand will be decremented by using ∆e pR (see Table 35).

The new requirement can be fulfilled either by increasing the share of renewable energy or by improving the building envelope parameters.

Table 35: Non renewable primary energy decrement factors for reference buildings

Parameter	**Symbol**	**Units**	**Type of building or zone**	**Reference value as of 1/1/2015**		
				Refurbishment	New	NZEB
Non renewable primary energy decrement for reference building	∆e pR	%	SFH, TH	3	10	25
		%	MFH, AB	3	10	20
		%	Other	3	8	10

Czech calculation method to comply with new building regulations for residential buildings

The new decree about energy performance of buildings introduced the method of so called reference building. Reference building is a virtual building with the same amount of delivered energy as the calculated building having building envelope parameters and technical systems parameters defined by the Czech legislation and standards.

Compared to the previous EPC methodology, instead of originally applied single value only criterion seven criterions have been newly introduced. This approach is taking into account the quality of building envelope, the efficiency of HVAC systems, the delivered energy and renewable as well as non-renewable primary energy.

The calculation methodology remained practically unchanged. The newly published technical report TNI 730331 [UMNZ 2013] contains typical values and information that shall be used in the calculation.

The technical report TNI 730331 has adopted and partly modified the calculation scheme from the German standard DIN V 18599 (Energetische Bewertung von Gebäuden) and compiled the complex calculation methods described in the standards:

- CSN EN 15316
- CSN EN 13779
- CSN EN 15193

The annexes to this report provide the informative parameters as follows:

Annex A - typical values and the range of parameters describing system efficiency

Annex B - typical user profiles (ventilation, lighting, DHW, heat gains from interior appliances, period of occupancy)

Annex C - climatic data (monthly)

Annex D – rules for definition of energy consumption related area for the purpose of energy performance evaluation.

As of January 2013, the building permits for new constructions can be issued only providing the energy performance requirements stipulated in the Energy Management Act are fulfilled. The compliance must be validated by the state Energy inspection authority. This obligation also applies to the owners of existing buildings undergoing major refurbishments.

Status of NZEB definition for residential buildings in Czech Republic

According to the Czech definition the NZEB is a building with a very low energy demand and with high share of renewable energy used to cover this energy demand. The appropriate values for referential building are prescribed by the newly amended legislation.

Renovations to highly efficient (nZEB) standard are still not clearly defined. Once the nZEB detailed specification process in Czech Republic is amended, it is planned to tighten the primary energy requirements in the national building code. This is expected to result in the implementation of the most convenient energy efficiency measures and RES, lowering the overall consumption of the buildings in the long term.

The timeline for NZEB is stipulated by the Czech Energy Management Act. New residential buildings in the years 2018 - 2020 shall comply with the requirement of nearly zero energy consumption as of:

January 1st 2018 (for buildings with floor area larger than 1 500 m2)

January 1st 2019 (for buildings with floor area larger than 350 m2)

January 1st 2020 (for buildings with floor area smaller than 350 m2)

Table 36: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of (assumed) NZEB definition in the Czech Republic

Calculation Method New Building Regulations – (part 1)

Country	CZ	Czech Republic	Status	08/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the National NZEB Definition

Legislation / Standards

Energy management Act 406/2000 Coll. novelized
Decree 78/2013 Coll
Czech standard CSN 730540 (Part1,2,3,4) latest versions
Czech versions of EU Standards:
CSN N ISO 6941
CSN EN ISO 13370
CSN EN ISO 13789
CSN EN ISO 13790
ČSN EN 15459
CSN EN 15603
TNI 730331

Explanation / Comments

Specific heating energy demand of Czech NZEB family house is ca. 45 kWh/m2.y. This energy performance level is more or less equivalent to Low Energy standard and far from passive house standard which is ca. 20 kWh/m2. The percentage of non-renewable primary energy will be decremented during the next years.

Special Aspects with regard to the National NZEB Definition:

A provisory definition of NZEB is included in the new legislation.

The Czech Housing development fund (SFRB) is currently synchronizing the subsidy scheme with the new legislation and energy performance requirements.

Technical report TNI 732309 will be used for EPC reporting.

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation	x	Lighting			

Explanation / Comments

Cooling systems are usually not installed in the Czech residential buildings.

Special Aspects with regard to the National NZEB Definition:

Appliances are not included in the calculation methodology.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Year
x	Calculation of delivered energy (system)	Month/Year

Explanation / Comments

Special Aspects with regard to the National NZEB Definition:

No deviation compared to the standard calculation method

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
x	Other special systems:	heat pumps

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x			
x	On-site PV		x	monthly	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Renewable primary energy is included in the balance, i.e. make part of the energy delivered to the building. The amount of energy is multiplied by factor zero in the calculation non-renewable primary energy balance.

Special Aspects with regard to the National NZEB Definition:

No deviation compared to the standard calculation method

In case of surplus electricity with connection to utility network negative delivered energy and primary energy demand is considered.

Table 36 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>Country</td><td>CZ</td><td colspan="3">Czech Republic</td><td>Status</td><td>08/2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the (preliminary) National NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6">Values calculated and compared with values calculated for reference building.
Calculated delivered energy related to calorific value of the fuel (in case if fuel is used)

EPC reporting
Average U_{value} requirement tightened compared to refurbishments and standard new buildings.
Higher share of renewable energy than in case of refurbishments and standard new buildings.</td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2">x</td><td rowspan="2">Primary energy</td><td rowspan="2">Non-renewable and total</td></tr>
<tr><td>x</td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td>x</td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td>x</td><td>Delivered energy</td><td>x</td><td>Other</td><td>Efficiency of technical systems</td></tr>
<tr><td colspan="5">Explanation / Comments
Mean U_{value} of the building envelope is calculated and compared with reference U-value. Delivered energy – total as well as partial. Primary energy demand calculated separately renewable and non-renewable.

EPC reporting
U-values on system borders and mean U_{value}. Mean U-value is a part of basis for EPC rating
Primary energy non-renewable and total
Total delivered energy
CO_2 emissions considered in case of energy audit</td></tr>
</table>

Assessment of energy carriers in Czech Republic

The energy performance assessment for the purpose of EPC using non-renewable primary energy factors is stipulated by the Decree 78/2013 Coll. [CZ DEC 78]. The non-renewable and total primary energy factors for different energy carriers are defined in the Annex 3 to this legal document. These factors are derived from energy balance based on statistical data published by the Czech Statistical Office. The principal of assessment consists in comparison between evaluated building and reference building. The reference building parameters are also defined by the Decree 78/2013 Coll. [ibidem]. The primary energy conversion factors for reference HVAC systems are defined as follows:

Table 37: Primary energy conversion factor by HVAC system type

HVAC system	Primary energy conversion factor [-]
Heating	1.1
Cooling+ AC	3.0
DHW	1.1
Mechanical ventilation	3.0
Lighting	3.0
Auxiliary energy	3.0

In case of PV or cogeneration systems exporting energy outside the building borders the Decree defines the amount of negative primary energy that can be considered in the balance. If the above mentioned systems are not connected to the public network only the used energy is considered (the calculated monthly electric energy demand for HVAC and auxiliary energy.

Table 38: Czech primary energy factors

Label / type of factor	Total Primary Energy Factor	Non-Renewable Primary Energy Factor
Used for EPC rating		x
Used for building regulations requirements	x	x
Label (national language)	Faktor celkové primární energie dle Přílohy č.3 vyhlášky 78/2013 Sb.	Faktor neobnovitelné primární energie dle Přílohy č.3 vyhlášky 78/2013 Sb.
Description / type of weighting factor	Total non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary
Factor is multiplied by delivered energy based on the	gross calorific value	gross calorific value
Reference	[Decree 78/2013 Coll]	[Decree 78/2013 Coll]
Natural gas	1.1	1.1
Heating oil	1.2	1.2
Firewood	1.1	0.1
Wood pellets	1.2	0.2
Electricity	3.2	3.0
Electricity production CHP	1.7	1.0
Electricity production PV system	1.0	0
District heating	1.1	1.0
District heating without CHP	1.1	1.0
District heating with 100 % CHP	1.1	0.1

Methodological points for discussion in Czech Republic

The crucial discussion points are:

- methodology of calculation of the cost optimum solutions
- national conversion factors for primary energy (especially electricity). Conversion factors were derived from the energy mix of 2010; in the meantime many PV plants were put into operation. It is obvious that the impact of PV plants and CHP is not correctly considered. For the time being Czech Republic has one of the highest conversion factors for electricity among the EU countries (3.0) and very low conversion factor for heating with biomass (e.g. wooden pellets)
- use of parameters building envelope mean U-value and total non-renewable primary energy consumption

3.4.2 Integration of National Requirements for New Buildings and NZEB Standards in the Czech Residential Building Typology

According to our knowledge the idea of residential building typology has not been developed in the Czech Republic before TABULA project [STU-K 2011]. The national requirements for new buildings and NZEB standards were integrated to original TABULA typology. The age band 2011 onwards is presenting 3 different energy efficiency levels – standard minimum requirements, improved values corresponding to NZEB level and passive house requirements.

The current requirements for NZEB are as follows:

Table 39**: Current requirements for NZEB by building type**

Requirements	SFH and TH	MFH
Required mean U-value	≤ 0.25	≤ 0.35
Energy need for heating	≤ 20 kWh/m^{2}a*	≤ 15 kWh/m^{2}a*
Primary energy level A	80 kWh/m^2.a	80 kWh/m^2.a
Primary energy level B	30 kWh/m$^{2.}$a	30 kWh/m^2.a

*) According to the Czech methodology the energy need for heating does not include the energy need to cover the storage, emission and distribution losses. The solar gains, internal heat gains and heat recovery gains are deducted from the energy need for heating.

Classification scheme for the Czech residential building stock ("Building Type Matrix")

In the framework of the project EPISCOPE the building type matrix was upgraded and extended towards recently and presently built houses. The newly introduced age band is corresponding to the current legal and technical requirements, especially to the latest version of the Energy management Act 406/2000 Coll. [CZ LAW 406] and the Czech standard ČSN 73 0540-2:2011 [CSN 730540]. Figure 14 shows the above mentioned matrix.

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Česká republika)	… 1920	generic (Standard)	 CZ.N.SFH.01.Gen	 CZ.N.TH.01.Gen	 CZ.N.MFH.01.Gen	 CZ.N.AB.01.Gen
2	national (Česká republika)	1921 … 1945	generic (Standard)	 CZ.N.SFH.02.Gen	 CZ.N.TH.02.Gen	 CZ.N.MFH.02.Gen	 CZ.N.AB.02.Gen
3	national (Česká republika)	1946 … 1960	generic (Standard)	 CZ.N.SFH.03.Gen	 CZ.N.TH.03.Gen	 CZ.N.MFH.03.Gen	 CZ.N.AB.03.Gen
4	national (Česká republika)	1961 … 1980	generic (Standard)	 CZ.N.SFH.04.Gen	 CZ.N.TH.04.Gen	 CZ.N.MFH.04.Gen	 CZ.N.AB.04.Gen
5	national (Česká republika)	1981 … 1994	generic (Standard)	 CZ.N.SFH.05.Gen	 CZ.N.TH.05.Gen	 CZ.N.MFH.05.Gen	 CZ.N.AB.05.Gen
6	national (Česká republika)	1995 … 2010	generic (Standard)	 CZ.N.SFH.06.Gen	 CZ.N.TH.06.Gen	 CZ.N.MFH.06.Gen	 CZ.N.AB.06.Gen
7	national (Česká republika)	2011 …	generic (Standard)	 CZ.N.SFH.07.Gen	 CZ.N.TH.07.Gen	 CZ.N.MFH.07.Gen	

Figure 14: Classification scheme ("Building Type Matrix") of the Czech residential building typology [STU-K 2014], now extended towards new buildings (age band 2011 onwards)

Three types of exemplary new buildings representing the latest construction year classes which are used for showcase calculations considering possible practical implementations of new buildings further to the Czech minimum requirements, the advanced (recommended) and so called target requirements are shown in the Table 40.

Table 40: Exemplary new buildings representing the latest construction year classes (2011 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 CZ.N.SFH.07.Gen	 CZ.N.TH.07.Gen	 CZ.N.MFH.07.Gen	
Number of dwellings		1	1	12	
Number of full storeys (conditioned)		2	2	4	
Number of directly attached neighbour buildings		0	1	0	
National reference area*	m²	170.0	170.0	1096.8	
TABULA reference area (conditioned floor area, internal dimensions)	m²	144.5	137.6	1052.4	

*) exterior dimensions considered for the national reference area

Building example: variants meeting three energy performance levels for new buildings

In the following table example variants of single family house are described in more detail. The same type of data for the other buildings can be found in the last updated version of the national typology brochure [STU-K 2014].

Table 41 shows the building parameters for different model configurations. According to the Czech mmethodology the choice of heating system does not impact the U values of the building envelope. Three energy performance levels are considered as follows:

1. Minimum requirements

Combination of building envelope with two types of supply systems complying with currently valid minimum requirements stipulated by the decree 78/2013 Coll. [CZ DEC 78] and the Czech standard ČSN 73 0540-2:2011 [CSN 730540].

2. Improved Standard

Improved standard is a set of middle of range U values of the building envelope in combination with two types of heating. This set up of values would comply with the NZEB definition if mechanical ventilation with heat recovery is applied, which is usually not the case in current practice.

3. Ambitious standard (NZEB)

Combination of ambitious U values from the Czech standard with two types of supply systems is corresponding to current NZEB definition and the definition of passive house. The requirement mechanical ventilation with heat recovery must be fulfilled. This level qualifies for a subsidy of 20,000 EUR from the subsidy programme „Saving scheme“ in case of construction of new single family or terraced house.

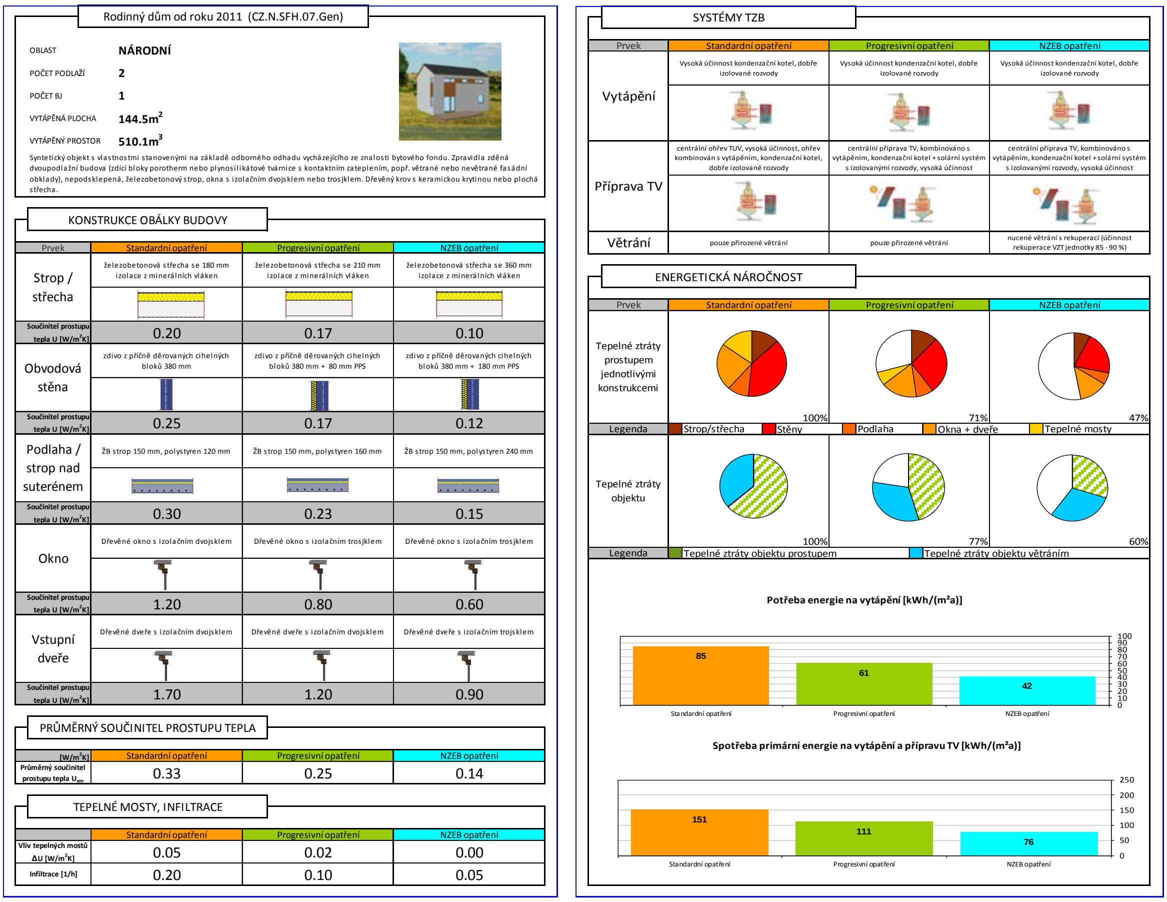
The two heating systems selected to demonstrate the different energy performance levels were condensing gas boiler and electric heat pump (soil-water sys). The DHW is produced with either the condensing boiler or condensing boiler with solar collector or with the heat pump.

The ambitious level has a heat recovery system.

Table 41: Exemplary new single family house (SFH) – definition of variants

Label of the variant triplet		"Natural Gas"			"Electricity"		
Variant N°		001	002	003	011	012	013***
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values							
Roof	W/(m²K)	0.2	0.17	0.10	0.2	0.17	0.10
Wall	W/(m²K)	0.25	0.17	0.12	0.25	0.17	0.12
Window	W/(m²K)	1.2	0.8	0.6	1.2	0.8	0.6
Door	W/(m²K)	1.7	1.2	0.9	1.7	1.2	0.9
Floor	W/(m²K)	0.3	0.23	0.15	0.3	0.23	0.15
Thermal bridging supplement (whole envelope)	W/(m²K)	0.05	0.02	0.00	0.05	0.02	0.00
Heat Supply System							
Heat generator		Condensing boiler			Heat pump soil		
Specification / Supplemental system		-	Solar DHW	Solar DHW + heat recovery	-	-	Heat recovery
Ventilation system		Natural	Natural	Mechanical	Natural	Natural	Mechanical
Thermal solar system		none	DHW	DHW	none	none	none
Further system		none	none	none	none	none	None

Building display sheet of the exemplary SFH (CZ) is presented below, see Figure 15. Further examples are available in [STU-K 2014].



Rodinný dům od roku 2011 (CZ.N.SFH.07.Gen)

OBLAST	NÁRODNÍ
POČET PODLAŽÍ	2
POČET BJ	1
VYTÁPĚNÁ PLOCHA	144.5m²
VYTÁPĚNÝ PROSTOR	510.1m³

Syntetický objekt s vlastnostmi stanovenými na základě odborného odhadu vycházejícího ze znalosti bytového fondu. Zpravidla zděná dvoupodlažní budova (zdící bloky porotherm nebo plynosilikátové tvárnice s kontaktním zateplením, popř. větrané nebo nevětrané fasádní obklady), nepodsklepená, železobetonový strop, okna s izolačním dvojsklem nebo trojsklem. Dřevěný krov s keramickou krytinou nebo plochá střecha.

KONSTRUKCE OBÁLKY BUDOVY

Prvek	Standardní opatření	Progresivní opatření	NZEB opatření
Strop / střecha	železobetonová střecha se 180 mm izolace z minerálních vláken	železobetonová střecha se 210 mm izolace z minerálních vláken	železobetonová střecha se 360 mm izolace z minerálních vláken
Součinitel prostupu tepla U [W/m²K]	0.20	0.17	0.10
Obvodová stěna	zdivo z příčně děrovaných cihelných bloků 380 mm	zdivo z příčně děrovaných cihelných bloků 380 mm + 80 mm PPS	zdivo z příčně děrovaných cihelných bloků 380 mm + 180 mm PPS
Součinitel prostupu tepla U [W/m²K]	0.25	0.17	0.12
Podlaha / strop nad suterénem	ŽB strop 150 mm, polystyren 120 mm	ŽB strop 150 mm, polystyren 160 mm	ŽB strop 150 mm, polystyren 240 mm
Součinitel prostupu tepla U [W/m²K]	0.30	0.23	0.15
Okno	Dřevěné okno s izolačním dvojsklem	Dřevěné okno s izolačním trosjklem	Dřevěné okno s izolačním trosjklem
Součinitel prostupu tepla U [W/m²K]	1.20	0.80	0.60
Vstupní dveře	Dřevěné dveře s izolačním dvojsklem	Dřevěné dveře s izolačním dvojsklem	Dřevěné dveře s izolačním trojsklem
Součinitel prostupu tepla U [W/m²K]	1.70	1.20	0.90

PRŮMĚRNÝ SOUČINITEL PROSTUPU TEPLA

[W/m²K]	Standardní opatření	Progresivní opatření	NZEB opatření
Průměrný součinitel prostupu tepla U_{em}	0.33	0.25	0.14

TEPELNÉ MOSTY, INFILTRACE

	Standardní opatření	Progresivní opatření	NZEB opatření
Vliv tepelných mostů ΔU [W/m²K]	0.05	0.02	0.00
Infiltrace [1/h]	0.20	0.10	0.05

SYSTÉMY TZB

Prvek	Standardní opatření	Progresivní opatření	NZEB opatření
Vytápění	Vysoká účinnost kondenzační kotel, dobře izolované rozvody	Vysoká účinnost kondenzační kotel, dobře izolované rozvody	Vysoká účinnost kondenzační kotel, dobře izolované rozvody
Příprava TV	centrální ohřev TUV, vysoká účinnost, ohřev kombinován s vytápěním, kondenzační kotel, dobře izolované rozvody	centrální příprava TV, kombinováno s vytápěním, kondenzační kotel + solární systém s izolovanými rozvody, vysoká účinnost	centrální příprava TV, kombinováno s vytápěním, kondenzační kotel + solární systém s izolovanými rozvody, vysoká účinnost
Větrání	pouze přirozené větrání	pouze přirozené větrání	nucené větrání s rekuperací (účinnost rekuperace VZT jednotky 85 - 90 %)

ENERGETICKÁ NÁROČNOST

Prvek	Standardní opatření	Progresivní opatření	NZEB opatření
Tepelné ztráty prostupem jednotlivými konstrukcemi	100%	71%	47%
Tepelné ztráty objektu	100%	77%	60%

Figure 15: "Building Display Sheet" of the exemplary SFH <CZ>

Table 42: Exemplary SFH – Results of the energy balance calculation; Czech national calculation methodology [UNMZ 2013]

Variant N°		**001**	**002**	**003**	**011**	**012**	**013**
Label of the variant triplet		“Natural gas”			“Electricity-heat pump”		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		[CZ DEC 78]	[CZ DEC 78]	[CZ GS 2014]	[CZ DEC 78]	[CZ DEC 78]	[CZ GS 2014]
Calculation method		TNI 73 033 [UNMZ 2013]			TNI 73 0331 [UNMZ 2013]		
National reference area*	m^2	170.04	170.04	170.04	170.04	170.04	170.04
Thermal transfer coefficient by transmission. related to envelope area	W/(m^{2}K)	0.33	0.25	0.14	0.33	0.25	0.14
Relation to requirement		83 %	71 %	54 %	83 %	71 %	54 %
Relation to reference standard		150 %	114 %	64 %	150 %	114 %	64 %
Energy need for heating	kWh/(m^{2}a)	77	52.5	14**	77	52.5	14**
Delivered energy							
Fossil fuels	kWh/(m^{2}a)	86.2	61.1	21.5	0	0	0
Renewable fuels	kWh/(m^{2}a)	0	0	0	0	0	0
Electricity	kWh/(m^{2}a)	8	8	10.5	31.4	25.2	18.1
Primary energy demand	kWh/(m^{2}a)	120.42	92.8	57.25	100.48	80.64	57.9
Relation to requirement		134 %	103 %***	95 %****	112 %	89.6 %	96.5 %
Funding level:		0	0	20000 EUR	0	0	20000 EUR

*) exterior dimensions considered for the national reference area

**) heat recovery

***) B1 requirement 90 kWh/(m^{2}a) of primary energy

****) B2 requirement 60 kWh/(m^{2}a) of primary energy

TABULA calculation results for all exemplary buildings

Table 43 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for three exemplary buildings (SFH, TH and MFH) in three different energy efficiency standards.

Table 43: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  CZ.N.SFH.07.Gen	01	Minimum Requirement	0.90	85	0	85	84	10	23	110	0	0	0	10	0	0	0
	02	Improved Standard	0.60	61	0	61	59	10	23	70	0	0	0	11	0	0	0
	03	Ambitious Standard / NZEB	0.38	42	21	21	21	10	23	31	0	0	0	13	0	0	0
	11	Minimum Requirement	0.90	85	0	85	93	10	23	0	0	0	0	39	0	0	0
	12	Improved Standard	0.60	61	0	61	69	10	23	0	0	0	0	33	0	0	0
	13	Ambitious Standard / NZEB	0.38	42	21	21	30	10	23	0	0	0	0	25	0	0	0
TH  CZ.N.TH.07.Gen	01	Minimum Requirement	0.80	78	0	78	77	10	23	102	0	0	0	10	0	0	0
	02	Improved Standard	0.53	54	0	54	53	10	23	64	0	0	0	11	0	0	0
	03	Ambitious Standard / NZEB	0.33	36	20	16	17	10	23	27	0	0	0	13	0	0	0
	11	Minimum Requirement	0.80	78	0	78	86	10	23	0	0	0	0	37	0	0	0
	12	Improved Standard	0.53	54	0	54	63	10	23	0	0	0	0	31	0	0	0
	13	Ambitious Standard / NZEB	0.33	36	20	16	26	10	23	0	0	0	0	24	0	0	0
MFH  CZ.N.MFH.07.Gen	01	Minimum Requirement	0.52	64	0	64	70	15	23	95	0	0	0	4	0	0	0
	02	Improved Standard	0.34	44	0	44	49	15	23	74	0	0	0	4	0	0	0
	03	Ambitious Standard / NZEB	0.22	30	20	10	16	15	23	40	0	0	0	7	0	0	0
	11	Minimum Requirement	0.52	64	0	64	70	15	23	0	0	0	0	4	98	0	0
	12	Improved Standard	0.34	44	0	44	49	15	23	0	0	0	0	4	76	0	0
	13	Ambitious Standard / NZEB	0.22	30	20	10	16	15	23	0	0	0	0	7	41	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.4.3 Sources / References Czech Republic

Table 44: Sources / References Czech Republich

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[CSN 730540]	Norma ČSN 73 0540 , část 1 až 4 Tepelná ochrana budov.	Czech standard on the thermal protection of buildings defines the terms used in the field of thermal building technology. Definition of variables, their symbols and units, used in ČSN 73 0540 -2, 3 and 4, describing the propagation of heat, moisture and air through building materials and construction, as well as the state of indoor and outdoor environments.
[CZ DEC 78]	Vyhláška 78/2013 Sb.	Decree on the energy performance of buildings – Czech national regulation to implement the EPBD II Directive to the Czech building construction practice.
[CZ GS 2014]	Směrnice č.. 1-2014. Nová zelená úsporám	New Green savings Directive Czech national regulation defining the rules of subsidy programme administered by the State Environmental Fund of the Czech Republic. This subsidy programme is focused on energy savings and renewable energy sources in family houses.
[CZ LAW 406]	Zákon o hospodaření s energií. 406/2000 Sb	Energy Management Act Czech national regulation transposing the EPBD II Directive to the Czech legistation.
[EPBD 2010]	Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). Online available: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0031 [2014-05-15]	EC regulation
[MPO EF 2011]	Budovy s téměř nulovou potřebou MPO Efekt 2013	Nearly zero energy buildings. Guidelines, definitions of parameters.
MPO EF 2013[]	Referenční budovy podle metodického rámce MPO Efekt 2013	Referential buildings according to Czech methodological framework. Guidelines.
[STU-K 2011]	STU-K (2011): Příručka typologií obytných budov s příklady opatření ke snížení jejich energetické náročnosti http://episcope.eu/fileadmin/tabula/public/docs/brochure/CZ_TABULA_TypologyBrochure_STU-K.pdf	National typology brochure for Czech Republic, developed during the IEE Project TABULA
[STU-K 2014]	STU-K (2014): Příručka typologií obytných budov s příklady opatření ke snížení jejich energetické náročnosti	National typology brochure for Czech Republic, developed during the IEE Project EPISCOPE
[UNMZ 2013]	Technická normalizační informace (TNI 73 0331) "Energetická náročnost budov - Typické hodnoty pro výpočet". Úřad pro technickou normalizaci, metrologii a státní zkušebnictví, 2013.	Technical standardization information directive (TNI 73 0331) "Energy Performance of Buildings – Typical values for calculation". Supporting document that defines typical values that shall be used for calculation of standardized usage of a building.

3.5 <DE> Germany

(by EPISCOPE partner IWU)

In the mid-1980s buildings with a much lower energy consumption than ordinary buildings were introduced in the German buildings market. The concepts based on experiences reported from Scandinavian countries where buildings with thick insulation and windows with 3 and more panes were realised (the German versions of these dwellings were then known as “Schweden-Standard” = “Sweden Standard”). In the early 1990s some federal states raised funding programmes to support these building concepts which were called “low energy houses” (“Niedrigenergiehäuser”) [Fingerling 1996]. In the same period the “passive house” concept was developed in the framework of a research project and a first prototype was built [Feist 2003]. In the following years the concept was refined, components needed for passive houses were introduced in the market and quality assurance concepts have been developed. Until now, more than 20,000 passive house dwellings have been built in Germany [iPHA].

In contrast, the level of national requirements has made up ground only slowly. The minimum energy standard of today is roughly corresponding to the level of what was promoted as “low energy house” in the early 1990s. Nevertheless, the actual energy levels are quite better in the average – not least because of the national funding scheme of the KfW Bank, which has already been implemented more than 10 years ago and supports the construction of energy efficient buildings on different levels.

Nearly zero-energy buildings (NZEBs) have not yet been officially defined, but there are reasons to assume that the best standard currently supported by the KfW banking group may be an appropriate benchmark.

3.5.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Germany

Since the first thermal regulation became law in 1978, several tightenings and changes of the legal requirements for new buildings took place. A revision of the German Energy Saving Ordinance came into force in May 2014. As a next step towards nearly zero-energy buildings, it includes a tightening of the requirements for new buildings in 2016.

Minimum requirements for new residential buildings in Germany

The current energy requirements for new buildings have been introduced in the framework of the energy saving ordinance (“Energieeinsparverordnung”, short EnEV) in 2009. In 2014 a recast came into force including some methodical revisions but no considerable change of the requirement level. However, a future 25 % reduction of the primary energy demand has been fixed for January 2016.

For all new buildings, primary energy requirements are specified by means of a “reference standard” of building and system components which need to be applied to the geometrical model of the given / planned new building. Therefore, the energy saving ordinance includes a complete description of parameters (U-values, supply system type and quality) which is applied to calculate a building-related primary energy requirement. Of course, other variants are allowed as well – as far as the primary energy demand is not exceeding that of the reference standard. As a second requirement maximum values of the heat transfer coefficient by transmission (related to the thermal envelope area) must be considered.

The improved energy performance level of 2016 is, however, based on the same reference standard as that of 2009. But then the maximal primary energy demand will be 75 % of that of the reference standard (and, in consequence, the reference standard will no longer be one possible variant of implementation).

In addition to the energy saving ordinance “EnEV”, the “Renewable Energies Heat Act” (RES) requires a certain share of renewable energy sources to cover the energy need for heating and for domestic hot water. The exact ratio depends on the chosen energy source; the given default solutions vary in share from 15 %, e.g., in the case of solar heat, to 50 % in the case of heat pumps using the heat source ground (see also [Schettler-Köhler / Kunkel 2012]). If this cannot be fulfilled the maximum primary energy demand, given by the energy saving ordinance, is reduced by 15 %.[21]

German calculation method to comply with new building regulations for residential buildings

In the case of residential buildings two alternative calculation methods can be used:

(1) DIN V 18599:2011 [DIN V 18599]

This standard consists of a complete scheme for the calculation of residential and non-residential buildings and includes calculation modules for heating, cooling, air-conditioning and ventilation systems and a primary energy based energy carrier assessment. Multi-zone calculations are possible but only obligatory for non-residential buildings.

(2) DIN V 4108-6:2003 + 4701-10:2003 (A1: 2012-07) [DIN V 4108-6 / 4701-10]

These two standards have already been introduced in the context of the energy saving ordinance 2002 [EnEV 2002] and are designed to calculate energy balances of the heat need (DIN V 4108-6) and the primary energy demand (DIN V 4701-10) of residential buildings. The calculation scheme is much less complex than DIN V 18599 and also includes default values to be used if details of a component are not known. In contrast to DIN V 18599 it is also possible to make a simplified calculation of the supply system by use of tabled values for heat generation, storage, distribution and emission. A simple calculation sheet to get an overview of the system efficiency is also part of the standard.

The primary energy factors to be used are the same for both methods (see section “Assessment of energy carriers in Germany”).

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[21] Lowering the maximum primary energy demand for buildings without RES has a strange effect: If for example a new building with a central heating system based on natural gas is built, a variant including a thermal solar system will consume more non-renewable resources than a building without thermal system. The reason is that compensation between energy saving measures and solar systems is already included in the standard EPC calculation. A further consideration by adjusting the primary energy limit leads to double counting of RES measures.

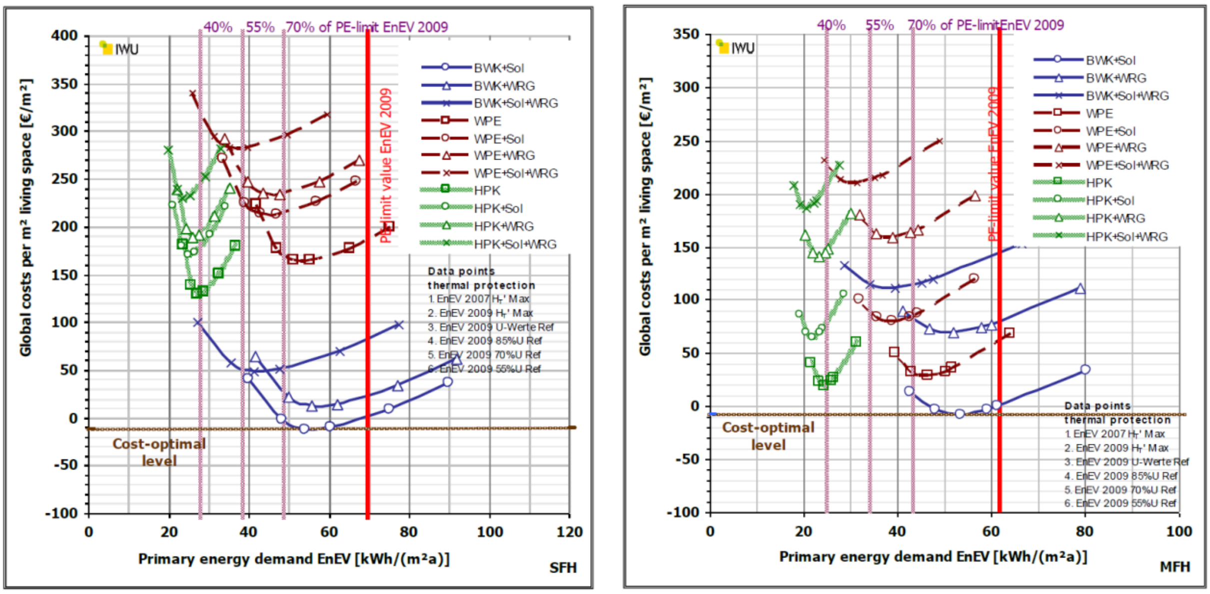
Status of NZEB definition for residential buildings in Germany

Nearly Zero-Energy Buildings (NZEBs) are addressed in the Energy Saving Act “Energieeinsparungsgesetz” from 2013 [EnEG 2013]. In this law a further amendment of the energy saving ordinance is prescribed before 2019 (with a regulation starting from January 2021). However, an official definition of the NZEB standard is not included and has also not yet been published by the German government.

Despite the lack of an official definition, the “KfW-Effizienzhaus 40” seems to be an appropriate benchmark for the definition of the NZEB level for residential buildings in Germany. It has already been used as a synonym for the future German new built NZEBs in scenario analyses for the German building sector performed on behalf of the Federal Government [IWU 2013a].

In [IWU 2012b] and [BPIE / IWU 2013] it was shown that the current national requirements (EnEV 2009) are not yet reaching the cost optimal level (see Figure 16) – but this will be attained by the next step, decided for January 2016 (-25 % primary energy demand). So, it is foreseeable that the global costs will rise when the level of 40 % of the minimum requirements (primary energy demand) is targeted (as long as no extreme increases in energy prices occur).

However, since its introduction in 1976 the Energy Saving Act [EnEG 2013] demands that requirements of the corresponding ordinance must be economically justifiable (usually interpreted: must not impose a rise of global costs for house owners). This regulation (resp. its current interpretation) appears as a contradiction to the obligation of an NZEB introduction in the year 2021 (see above). It is currently unclear how these disaccording regulations in the same law will be overcome.



BWK (“Brennwertkessel”): natural gas condensing boiler

WPE („Wärmepumpe elektrisch“): electrical heat pump, heat source ground

HPK (“Holzpelletkessel”): wood pellets boiler

Sol (“Solaranlage”): including thermal solar DHW system

WRG (“Wärmerückgewinnung”): including ventilation system with heat recovery

Figure 16: Dependence of the global costs of a single-family (left chart) and a multi-family house (right chart) from the energy performance level (new buildings / assumption: medium energy price development) [BPIE / IWU 2013]

As already pointed out in the introduction of the “<DE> Germany” chapter the targeted level of NZEB is not only theoretical but has been implemented in practice for numerous years. The “KfW-Effizienzhaus 40” has been promoted as one of several levels by the main national subsidy program of the “KfW Group”, a bank owned by the German government, specialised in reduced interest loans and public subsidies. In 2012 already 50 % of the newly built residential dwellings received a funding from KfW and thus had a higher energy performance than the national minimum requirements. The shares of the three KfW standards are shown in the table below. Accordingly, about 4 % of the newly constructed residential buildings supposedly correspond to a possible future NZEB level [IWU 2013c].

Table 45: Share of KfW funding levels [IWU 2013c]

Name of the KfW funding level	**Primary energy demand with respect to national minimum requirements (EnEV 2009/2014)**	**Share of funded new buildings 2012** (100% = all new buildings funded by the KfW programme)	**Estimated share of new buildings 2012** (100 % = all new residential buildings in Germany)
“KfW-Effizienzhaus 70”	70 %	73 %	37 %
“KfW-Effizienzhaus 55”	55 %	19 %	10 %
“KfW-Effizienzhaus 40”*	40 %	8 %	4 %

*) in EPISCOPE it is assumed that the NZEB standard will be comparable to the “KfW-Effizienzhaus 40”, see text

The estimated fractions related to all new built residential houses in Germany are a rough estimate according to the above mentioned approximate 50 % share of the KfW funding among new buildings. Besides, the numbers might even be larger because not all new buildings which are erected according to a KfW level are necessarily funded by the KfW.

In addition to these standards the German government has introduced in 2012 the standard “Effizienzhaus Plus” (“Efficiency House Plus”) which includes on-site electricity production as an obligatory element. The respective promotion programme requires an “energy surplus”, meaning that the annual electricity production must exceed the electricity demand for heating, DHW and household electricity. At present this standard has still an experimental character, i.e. only a small number buildings is currently funded [BMVI 2014].

Further aspects of the NZEB discussion in Germany can be found in the working paper of the new German Typology Brochure [IWU 2014a].

Table 46: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition in Germany

Calculation Method New Building Regulations – (part 1)

Country	DE	Germany	Status	04/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the assumed German NZEB Definition
Legislation / Standards German Energy Saving Ordinance 2014 (EnEV 2014) German Renewable Energies Heat Act 2011 (EEWärmeG 2011) German Energy Saving Act 2013 (EnEG 2013) calculation standard (2 alternatives): (1) DIN V 18599:2011 (2) DIN V 4108-6:2003 + 4701-10:2003 (A1:2012-07) **Explanation / Comments** The current level of requirements has been introduced in 2009. In 2016 the primary energy demand will be reduced by 25 % and the fabric losses by 10 %. Since 2009 it is mandatory to cover a certain share of the heat demand by renewable energies.	No official German NZEB definition until now. In EPISCOPE it is assumed that the NZEB standard will be comparable to the "KfW efficiency house 40" (60 % below current primary energy requirements). This level of energy performance has been part of the national funding scheme of the KfW Bank since 2010.
Energy Services **Explanation / Comments** Cooling systems are usually not installed in German residential buildings.	The proof of the “Effizienzhaus 40” standard is methodically based on the German calculation procedure for new buildings. Appliances and lighting are not considered in the regular EP requirements, but in the optional calculation procedure for “Efficiency Houses Plus” (see text section above this table).

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

Cooling systems are usually not installed in German residential buildings.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Year / Month*

Explanation / Comments

*) DIN V 4701-10: "Year" / DIN V 18599: "Month"

No deviations for “Effizienzhaus 40” proof.

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x		-	-
x	On-site PV		x	Month	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Photovoltaic is currently included in the balance as far as provisions are taken to use the produced electricity on-site and the calculated monthly electrical energy demand is directly covered – no bonus for exported energy foreseen (different approach for promoting programme “Efficiency House Plus”)

No deviations for “Effizienzhaus 40” proof.

Calculation procedure for “Efficiency Houses Plus” (see above) is considering PV coverage of household electricity (HE), balance is done on a yearly basis, and feed-in of surplus electricity is part of the requirement.

Table 46 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td colspan="2">Country</td><td>DE</td><td colspan="2">Germany</td><td>Status</td><td>04/2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the assumed German NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6">No deviations for “Effizienzhaus 40” proof.
Requirement type of “Efficiency Houses Plus” (see above) is different: negative delivered energy and primary energy demand.</td></tr>
<tr><td></td><td>U-values of building elements</td><td rowspan="2">x</td><td rowspan="2">Primary energy</td><td rowspan="2">non-renewable</td></tr>
<tr><td>x</td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>share of renewables*</td></tr>
<tr><td colspan="5">Explanation / Comments
* depending on heat supply technology
Delivered energy and – on a voluntary basis - carbon dioxide emissions are included in EPCs (for information purposes only). Basis for the classification by the recently introduced labels A, B, C, … is delivered energy.</td></tr>
</table>

Assessment of energy carriers in Germany

The assessment of the energy performance of buildings by use of non-renewable primary energy factors (related to delivered energy) derived from [GEMIS] has been in use for more than 15 years in Germany (see e.g. energy certificate procedure in [IWU 1997]). Today the basis of the primary energy factors given in the German standards is still GEMIS (Global Emissions Model for integrated Systems), a public domain life-cycle and material flow analysis model and database which is maintained and further developed continuously [GEMIS].

Tabled values of total and non-renewable primary energy factors are published in DIN V 18599-1. However, the German energy saving ordinance (EnEV) prescribes to use values for electricity deviating from the DIN standard. An overview of the values of DIN / EnEV is given in Table 47.

On-site photovoltaic systems are considered in the primary energy demand of the EnEV procedure in the extent that the calculated monthly electrical energy demand for heating, DHW and auxiliary energy is directly covered. If for a month the electricity production exceeds the electricity demand this surplus is summed up as exported electricity. A bonus for the exported fraction of the produced electricity is not foreseen. This principle was also applied when calculating the exemplary buildings in the next chapter by means of the TABULA method (however, the TABULA method is not fixed to monthly balance of onsite supply and demand, since a precalculation can be performed by using arbitrary lengths of compensation steps).

In the special promoting programme “Efficiency House Plus” a different approach for considering PV systems is followed. In addition to space heating and DHW also household electricity (HE) can be taken into account. In this case the balance is done on a yearly basis and the feed-in of surplus electricity into the grid is considered as a bonus in the energy balance. The requirement is that the primary energy demand must be negative.

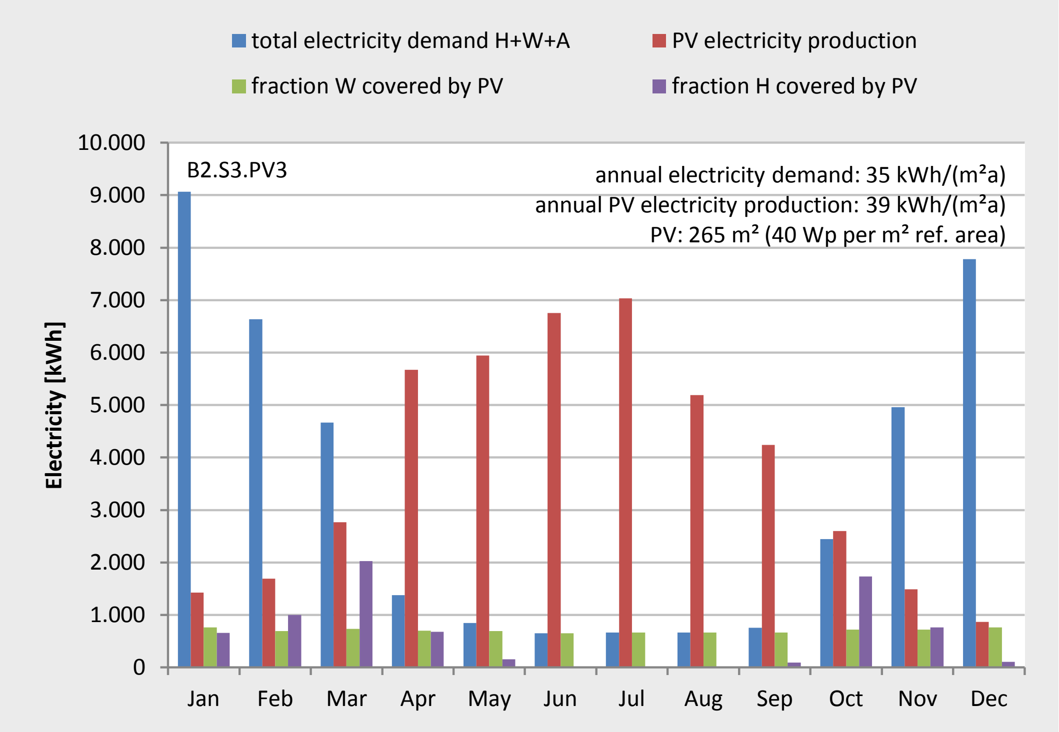


Figure 17: Monthly compensation by the German EnEV calculation method

In Table 47, the values used in the German EnEV calculation procedure are displayed in the second column. The table also shows the GEMIS values integrated in the TABULA database as a second set of assessment factors. In case of electricity the values differ due to the following reasons:

- Electricity production by PV systems: PV electricity is considered as one of the energy carriers. The factors of the column “GEMIS + IWU” are including the energy effort for production and installation of PV systems in the same way as for the other energy carriers. Values are applicable if electricity from distinct PV systems is considered to supply a part of the delivered energy demand of a building.
- Electricity production by CHP systems: According to the German EnEV the produced electricity is considered by a “bonus” in the total primary energy assessment that allocates the complete efficiency gain of CHP to the heat supply system and leaves the efficiency of the electric grid unchanged. The primary energy factor of 2.8 is even higher than the factor of the average grid due to the approach that the electricity produced by CHP is considered to replace a special segment of the German power plants with the mentioned primary energy factors.
  For the values on the right side of the table (“GEMIS + IWU”) a more balanced approach is followed partitioning the efficiency gain equally to the electricity and to the heat sector [Diefenbach 2002] [IWU 2014b] (see also discussion points in the next section).

Table 47: German primary energy and greenhouse gas emission factors

Label / type of factor	**Total Primary Energy Factor**	**Non-Renewable Primary Energy Factor**	**Total Primary Energy Factor GEMIS + IWU**	**Non-Renewable Primary Energy Factor GEMIS + IWU**	**Greenhouse Gas Emissions (CO2 Equivalent) GEMIS + IWU**
used for EPC rating		x			
used for building regulations requirements		x			
Label (national language)	Primärenergiefaktor gesamt nach DIN V 18599-1:2011-12	Primärenergiefaktor nicht-erneuerbar nach DIN V 18599-1:2011-12	kumulierter Energieaufwand gesamt GEMIS	kumulierter Energieaufwand nicht-regenerativer Anteil GEMIS	Treibhausgase (CO2-Äquivalent)
Description / type of weighting factor	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	greenhouse gas emissions expressed in carbon dioxide equivalents; reference period 100 years; includes upstream emissions beyond the national boundary
Factor is multiplied by delivered energy based on the	net calorific value	net calorific value	net calorific value	net calorific value	net calorific value
Reference	[DIN V 18599:2011]	[DIN V 18599:2011]	[IWU 2014c] based on GEMIS version 4.9 + [IWU 2014b] (CHP)	[IWU 2014c] based on GEMIS version 4.9 + [IWU 2014b] (CHP)	[IWU 2014c] based on GEMIS version 4.9 + [IWU 2014b] (CHP)
Unit	[-]	[-]	[-]	[-]	[g/kWh]
Natural gas	1.1	1.1	1.13	1.13	239
Heating oil	1.1	1.1	1.16	1.15	313
Firewood	1.2	0.2	1.01	0.01	11
Wood pellets	1.2	0.2	1.08	0.06	18
Electricity	2.8	2.4 / 1.8 *	2.71	2.19	631
PV System: electricity production	1.0	0.0	1.25 ***	0.23 ***	62 ***
CHP system: electricity export to the grid	2.8	2.8	1.90 **	1.90 **	346 **
District heating	1.3	1.3	1.32	1.08	****
District heating without CHP	1.3	1.3	****	****	****
District heating with 100 % CHP	0.7	0.7	****	****	****

*) deviation of EnEV 2014 from DIN V 18599, starting from January 2016

**) depending on size of CHP engine, here determined for gas-fuelled CHP engine with 50 kW electrical power, see [IWU 2014b]

***) Electricity production PV system: PV electricity is considered as one of the energy carriers. Values are applicable if electricity from distinct PV systems is considered to supply a part of the delivered energy needed by the building; including energy effort for production and installation of the PV system; assumption: polycrystalline cells; standard values for other types: amorphous PV cells: 0.27 (81 g/kWh); monocrystalline PV cells 0.47 (127 g/kWh)

****) not yet determined

Methodological points for discussion in Germany

There are some methodological points for discussion in Germany, especially in the context of produced electricity and assessment of renewables:

- PV electricity production:

  The general approach of the EnEV regulations is to account for the directly used fraction of the produced electricity (bonus identical to the avoided electricity supply by the grid) and to disregard the surplus which is considered as export to the grid.

  However, the concept of the “Effizienzhaus Plus” (“Efficiency House Plus”) promoted by the German government is deducting the total annual energy production from the electricity demand and is setting a surplus (export to the grid) as the criterion for reaching this standard. Since the main energy production is occurring in summer and the main energy demand in winter this it appears doubtful if this approach should be generalised for a NZEB definition.

  Moreover, it can be discussed if the sum of the monthly compensations is not still too optimistic: If PV is considered as a normal “energy saving technology” it should be able to cover the instantaneous energy demand (in a similar way as thermal solar systems) – which would require a consideration of much smaller time steps of compensation than month.

- Combined Heat and Power (CHP):

  According to the DIN/EnEV scheme a primary energy bonus is given for electricity produced by CHP devices which is derived from the average (or incremental efficiency) of the national power plant sector. The concept allocates the energy efficiency gain attained by cogeneration only to the heat production. With this viewpoint the efficiency of the national electricity power supply sector would not be improved by installation of CHP. A further problematic point of the approach is that in some cases it results in Zero or negative primary energy factors for produced electricity (in the EnEV practice negative values are simply cut to Zero). This single-sided allocation is currently discussed among German experts. For the TABULA values a more balanced approach is followed partitioning the efficiency gain equally to the electricity and to the heat sector ([Diefenbach 2002], [IWU 2014b], the latter paper including a comparison and of the different approaches).

- Assessment of biomass:

  The standard assessment in Germany is the non-renewable primary energy. In consequence the use of biomass only contributes to a small extent to the overall energy demand and is in competition to energy saving technologies as insulation or heat recovery. On the other hand biomass is – although renewable – also a very limited resource. In the buildings regulations this is accounted for by a supplemental requirement on the energy quality of the fabric. But the rating of the building by use of non-renewable energy (basis for KfW funding) is not reflecting this point. One suggestion to deal with this question is to use the primary energy factors based on non-renewable energy only up to certain amount of floor area related delivered energy demand (e.g. 30 kWh/(m²a) and to apply the total primary energy factors for the exceeding values [Diefenbach 2002]. Another option would be to set requirements to both – to the non-renewable and to the total primary energy demand [Zirngibl 2014].

- Usage of energy performance calculations for energy-efficient operation of the building:

  A further topic is if and how the energy demand determined by building regulations calculation can be compared with actual measured consumptions during the usage phase. Experiences from pilot projects show that the more complex the technologies for supply of energy efficient buildings are the more difficult it seems to be to achieve a function as desired and thus to attain the targeted consumption values and indoor conditions. So the question arises if the building’s energy balance calculation could be used during the usage of the building to verify adequate operation.

3.5.2 Integration of National Requirements for New Buildings and NZEB Standards in the German Residential Building Typology

A first version of the national residential building typology was developed in 1990 on the basis of energy saving audit reports and was applied during scenario analyses to determine the energy saving potentials of the German building stock [IWU 1990]. The German building typology was regularly updated according to new developments. Also a number of regional building typologies have been developed during the past two decades for German cities or provinces (for more details see [IWU 2012a]). Apart from scenario analyses and energy advice brochures, the regional and national building typologies are also used by a number of software applications as a set of example buildings.

During the TABULA project the differentiated national version of the classification scheme (“building type matrix”) was transformed into the common TABULA concept [IWU 2011]. The datasets of existing buildings were adjusted and transferred to the TABULA data structure [IWU 2012a].

Classification scheme for the German residential building stock (“Building Type Matrix”)

During the IEE Project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current legal requirements (EnEV 2009/2014). Figure 18shows the respective matrix. Three further examples buildings have been identified which are now used for showcase calculations reflecting possible practical implementations of new buildings according to the national minimum requirements and future NZEB standards (Table 48).

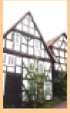
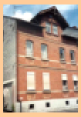
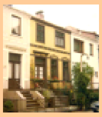
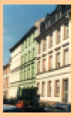
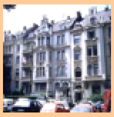
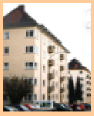
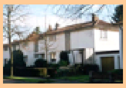
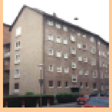
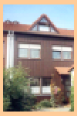
	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	National (nicht regional spezifiziert)	… 1859	Generic (Basis-Typ)	 DE.N.SFH.01.Gen		 DE.N.MFH.01.Gen	
2	National (nicht regional spezifiziert)	1860 … 1918	Generic (Basis-Typ)	 DE.N.SFH.02.Gen	 DE.N.TH.02.Gen	 DE.N.MFH.02.Gen	 DE.N.AB.02.Gen
3	National (nicht regional spezifiziert)	1919 … 1948	Generic (Basis-Typ)	 DE.N.SFH.03.Gen	 DE.N.TH.03.Gen	 DE.N.MFH.03.Gen	 DE.N.AB.03.Gen
4	National (nicht regional spezifiziert)	1949 … 1957	Generic (Basis-Typ)	 DE.N.SFH.04.Gen	 DE.N.TH.04.Gen	 DE.N.MFH.04.Gen	 DE.N.AB.04.Gen
5	National (nicht regional spezifiziert)	1958 … 1968	Generic (Basis-Typ)	 DE.N.SFH.05.Gen	 DE.N.TH.05.Gen	 DE.N.MFH.05.Gen	 DE.N.AB.05.Gen
6	National (nicht regional spezifiziert)	1969 … 1978	Generic (Basis-Typ)	 DE.N.SFH.06.Gen	 DE.N.TH.06.Gen	 DE.N.MFH.06.Gen	 DE.N.AB.06.Gen
7	National (nicht regional spezifiziert)	1979 … 1983	Generic (Basis-Typ)	 DE.N.SFH.07.Gen	 DE.N.TH.07.Gen	 DE.N.MFH.07.Gen	
8	National (nicht regional spezifiziert)	1984 … 1994	Generic (Basis-Typ)	 DE.N.SFH.08.Gen	 DE.N.TH.08.Gen	 DE.N.MFH.08.Gen	
9	National (nicht regional spezifiziert)	1995 … 2001	Generic (Basis-Typ)	 DE.N.SFH.09.Gen	 DE.N.TH.09.Gen	 DE.N.MFH.09.Gen	
10	National (nicht regional spezifiziert)	2002 … 2009	Generic (Basis-Typ)	 DE.N.SFH.10.Gen	 DE.N.TH.10.Gen	 DE.N.MFH.10.Gen	
11	National (nicht regional spezifiziert)	2010 … 2015	Generic (Basis-Typ)	 DE.N.SFH.11.Gen	 DE.N.TH.11.Gen	 DE.N.MFH.11.Gen	
12	National (nicht regional spezifiziert)	2016 …	Generic (Basis-Typ)	 DE.N.SFH.12.Gen	 DE.N.TH.12.Gen	 DE.N.MFH.12.Gen	

Figure 18: Classification scheme ("Building Type Matrix") of the German residential building typology [IWU 2014a], now extended towards new buildings

Table 48: **Exemplary new buildings representing the latest construction year classes (2010 … 2015; 2016 …)**

Building Size Class		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
Picture		 DE.N.SFH.11.Gen	 DE.N.TH.11.Gen	 DE.N.MFH.11.Gen	
Number of dwellings		1	1	17	
Number of full storeys (conditioned)		2	2	4	
Number of directly attached neighbour buildings		0	1	0	
National reference area (Gebäudenutzfläche A_N nach EnEV / synthetical quantity)	m²	265	239	1458	
TABULA reference area (conditioned floor area, internal dimensions)	m²	187	196	1305	

Building example: variants meeting three energy performance levels for new buildings

In the following the exemplary multi-family house is demonstrated in more detail. Comparable information for the other buildings can be found in the updated national typology brochure [IWU 2014a].

Table 49 shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels

4. **“Minimum Requirements”** (“Mindestanforderung EnEV 2009 / 2014”)
   Combination of building and supply system that exactly complies with the current minimum requirements (EnEV 2009 / 2014[22])
5. **“Improved Standard”** (“KfW Effizienzhaus 70”)
   Level of “KfW-Effizienzhaus 70”, the most moderate of the three standards funded by the national grant programme; new requirements EnEV 2016 will almost attain this energy performance level;

“Ambitious Standard / NZEB” (“Niedrigstenergiehaus (KfW Effizienzhaus 40)”)
Level of “KfW-Effizienzhaus 40”, the most ambitious of the three standards funded by the national grant programme. In our examples this is attained by U-values of typical passive houses and a heat supply system with an utmost fraction of renewables.

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[22] The level of requirements has in principle not been altered by EnEV 2014.

Three basic types of heat supply systems have been defined:

- **“Natural Gas“ (Variants 01, 02, 03):**

  Variant 01 is predefined by the reference features of the energy saving ordinance: The U-values as well as the description of the heating system (condensing boiler + thermal solar system for DHW + exhaust ventilation system) have been directly taken from the regulation (exception: natural gas instead of oil).

  Variant 02 consists of the same system but the U-values are considerably lower (heat transfer coefficient by transmission about 45 % lower than Variant 01).

  For **Variant 03** U-values that are typical for passive houses have been defined. For the system a CHP plant and a ventilation system with heat recovery is needed to fulfil the requirements.

- **“Biomass“ (Variants 11, 12, 13):**

  Because of the much lower non-renewable primary energy factor of biomass the U-values of Variant 11 can be higher than in the case of “Natural Gas” (Variant 01). The maximum U-values (second requirement) set by the energy saving ordinance are reached here.

  The U-values of Variant 12 are about 30 % lower than of Variant 11, the system remains the same.

  For Variant 13 passive house U-values are defined. The heat supply is provided by a ventilation system with heat recovery and a Bio-Methan CHP plant. In addition a PV system is installed. This variant corresponds to the actual realisation of this building (see [IWU 2013b]).

- **“Electricity“(Variants 21, 22, 23):**

  The supply system consists in all variants of an electrical heat pump, in case of variant 21 with heat source external air, in both other cases (Variant 22 and 23) with heat source ground. Variant 23 is furthermore equipped with a ventilation system with heat recovery and a PV system. To implement the first supply system variant the fabric has to be a bit more efficient than the reference building. The U-values of the other two variants correspond to those of the supply system type “Biomass”.

Table 49: Exemplary multi-family house (MFH) – definition of variants

 DE.N.MFH.11.Gen ReEx.001		„natural gas“			„biomass“			„electricity“		
Variant N°		**001**	**002**	**003**	**011**	**012**	**013*** **	**021**	**022**	**023**
Variation type		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
Energy Performance Level		EnEV 2009/2014	KfW Effizienz-haus” 70	Niedrigst-energie-haus (KfW Effien-zienzhaus 40)	EnEV 2009/2014	KfW Effizienz-haus” 70	Niedrigst-energie-haus (KfW Effien-zienzhaus 40)	EnEV 2009/2014	KfW Effizienz-haus” 70	Niedrigst-energie-haus (KfW Effien-zienzhaus 40)
U-values										
Roof	W/(m²K)	0.20	0.10	0.08	0.25	0.15	0.08	0.20	0.15	0.08
Wall	W/(m²K)	0.28	0.14	0.12	0.33	0.18	0.12	0.24	0.18	0.12
Window	W/(m²K)	1.30	0.70	0.70	1.30	1.10	0.70	1.30	1.10	0.70
Door	W/(m²K)	1.80	0.80	0.80	1.80	1.30	0.80	1.80	1.30	0.80
Floor	W/(m²K)	0.35	0.18	0.12	0.50	0.25	0.12	0.35	0.25	0.12
Thermal bridging supplement (whole enve-lope)	W/(m²K)	0.05*	0.05*	0.01**	0.05*	0.05*	0.01**	0.05*	0.05*	0.01**
Heat Supply System										
Heat generator		condensing boiler			wood pellets boiler		Bio-Methan CHP	electrical heat pump		
Specification / supplemental system				+CHP				ext. air + buffer storage + electric heating rod	soil	soil
Thermal solar system		DHW	DHW	DHW	-	-	DHW	-	-	-
Distribution system		located completely inside of thermal envelope			located completely inside of thermal envelope			located completely inside of thermal envelope		
Maximum temperature heating distribution		55°C	55°C	55°C	55°C	55°C	55°C	55°C	55°C	35°C
DHW circulation pump		installed	installed	installed	installed	installed	installed	installed	installed	installed
Ventilation system		exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery
Further system		-	-	-	-	-	PV	-	-	PV

status: 10-10-2014

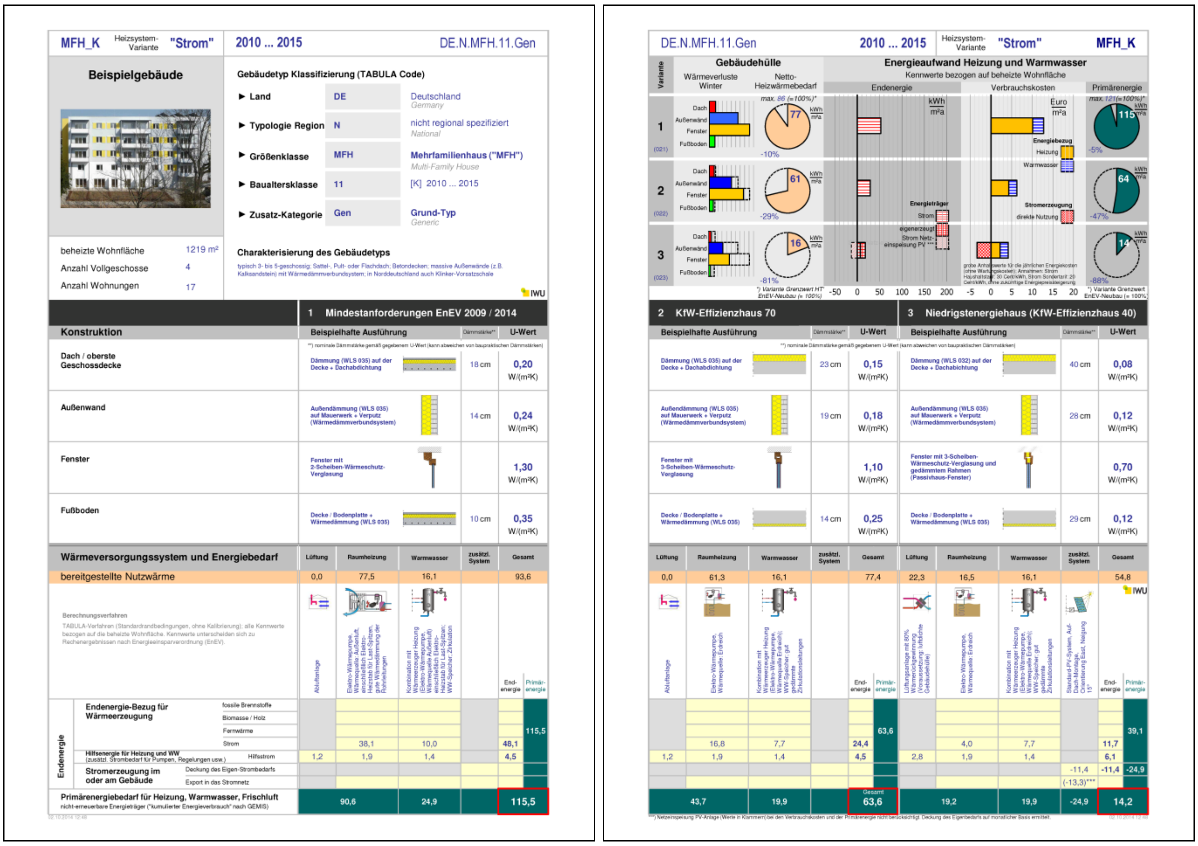
*) Default value of German calculation procedure, if certain conditions are kept

**) Calculated effect of actual thermal bridges according to design drawings, transformed as a supplement on the total envelope area

***) actual implementation of this building, see documentation in [IWU 2013b]

In the new version of the German “Building Typology Brochure” [IWU 2014a] the three variants of the new buildings are displayed on a double page for each supply system type. As an example, a “Building Type Display Sheet” for one supply system type is shown in Figure 19. Starting point for the development were the sheets developed for existing buildings and showcasing possible refurbishment measures [IWU 2014a]. The following changes have been implemented to adapt to the context of new buildings / NZEBs:

- The system definition includes a special row for displaying features of ventilation systems (including values for fan electricity demand and heat gain from the heat recovery).
- Electricity production by PV and CHP is now included in the system definition.
- Also the charts representing delivered energy, primary energy and energy costs have been revised to enable a display of the electricity production.



MFH_K Heizsystem-Variante "Strom" | 2010 ... 2015 | DE.N.MFH.11.Gen

Beispielgebäude

Gebäudetyp Klassifizierung (TABULA Code)

► Land	DE	Deutschland *Germany*
► Typologie Region	N	nicht regional spezifiziert *National*
► Größenklasse	MFH	Mehrfamilienhaus ("MFH") *Multi-Family House*
► Baualtersklasse	11	[K] 2010 ... 2015
► Zusatz-Kategorie	Gen	Grund-Typ *Generic*

beheizte Wohnfläche	1219 m²
Anzahl Vollgeschosse	4
Anzahl Wohnungen	17

Charakterisierung des Gebäudetyps

typisch 3- bis 5-geschossig; Sattel-, Pult- oder Flachdach; Betondecken; massive Außenwände (z.B. Kalksandstein) mit Wärmedämmverbundsystem; in Norddeutschland auch Klinker-Vorsatzschale

IWU

1 Mindestanforderungen EnEV 2009 / 2014

Konstruktion	Beispielhafte Ausführung	Dämmstärke**	U-Wert
Dach / oberste Geschossdecke	Dämmung (WLS 035) auf der Decke + Dachabdichtung	18 cm	0,20 W/(m²K)
Außenwand	Außendämmung (WLS 035) auf Mauerwerk + Verputz (Wärmedämmverbundsystem)	14 cm	0,24 W/(m²K)
Fenster	Fenster mit 2-Scheiben-Wärmeschutz-Verglasung		1,30 W/(m²K)
Fußboden	Decke / Bodenplatte + Wärmedämmung (WLS 035)	10 cm	0,35 W/(m²K)

**) nominale Dämmstärke gemäß gegebenem U-Wert (kann abweichen von baupraktischen Dämmstärken)

Wärmeversorgungssystem und Energiebedarf		Lüftung	Raumheizung	Warmwasser	zusätzl. System	Gesamt End-energie	Gesamt Primär-energie
bereitgestellte Nutzwärme		0,0	77,5	16,1		93,6	
Berechnungsverfahren TABULA-Verfahren (Standardrandbedingungen, ohne Kalibrierung); alle Kennwerte bezogen auf die beheizte Wohnfläche. Kennwerte unterscheiden sich zu Rechenergebnissen nach Energieeinsparverordnung (EnEV).		Abluftanlage	Elektro-Wärmepumpe, Wärmequelle: Außenluft, einschließlich Elektro-Heizstab für Last-Spitzen, gute Wärmedämmung der Rohrleitungen	Kombination mit Wärmeerzeuger Heizung (Elektro-Wärmepumpe, Wärmequelle Außenluft) einschließlich Elektro-Heizstab für Last-Spitzen; WW-Speicher; Zirkulation			
Endenergie – Endenergie-Bezug für Wärmeerzeugung	fossile Brennstoffe						115,5
	Biomasse / Holz						
	Fernwärme						
	Strom		38,1	10,0		48,1	
Hilfsenergie für Heizung und WW (zusätzl. Strombedarf für Pumpen, Regelungen usw.)	Hilfsstrom	1,2	1,9	1,4		4,5	
Stromerzeugung im oder am Gebäude	Deckung des Eigen-Strombedarfs						
	Export in das Stromnetz						
Primärenergiebedarf für Heizung, Warmwasser, Frischluft nicht-erneuerbare Energieträger ("kumulierter Energieverbrauch" nach GEMIS)		90,6		24,9		115,5	

02.10.2014 12:48

DE.N.MFH.11.Gen | 2010 ... 2015 | Heizsystem-Variante "Strom" | MFH_K

2 KfW-Effizienzhaus 70

Beispielhafte Ausführung	Dämmstärke**	U-Wert
Dämmung (WLS 035) auf der Decke + Dachabdichtung	23 cm	0,15 W/(m²K)
Außendämmung (WLS 035) auf Mauerwerk + Verputz (Wärmedämmverbundsystem)	19 cm	0,18 W/(m²K)
Fenster mit 3-Scheiben-Wärmeschutz-Verglasung		1,10 W/(m²K)
Decke / Bodenplatte + Wärmedämmung (WLS 035)	14 cm	0,25 W/(m²K)

3 Niedrigstenergiehaus (KfW-Effizienzhaus 40)

Beispielhafte Ausführung	Dämmstärke**	U-Wert
Dämmung (WLS 032) auf der Decke + Dachabdichtung	40 cm	0,08 W/(m²K)
Außendämmung (WLS 035) auf Mauerwerk + Verputz (Wärmedämmverbundsystem)	28 cm	0,12 W/(m²K)
Fenster mit 3-Scheiben-Wärmeschutz-Verglasung und gedämmtem Rahmen (Passivhaus-Fenster)		0,70 W/(m²K)
Decke / Bodenplatte + Wärmedämmung (WLS 035)	29 cm	0,12 W/(m²K)

**) nominale Dämmstärke gemäß gegebenem U-Wert (kann abweichen von baupraktischen Dämmstärken)

Lüftung	Raumheizung	Warmwasser	zusätzl. System	Gesamt End-energie	Gesamt Primär-energie
0,0	61,3	16,1		77,4	
Abluftanlage	Elektro-Wärmepumpe, Wärmequelle: Erdreich	Kombination mit Wärmeerzeuger Heizung (Elektro-Wärmepumpe, Wärmequelle Erdreich); WW-Speicher; gut gedämmte Zirkulationsleitungen			
					63,6
	16,8	7,7		24,4	
1,2	1,9	1,4		4,5	
43,7		19,9		Gesamt 63,6	

Lüftung	Raumheizung	Warmwasser	zusätzl. System	Gesamt End-energie	Gesamt Primär-energie
22,3	16,5	16,1		54,8	
Lüftungsanlage mit 80% Wärmerückgewinnung (Voraussetzung: luftdichte Gebäudehülle)	Elektro-Wärmepumpe, Wärmequelle: Erdreich	Kombination mit Wärmeerzeuger Heizung (Elektro-Wärmepumpe, Wärmequelle Erdreich); WW-Speicher; gut gedämmte Zirkulationsleitungen	Standard-PV-System, Auf-Dach-Montage, Orientierung East, Neigung 15°		
					39,1
	4,0	7,7		11,7	
2,8	1,9	1,4		6,1	
			-11,4	-11,4	-24,9
			(-13,3)***		
19,2		19,9	-24,9	14,2	

IWU

***) Netzeinspeisung PV-Anlage (Werte in Klammern) bei den Verbrauchskosten und der Primärenergie nicht berücksichtigt. Deckung des Eigenbedarfs auf monatlicher Basis ermittelt.

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Figure 19: “Building Display Sheet” of the exemplary MFH <DE> (further examples in [IWU 2014a])

In Table 50 results of the national EnEV calculation method are displayed. The delivered and primary energy results do not include the PV system since the method has not yet been implemented in the respective software.

Table 50: Exemplary MFH – Results of the energy balance calculation; Procedure: EnEV 2009 / 2014 DIN V 4108-6 + DIN V 4701-10

Label of the variant triplet		**“natural gas”**			**"biomass"**			**"electricity"**		
Variant N°		001	002	003	011	012	013	021	022	023
Variation type		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy performance level		EnEV 2009/2014	KfW Effizienzhaus 70	Niedrigstenergiehaus (KfW Effienzienzhaus 40)	EnEV 2009/2014	KfW Effizienzhaus 70	Niedrigstenergiehaus (KfW Effiezienzhaus 40)	EnEV 2009/2014	KfW Effizienzhaus 70	Niedrigstenergiehaus (KfW Effizienzhaus 40)
Method		EnEV 2009 / DIN V 4108-6 + DIN V 4701-10*								
National reference area**	m^2	1458.4	1458.4	1458.4	1458.4	1458.4	1458.4	1458.4	1458.4	1458.4
Thermal transfer coefficient by transmission. related to envelope area	W/(m^{2}K)	0.453	0.255	0.197	0.500	0.348	0.197	0.431	0.348	0.197
Relation to requirement		91 %	51 %	39 %	100 %	70 %	39 %	86 %	70 %	39 %
Relation to reference standard (criteria for KfW funding)		100 %	56 %	43 %	110 %	77 %	43 %	95 %	77 %	43 %
Gross energy need for heating***	kWh/(m^{2}a)	51.0	31.8	29.4	55.7	40.6	29.4	48.8	40.6	29.4
Delivered energy										
Fossil fuels	kWh/(m^{2}a)	59.7	41.3	7.6	0	0	0	0	0	0
Renewable fuels	kWh/(m^{2}a)	0	0	0	100.9	80.4	19.7	0	0	0
Electricity	kWh/(m^{2}a)	0	0	12.4	0	0	0	25.8	16.0	7.6
Auxiliary energy	kWh/(m^{2}a)	2.0	1.9	3.1	3.4	3.4	3.1	1.8	2.8	4.1
Primary energy demand	kWh/(m^{2}a)	71.0	50.5	25.1	29.1	25.0	8.0	71.6	48.9	30.6****
Relation to requirement		98 %	70 %	35 %	40 %	34 %	11 %	99 %	68 %	(42 %) ****
KfW funding level: "Effizienzhaus …"		-	70	40	-	70	40	-	70	(55)****

*) Calculated by use of EnEV-XL 5.0 (MS Excel workbook), PV system not included status: 10-10-2014

**) “Gebäudenutzfläche A_N nach EnEV” (synthetical quantity)

***) Heat recovery by ventilation systems not considered

****) Effect of PV system not included in the used calculation software. By assuming 20.6 kWh/(m^{2}a) PV electricity production about 8.2 kWh/(m^{2}a) of the building’s electricity demand can be directly covered (“self-use”). The primary energy demand is then reduced from 30.6 to to 10.9 kWh/(m^{2}a). This primary energy demand would be complying with the “KfW Effizienzhaus 40” funding level.

TABULA calculation results for all exemplary buildings

Table 51 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

In January 2016 a tightening of requirements will come into force. The level of energy demand which will be achieved by the recast is displayed in Table 52 (NZEB definition is identical, for more details see [IWU 2014a]).

Table 51: Exemplary new buildings construction year class 2010 … 2015 – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  DE.N.SFH.11.Gen	01	Minimum Requirement	1.04	86	0	86	80	10	22	98	0	0	0	9	0	0	0
	02	Improved Standard	0.88	70	23	48	44	10	20	58	0	0	0	10	0	0	0
	03	Ambitious Standard / NZEB	0.47	44	21	23	20	10	20	31	0	0	0	10	0	0	0
	11	Minimum Requirement	1.09	89	0	89	84	10	22	0	0	0	151	9	0	0	0
	12	Improved Standard	0.88	70	0	70	70	10	20	0	0	0	128	8	0	0	0
	13	Ambitious Standard / NZEB	0.47	44	21	23	20	10	20	0	0	0	40	10	0	0	0
	21	Minimum Requirement	0.96	81	0	81	84	10	22	0	0	0	0	60	0	0	0
	22	Improved Standard	0.88	70	0	70	70	10	20	0	0	0	0	34	0	0	0
	23	Ambitious Standard / NZEB	0.47	44	22	22	22	10	20	0	0	0	0	22	0	0	-28
TH  DE.N.TH.11.Gen	01	Minimum Requirement	0.69	72	0	72	67	10	22	83	0	0	0	9	0	0	0
	02	Improved Standard	0.59	59	24	35	32	10	20	45	0	0	0	10	0	0	0
	03	Ambitious Standard / NZEB	0.32	38	21	17	14	10	20	25	0	0	0	10	0	0	0
	11	Minimum Requirement	0.86	82	0	82	77	10	22	0	0	0	141	9	0	0	0
	12	Improved Standard	0.59	59	0	59	59	10	20	0	0	0	113	8	0	0	0
	13	Ambitious Standard / NZEB	0.32	38	21	17	14	10	20	0	0	0	32	10	0	0	0
	21	Minimum Requirement	0.62	68	0	68	71	10	22	0	0	0	0	54	0	0	0
	22	Improved Standard	0.57	58	0	58	58	10	20	0	0	0	0	31	0	0	0
	23	Ambitious Standard / NZEB	0.32	38	22	16	16	10	20	0	0	0	0	20	0	0	-19
MFH  DE.N.MFH.11.Gen	01	Minimum Requirement	0.74	75	0	75	72	15	22	92	0	0	0	4	0	0	0
	02	Improved Standard	0.42	46	0	46	43	15	22	61	0	0	0	4	0	0	0
	03	Ambitious Standard / NZEB	0.34	36	21	15	14	15	22	29	0	0	0	6	0	0	-5
	11	Minimum Requirement	0.81	80	0	80	77	15	22	0	0	0	126	4	0	0	0
	12	Improved Standard	0.57	57	0	57	54	15	22	0	0	0	97	4	0	0	0
	13	Ambitious Standard / NZEB	0.34	36	21	15	14	15	22	0	0	0	34	6	0	0	-31
	21	Minimum Requirement	0.70	72	0	72	71	15	22	0	0	0	0	49	0	0	0
	22	Improved Standard	0.57	57	0	57	54	15	22	0	0	0	0	27	0	0	0
	23	Ambitious Standard / NZEB	0.34	36	21	15	13	15	22	0	0	0	0	17	0	0	-23

Explanation of Quantities (TABULA Datafields) status: 10-10-2014

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

Table 52: Exemplary new buildings construction year class “from 2016” – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  DE.N.SFH.12.Gen	01	Minimum Requirement	0.76	72	0	72	68	10	20	84	0	0	0	8	0	0	0
	02	Improved Standard	0.73	63	23	40	37	10	20	50	0	0	0	10	0	0	0
	03	Ambitious Standard / NZEB	0.47	44	21	23	20	10	20	31	0	0	0	10	0	0	0
	11	Minimum Requirement	1.04	86	0	86	85	10	20	0	0	0	149	8	0	0	0
	12	Improved Standard	0.73	63	0	63	63	10	20	0	0	0	119	8	0	0	0
	13	Ambitious Standard / NZEB	0.47	44	21	23	20	10	20	0	0	0	40	10	0	0	0
	21	Minimum Requirement	1.04	88	0	88	87	10	20	0	0	0	0	39	0	0	0
	22	Improved Standard	0.73	63	0	63	63	10	20	0	0	0	0	32	0	0	0
	23	Ambitious Standard / NZEB	0.47	44	22	22	22	10	20	0	0	0	0	22	0	0	-28
TH  DE.N.TH.12.Gen	01	Minimum Requirement	0.49	61	0	61	57	10	20	71	0	0	0	8	0	0	0
	02	Improved Standard	0.49	54	24	30	27	10	20	39	0	0	0	10	0	0	0
	03	Ambitious Standard / NZEB	0.32	38	21	17	14	10	20	25	0	0	0	10	0	0	0
	11	Minimum Requirement	0.69	73	0	73	72	10	20	0	0	0	131	8	0	0	0
	12	Improved Standard	0.49	54	0	54	53	10	20	0	0	0	105	8	0	0	0
	13	Ambitious Standard / NZEB	0.32	38	21	17	14	10	20	0	0	0	32	10	0	0	0
	21	Minimum Requirement	0.69	74	0	74	73	10	20	0	0	0	0	35	0	0	0
	22	Improved Standard	0.49	54	0	54	53	10	20	0	0	0	0	29	0	0	0
	23	Ambitious Standard / NZEB	0.32	38	22	16	16	10	20	0	0	0	0	20	0	0	-19
MFH  DE.N.MFH.12.Gen	01	Minimum Requirement	0.70	74	29	45	43	15	22	61	0	0	0	6	0	0	0
	02	Improved Standard	0.48	50	24	27	24	15	22	41	0	0	0	6	0	0	0
	03	Ambitious Standard / NZEB	0.34	36	21	15	14	15	22	29	0	0	0	6	0	0	-5
	11	Minimum Requirement	0.74	75	0	75	72	15	22	0	0	0	119	4	0	0	0
	12	Improved Standard	0.52	54	0	54	50	15	22	0	0	0	92	4	0	0	0
	13	Ambitious Standard / NZEB	0.34	36	21	15	14	15	22	0	0	0	34	6	0	0	-31
	21	Minimum Requirement	0.74	77	0	77	73	15	22	0	0	0	0	33	0	0	0
	22	Improved Standard	0.52	54	0	54	50	15	22	0	0	0	0	26	0	0	0
	23	Ambitious Standard / NZEB	0.34	36	21	15	13	15	22	0	0	0	0	17	0	0	-23

Explanation of Quantities (TABULA Datafields) status: 10-10-2014

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.5.3 Sources / References Germany

Table 53: Sources / References Germany

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[BMVI 2014]	Bundesministerium für Verkehr und digitale Infrastruktur (BMVI) (Hrsg.): Modellprojekte im Effizienzhaus Plus Standard. Berlin, 2014, http://www.bmvi.de/DE/EffizienzhausPlus/Foerderprogramm/effizienzhaus-plus-foerderprogramm_node.html	Description oft he funding programme and building performance level „Effizienzhaus Plus“
[BPIE / IWU 2013]	Enseling, Andreas; Loga, Tobias: Implementing the cost-optimal methodology in EU countries - Case Study Germany; editor: BPIE, Brussels / Belgium 2013	Exemplary analyses of the total costs of new buildings in dependence of the energy performance level
[Diefenbach 2002]	Diefenbach, Nikolaus: Bewertung der Wärmeerzeugung in KWK-Anlagen und Biomasse-Heizsystemen, Institut Wohnen und Umwelt, Darmstadt 2002	Discussion of an alternative approach for assessing the non-renewable primary energy demand of buildings, supplied by CHP and biomass systems in Germany
[DIN V 18599]	Deutsches Institut für Normung (DIN): DIN V 18599 – „Energetische Bewertung von Gebäuden“; 2011-12	German standard; scheme for calculation of the energy need for heating; basis for EPC calculation (non-residential and residential buildings)
[DIN V 4108-6 / 4701-10]	Deutsches Institut für Normung (DIN): DIN V 4108-6 – „Berechnung des Jahresheizwärme- und des Jahresheizenergiebedarfs“; 2003-06, geändert durch Berichtigung 1 2004-03.	German standard; scheme for calculation of the energy need for heating; basis for EPC calculation (residential buildings)
[EnEG 2013]	Energieeinsparungsgesetz (EnEG) in der Fassung der Bekanntmachung vom 1. September 2005 (BGBl. I S. 2684), das zuletzt durch Artikel 1 des Gesetzes vom 4. Juli 2013 (BGBl. I S. 2197) geändert worden ist http://www.gesetze-im-internet.de/bundesrecht/eneg/gesamt.pdf	German Energy Saving Act
[Feist 2003]	Feist, Wolfgang: Das Passivhaus: Die Optimierung energiebewusster Bauweisen. VDE Verlag (Germany), 2003	Overview of passive house principles, experiences from the first demonstration buildings
[Feist 2007]	Feist, Wolfgang: Passive House Standard – A Proven Energy Saver; Passive House Institute, Darmstadt / Germany 2007; webarticle at: http://www.passivhaustagung.de/Passive_House_E/Passivehouse_measured_consumption.html	Overview of measured consumption values in terraced housing estates in Germany, constructed according to the passive house concept
[Fingerling 1996]	Fingerling, Anne: Eine Geschichte der Niedrigenergiehäuser bis zum Passivhaus; IWU, Darmstadt 1996 http://www.iwu.de/fileadmin/user_upload/dateien/energie/neh_ph/IWU_1996_Fingerling_Eine-Geschichte-der-Niedigenergiehaeuser-bis-zum-Passivhaus.pdf	History of the development of low energy buildings in Germany towards passive houses
[GEMIS]	IINAS - International Institute for Sustainability Analysis and Strategy (ed.): GEMIS - Global Emissions Model for integrated Systems: http://www.iinas.org/gemis.html for publications see: http://www.iinas.org/gemis-docs-en.html	GEMIS (Global Emissions Model for integrated Systems), a public domain life-cycle and material flow analysis model and database
[iPHA]	„International Passive House Association (iPHA)“; information at the homepage: http://www.passivehouse-international.org/index.php?page_id=79	Current overview of the status of passive house spread in Germany and other countries, in English language
[IWU 1990]	Ebel, Witta; Eicke, Werner; Feist, Wolfgang; Hildebrandt, Olaf; Hilpert, Hans-Peter; Klien, Jobst; Kröning, Wolfgang; Schmidt, Hemlut.; Siepe, Benedikt; Wullkopf, Uwe.: Energiesparpotential im Gebäudebestand; IWU, Darmstadt 1990	Model of the German residential building stock; energy saving potentials; scenario calculations;

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[IWU 1997]	Loga, Tobias; Imkeller-Benjes, Ulrich: Energie-Paß Heizung/Warmwasser. Energetische Qualität von Baukörper und Heizungssystem; IWU, Darmstadt 1997	Procedure for the calculation of the primary energy demand of buildings
[IWU 2003]	Institut Wohnen und Umwelt (Hrsg.): Deutsche Gebäudetypologie – Systematik und Datensätze; IWU, Darmstadt 2003 http://www.iwu.de/fileadmin/user_upload/dateien/energie/klima_altbau/Gebaeudetypologie_Deutschland.pdf	Publication of Datasets of exemplary buildings from the German Residential Buildings Typology
[IWU 2011]	Loga, Tobias; Diefenbach, Nikolaus; Born, Rolf: Deutsche Gebäudetypologie. Beispielhafte Maßnahmen zur Verbesserung der Energieeffizienz von typischen Wohngebäuden; Institut Wohnen und Umwelt (IWU), Darmstadt 2011 http://www.building-typology.eu/downloads/public/docs/brochure/DE_TABULA_TypologyBrochure_IWU.pdf	National typology brochure Germany, developed during the IEE Project TABULA
[IWU 2013a]	Diefenbach, Nikolaus; v. Malottki, Christian; Enseling, Andreas; Loga, Tobias; Cischinsky, Holger; Stein, Britta; Hörner, Michael; Grafe, Michael: Maßnahmen zur Umsetzung der Ziele des Energiekonzepts im Gebäudebereich – Zielerreichungsszenario. Studie im Auftrag des Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS): BMVBS-Online-Publikation 03/2013.	Calculation of scenarios for the German Building Stock
[IWU 2013b]	Schaede, Margrit; Großklos, Marc: Passivhäuser mit Energiegewinn – Begleitung des Projektes Cordierstraße 2-6 in Frankfurt am Main; IWU, Darmstadt/Germany 2013	Realisation of an apartment building as “passive house with energy gain”, description of the optimisation of construction and supply system details; discussion of the energy balance calculation
[IWU 2013c]	Diefenbach, Nikolaus; Stein, Britta; Loga, Tobias; Rodenfels, Markus (IWU); Gabriel, Jürgen; Fette, Max (Fraunhofer IFAM): Gutachten Monitoring der KfW-Programme „Energieeffizient Sanieren“ und „Energieeffizient Bauen“ 2012; im Auftrag der KfW-Bankengruppe; Institut Wohnen und Umwelt, Darmstadt / Germany 2013 http://www.iwu.de/fileadmin/user_upload/dateien/energie/KfW_Monitoringbericht_fuer_2012.pdf	Evaluation of the national grant programme of the KfW Bank for the year 2012; a short English description of the funding scheme can be found at: https://www.kfw.de/Download-Center/Konzernthemen/Nachhaltigkeit/englisch/Sustainability-Report-2012-1.pdf
[IWU 2012a]	Loga, Tobias; Diefenbach, Nikolaus; Stein, Britta; Born, Rolf: TABULA - Scientific Report Germany. Further Development of the National Residential Building Typology; IWU - Institut Wohnen und Umwelt; Darmstadt / Germany; October 2012 http://www.building-typology.eu/downloads/public/docs/scientific/DE_TABULA_ScientificReport_IWU.pdf	Description of the revision and further development of the national residential building typology Germany
[IWU 2012b]	Enseling, Andreas; Diefenbach, Nikolaus; Hinz, Eberhard; Loga, Tobias: Evaluierung und Fortentwicklung der EnEV 2009: Untersuchung zu ökonomischen Rahmenbedingungen im Wohnungsbau. Studie im Auftrag des Bundesinstituts für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR); BMVBS (Hrsg.), Berlin 2012	Analysis of the economic conditions for new buildings and refurbishments in dependence of the energy performance level; evaluation of the requirements of the German energy saving ordinance 2009 and of the consequences of a possible tightening
[IWU 2014a]	Loga, Tobias; Stein, Britta; Diefenbach, Nikolaus; Born, Rolf: Deutsche Gebäudetypologie. Beispielhafte Maßnahmen zur Verbesserung der Effizienz von typischen Wohngebäuden; second edition, IWU, Darmstadt / Germany, draft version October 2014, previously unreleased	German typology brochure, second edition 2014
[IWU 2014b]	Hörner, Michael: Vorschlag zur Neuregelung der Brennstoff-Allokation bei der Kraft-Wärme-Kopplung; IWU, Darmstadt / Germany 2014, previously unreleased	Proposal for a new concept of fuel allocation for combined heat and power (CHP) plants

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[IWU 2014c]	Großklos, Marc: Kumulierter Energieaufwand und CO_2-Emissionsfaktoren verschiedener Energieträger und –versorgungen . IWU, Darmstadt / Germany 28.07.2014: http://www.iwu.de/fileadmin/user_upload/dateien/energie/werkzeuge/kea.pdf	Publication containing cumulated energy demand and CO_2 emission factors for different energy carriers and supply systems
[Schettler-Köhler / Kunkel 2012]	Schettler-Köhler, Horst-P.; Kunkel, Sara: EPBD implementation in Germany – Status at the end of 2012; report included in the book “Implementing the Energy Performance of Buildings Directive (EPBD)”; ADENE / Portugal 2013 http://www.buildup.eu/sites/default/files/content/CA3-National-2012-Germany-ei.pdf	Overview of the status of EPBD implementation in Germany (end 2012)
[Zirngibl 2014]	Zirngibl, Johann: Nearly Zero Energy Buildings (NZEB) in the CEN draft standard; REHVA Journal – May 2014 http://www.rehva.eu/publications-and-resources/hvac-journal/2014/032014/nearly-zero-energy-buildings-NZEB-in-cen-draft-standard/	Overview on the CEN approach for assessing NZEBs

3.6 <DK> Denmark

(by EPISCOPE partner SBi)

The Danish EPISCOPE building typology comprises residential buildings (detached single family houses; terraced houses; and blocks of flats) divided into typical age categories each reflecting a change in building tradition or a change in building energy requirements stated in the different Danish building codes. The first nation-wide building energy requirements were introduced in the Danish building regulations 1961, and they have been tightened several times since then.

Table 54: Identified typical building periods in the Danish EPISCOPE building typology.

Period of construction	Comment
Before 1850	Solid walls
1851–1930	Shift in building tradition
1931–1950	Cavity walls introduced
1951–1960	Insulated cavity walls introduced
1961–1972	First energy requirements in BR61[a)]
1973–1978	Tightened energy requirements in BR72[a)]
1979–1998	Tightened energy requirements in BR78[a)]
1999–2006	Tightened energy requirements in BR98[a)]
2007–2010	Tightened energy requirements in BR06/08[a)]
2010-2015	Tightened energy requirements in BR2010[a)]
2015-2020	Tightened energy requirements in BR2015[b)]
After 2020	Tightened energy requirements in BR2020 (NZEB)[b)]

[a)] BR is a reference to the Danish Building Regulations and the following digits refer to the year when the BR came into force.
[b)] Indicates the expected years for future Danish Building Regulations that will come into force.

In the Danish 2010 Building Regulations, there are projections for planned tightening of the building energy requirements that are expected to come into force in 2015 and 2020. The planned 2020 building energy requirements reflect the Danish nearly zero energy building (NZEB) building energy performance requirement. Currently the maximum consumption of primary energy for a residential building that complies with the 2020 requirements is 20 kWh/m² per year, covering heating, domestic hot water, ventilation, electricity for operating the building (fans, pumps, etc.) and potential penalty for overheating (calculated as the amount of electricity converted to primary energy, used in an imaginary mechanical cooling system with an average COP of 3, to bring down the indoor temperature to 26 °C). For non-residential buildings the limit for primary energy consumption is 25 kWh/m² per year, which in addition to the above also includes electricity for artificial lighting.

3.6.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Denmark

This section presents an outline for the transposition and implementation of the EPBD (Energy Performance of Buildings Directive) Energy Performance (EP) requirements in Denmark. It also describes the future transition to the cost-optimal EP requirements, as well as the action plan for progression to NZEB by 2020.

Table 55 **Development of energy performance requirements (kWh primary energy per m^2 of heated gross floor area per year) for typically sized residential and non-residential buildings in Denmark.**

kWh/m² per year	2006	2010	2015	2020
Residential, 150 m² heated gross floor area	84.7	63.0	36.7	20
Non-residential, 1000 m² heated gross floor area	97.2	73.0	42.0	25

Minimum requirements for new residential buildings in Denmark

The EP requirements for new buildings were implemented in their current form, i.e., the EP calculation method, in 2006, after the implementation of the first EPBD. These requirements included forecasts for the tightening of the EP requirements in 2010 and 2015 — approximately 25 % compared with the 2006 requirements in each step. In 2009, the requirements were revised, and the EP requirements for new buildings were tightened by 25 % in the Danish Building Regulations 2010 (BR10). In the 2010 revision, no forecast for the 2020 EP requirements was included, but the building industry requested this forecast. This led to a process of cost analysis for establishing the different levels of EP requirements. The outcome was the forecast for the EP requirements for new buildings in 2020 — i.e., the Danish NZEB definition.

For existing buildings, the requirements were initially implemented according to the definition of the 25 % rule stated in the EPBD (though no area threshold was implemented), in combination with component requirements. According to the previous Danish Building Regulation, all cost-effective measures had to be implemented if more than 25 % of the building envelope or the value of the building were affected in a renovation project. However, studies regarding the impact of this rule on the implementation of energy saving measures showed that the rule was a hindrance to energy savings. It was thus decided to increase the uptake of energy saving measures in the existing building stock, by implementing more strict requirements for the replacement or renovation of the individual building components. The BR10 includes a list of minimum requirements; most of these are considered economically profitable under normal conditions. However, the requirements for the replacement of windows must be fulfilled without consideration of the economic aspects.

New buildings

The existing BR10 sets the minimum energy requirements for all types of new buildings. These requirements relate to the energy frame and the envelope of the building. In addition to the minimum requirements, BR10 also sets the requirements for two voluntary low energy classes: Low-energy Class 2015 and Building Class 2020. These two classes are expected to be introduced as the minimum requirements by 2015 and 2020, respectively.

The energy frame is the maximum allowed primary energy demand for a building, including e.g., thermal bridges, solar gains, ventilation, heat recovery, cooling, lighting (non-residential buildings only), boiler and heat pump efficiency, electricity for operating the building, and potential sanctions for overheating. The overheating sanction is calculated on a fictive energy use, equal to the energy needed in an imaginary mechanical cooling system in order to keep the indoor temperature at 26 °C. This additional energy use is included in the calculated overall energy consumption of the building.

The energy frame for the primary energy demand in new buildings has been tightened by 25 % compared with the 2006 baseline. Low-energy Class 2015 introduces a 50 % tightening compared with the 2006 baseline, and Building Class 2020 further tightens the energy frame by 25 %, thereby reducing the allowed energy frame by 75 % compared with the 2006 baseline.

The building code also sets requirements for calculating the design transmission heat loss for the opaque part of the building envelope for new buildings (it fixes the temperature differential indoors-outdoors at 32 ºC), as well as the minimum requirements for components and installations. The minimum component requirements are primarily intended to eliminate the risk of mould growth due to cold surfaces. It is not possible to construct a building, meeting the energy frame solely by fulfilling the minimum component requirements. Both sets of requirements work in parallel with the requirements for the energy frame, and are set in order to avoid having new dwellings and/or building components and installations with a high level of renewable energy but poor insulation. A Building Class 2020 building must be constructed so that the designed transmission loss does not exceed 3.7 W/m² of the building envelope in the case of single-storey buildings, 4.7 W/m² for two-storey buildings and 5.7 W/m² for buildings with three storeys or more. Table 56 shows the maximum allowed dimensioning transmission heat loss through the opaque building envelope. This requirement was introduced with the implementation of the EPBD in Denmark.

The BR10 minimum energy frame requirement is:

- 52.5 + 1,650 / A [kWh/m^2.year] for residential buildings, and
- 71.3 + 1,650 / A [kWh/m^2.year] for non-residential buildings,

where A is the heated gross floor area.

The energy frame for the voluntary Low-energy Class 2015 is:

- 30 + 1,000 / A [kWh/m^2.year] for residential buildings, and
- 41 + 1,000 / A [kWh/m^2.year] for non-residential buildings.

The energy frame for the voluntary Building Class 2020 (NZEB) is:

- 20 / A [kWh/m^2.year] for residential buildings, and
- 25 / A [kWh/m^2.year] for non-residential buildings.

Table 56 Maximum allowed design (outdoor temperature = -12 °C) transmission heat loss through the opaque part of the building envelope (W/m²).

Floors	2006	BR10	LE2015	BC2020
1	6	5	4	3.7
2	7	6	5	4.7
2+	8	7	6	5.7

In addition to the energy performance requirements, an indoor climate requirement for residential buildings that comply with the Low-energy class 2015 or Building class 2020 requirements has been introduced. The room in a residential building that has the highest internal loads must not show indoor room temperatures above 26 °C for more than 100 hours per year and not above 27 °C for more than 25 hours per year. The number of hours with high room temperatures in residential buildings can be calculated in the national energy performance compliance checking tool, Be10. For other building types, dynamic simulation tools are required for proof of compliance with the thermal indoor climate requirements.

Danish calculation method to comply with new building regulations for residential buildings

The calculation procedure in the BR10 has been updated according to the new requirements, and is described in the SBi Direction 213: Energy demand in buildings[23]. The procedure follows the relevant CEN standards to great extent. This publication also includes the updated PC calculation program Be10. The calculation core of this program is to be used by all other programs for compliance checks and energy certification, to ensure the identical calculation of the EP of buildings. Compared with the previous calculation procedure, Be06, the new procedure has been updated with respect to:

- New energy frames and energy requirements given in BR10;
- Low-energy Class 2015 and Building Class 2020, including new district heating factors (conversion to primary energy);
- New energy frame for buildings heated to 5-15 °C;
- Multiple tanks for Domestic Hot Water (DHW);
- Improved calculation of cooling demand;
- Multiple heat pumps in the same building/zone;
- Multiple solar cell (photovoltaic) systems;
- Calculation of the electricity production by on-site wind turbines.
- New principle for deduction of electricity from PV and wind turbines.

Status of NZEB definition for residential buildings in Denmark

The Danish NZEB definition is implemented in the current Danish Building Regulations BR10 as predictions for tightening of the energy performance requirements in 2020, and has been described in the section above.

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[23] In Danish at: www.anvisninger.dk - requires license for download

Table 57: **Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the NZEB definition in Denmark**

Calculation Method New Building Regulations – (part 1)

Country	DK	Denmark	Status	08/2014

National Requirements for New Residential Buildings

Legislation / Standards

Danish Building Regulations 2010 [BR10]

Explanation / Comments

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Month

Explanation / Comments

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

On-Site Electricity Production		Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
	On-site CHP				
x	On-site PV	x	x	month	H-C-W
	Other energy generation systems:				
x	Wind turbines	x	x	month	H-C-W

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Feed in tariff for selling electricity produced by PV or wind turbines to the grid is being balanced hourly, but in the calculations a monthly balancing period is being used.

Special Aspects with regard to the National NZEB Definition

The NZEB definition has been implemented in the Danish Building Regulations 2010 as a voluntary building class and a projection for the minimum requirements from 2020.

Proof of compliance with the Building Class 2020 is done in the same tool as is being used for proof of compliance with the current minimum requirements.

Table 57 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>Country</td><td>DK</td><td colspan="3">Denmark</td><td>Status</td><td>08/2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the National NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6">The primary energy factors change from the current minimum requirements to the NZEB level. For district heating the primary energy factor drops from 1 to 0.6 and for electricity it drops from 2.5 to 1.8. This is done to take into account the increasing share of renewable energy in the national energy grid. It is estimated that there will be a renewable energy share in the national energy grids in 2020 of at least 50%, and this is why there is no required renewable energy share in the 2020 requirements.
For other buildings than residential buildings, it is possible to obtain an extension of the energy frame to cover special processes going on in the building, i.e. long weekly hours of operation, special needs for high ventilation rates or artificial lighting, high room heights, large number of people in the building, large consumption of hot water. The extension is being calculated with a sign and can thus be negative if the special processes contribute in a positive way to the energy consumption of the building.
The room that has the highest internal loads must not show indoor room temperatures above 26 °C for more than 100 hours per year and not above 27 °C for more than 25 hours per year.</td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2">x</td><td rowspan="2">Primary energy</td><td rowspan="2">Agreed weighting factor</td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>Summer temperatures</td></tr>
<tr><td colspan="5">Explanation / Comments
The requirements for U-values are primarily set to prevent constructions from having a too low inside surface temperature and provide a breeding ground for fungus.
Requirement for the overall heat transfer coefficient by transmission is set to hinder the making of a poorly insulated building with a lot of renewable energy to balance the energy need for heating.</td></tr>
</table>

Assessment of energy carriers in Denmark

Table 58: Danish primary energy factors

Label / type of factor	Primary Energy Factor Danish Building Regulations 2010
used for EPC rating	x
used for building regulations requirements	x
Label (national language)	Energimærke
Description / type of weighting factor	agreed weighting factors1)
Factor is multiplied by delivered energy based on the	H_s (gross calorific value)
Reference	[BR10]
Natural gas	1
Heating oil	1
Firewood	1
Wood pellets	1
Electricity	2.5 / 1.82)
Electricity production CHP	2.5 / 1.82)
Electricity production PV system	2.5 / 1.82)
District heating	1.0 / 0.62)
District heating without CHP	1.0 / 0.62)
District heating with 100 % CHP	1.0 / 0.62)

1) The factors are rather a political decision, based on averages and wishes for promoting certain technologies than measuring energy produced in a chemical reaction.

2) The Primary energy factors for district heating and electricity in Denmark change over time and today buildings that comply with the low energy class 2015 or the building class 2020 use the future primary energy factors. The primary for district heating is an average for all Danish district heating systems and is fixed to 1.0 for buildings that comply with the 2010 requirements, 0.8 for buildings that comply with the 2015 requirements, and 0.6 for buildings that comply with the 2020 requirements. The primary energy factor for electricity is 2.5 for buildings that comply with the 2010 and 2015 requirements and is 1.8 for buildings that comply with the 2020 requirements.

Methodological points for discussion in Denmark

Electricity from combined heat and power in individual buildings is not considered a contribution which is acknowledged in the energy performance of the building.

Production of electricity from PV systems and local wind turbines must be at the building, the building site or located nearby on a site that is connected to the building in legally binding agreement (it is e.g. not legal to sell the wind turbine located near by after having constructed the building). This electricity production can be deducted from that part of the overall electricity need of the building which is covered by the regulation in the Danish Building Regulations, i.e. electricity for pumps, fans, input to heat pumps and – in non-residential buildings – electricity for artificial lighting. The balancing period in the calculations is monthly, while the economic balancing period towards the electricity grid is instantaneous. For private households, the feed-in tariff for selling electricity to the grid is currently less than 1/3 of the total price for buying electricity.

Biomass is considered a scarce energy source in Denmark and has no special benefit in the Danish energy performance calculations and has been assigned a primary energy factor of 1.0. In reality, this means that building energy saving measures in buildings heated by biomass is equally feasible as in buildings heated by fossil fuels.

District heating and ground or air source heat pumps are considered the only acceptable heating energy sources in the future Danish energy landscape. It is expected that replacement of existing oil- or gas-burners will be limited to one of the above sources in the near future.

3.6.2 Integration of National Requirements for New Buildings and NZEB Standards in the Danish Residential Building Typology

Houses that comply with the expected Danish 2020 (NZEB) requirements already exist and real example houses have been implemented in the Danish building typologies. The number of houses is still limited, and it has thus not been possible to establish typologies of the average house.

Classification scheme for the Danish residential building stock (“Building Type Matrix”)

Building Type Matrix

	Region	Construction Year Class	Additional Classification	Denmark SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Hele Denmark)	… 1850	Generic (Standard)	DK.N.SFH.01.Gen	DK.N.TH.01.Gen		DK.N.AB.01.Gen
2	national (Hele Denmark)	1851 … 1930	Generic (Standard)	DK.N.SFH.02.Gen	DK.N.TH.02.Gen		DK.N.AB.02.Gen
3	national (Hele Denmark)	1931 … 1950	Generic (Standard)	DK.N.SFH.03.Gen	DK.N.TH.03.Gen		DK.N.AB.03.Gen
4	national (Hele Denmark)	1951 … 1960	Generic (Standard)	DK.N.SFH.04.Gen	DK.N.TH.04.Gen		DK.N.AB.04.Gen
5	national (Hele Denmark)	1961 … 1972	Generic (Standard)	DK.N.SFH.05.Gen	DK.N.TH.05.Gen		DK.N.AB.05.Gen
6	national (Hele Denmark)	1973 … 1978	Generic (Standard)	DK.N.SFH.06.Gen	DK.N.TH.06.Gen		DK.N.AB.06.Gen
7	national (Hele Denmark)	1979 … 1998	Generic (Standard)	DK.N.SFH.07.Gen	DK.N.TH.07.Gen		DK.N.AB.07.Gen
8	national (Hele Denmark)	1999 … 2006	Generic (Standard)	DK.N.SFH.08.Gen	DK.N.TH.08.Gen		DK.N.AB.08.Gen
9	national (Hele Denmark)	2007 … 2010	Generic (Standard)	DK.N.SFH.09.Gen	DK.N.TH.09.Gen		DK.N.AB.09.Gen
10	national (Hele Denmark)	2011 …	Generic (Standard)	DK.N.SFH.10.Gen	DK.N.TH.10.Gen		DK.N.AB.10.Gen

Figure 20: Classification scheme ("Building Type Matrix") of the Danish residential building typology, now extended towards new buildings

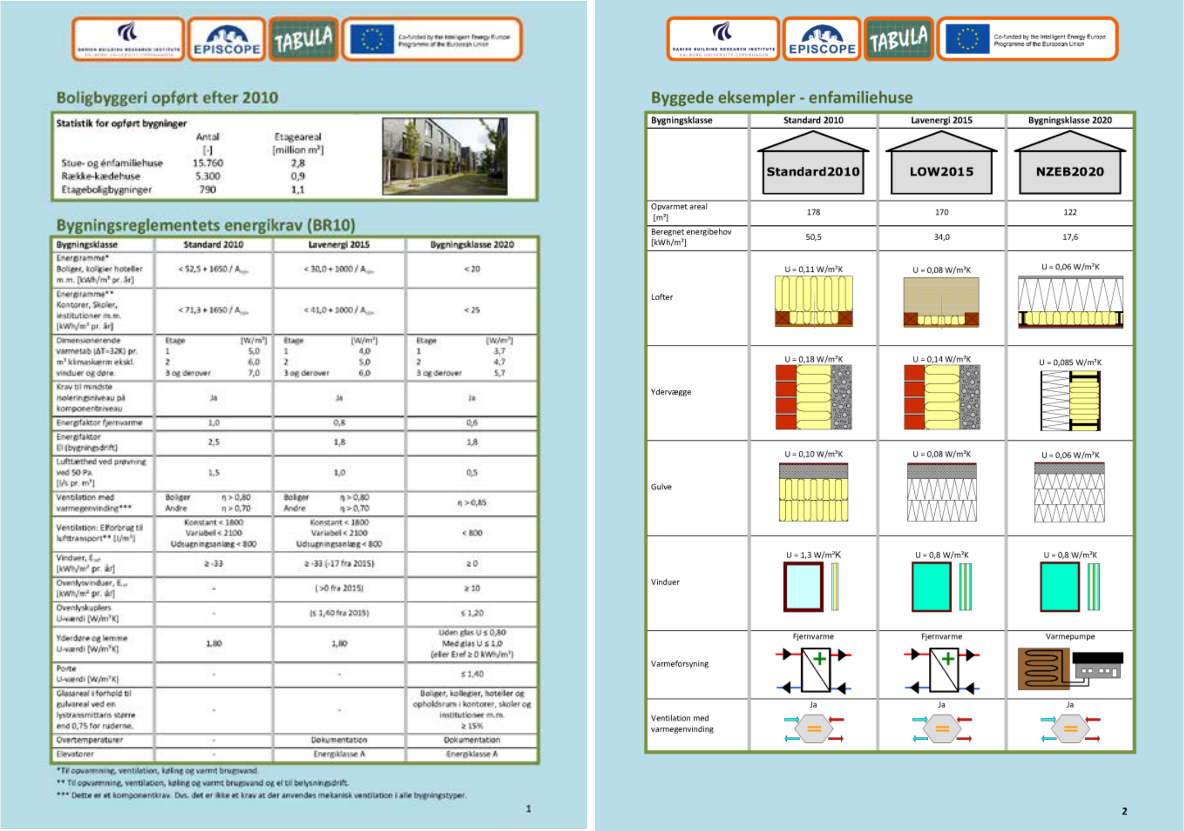
Table 59: Exemplary new buildings representing the latest construction year classes (2011 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
				-	
Number of dwellings		1	1	-	72
Number of full storeys (conditioned)		1	2	-	8
Number of directly attached neighbour buildings		0	1	-	0
National reference area (heated gross floor area based on external dimension)	m²	178	155		8221
TABULA reference area (conditioned floor area, internal dimensions)	m²	151	132	-	6988

Building example: variants meeting three energy performance levels for new buildings

Table 60: Exemplary single family house (SFH) – definition of variants

Label of the variant triplet		"SFH"		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values				
Roof	W/(m²K)	0.11	0.08	0.06
Wall	W/(m²K)	0.18	0.14	0.085
Window	W/(m²K)	1.3	0.8	0.8
Floor	W/(m²K)	0.10	0.08	0.06
Thermal bridging supplement (TABULA definition)		Very low (0.02 W/(m²K))	Very low (0.02 W/(m²K))	Minimal (0 W/(m²K))
Heat Supply System				
Heat generator				
Specification / Supplemental system		District Heating	District Heating	Heat Pump
Ventilation system		Heat recovery	Heat recovery	Heat recovery
Thermal solar system		No	No	No



Boligbyggeri opført efter 2010

Statistik for opført bygninger

	Antal [-]	Etageareal [million m²]
Stue- og énfamiliehuse	15.760	2,8
Række-kædehuse	5.300	0,9
Etageboligbygninger	790	1,1

Bygningsreglementets energikrav (BR10)

Bygningsklasse	Standard 2010	Lavenergi 2015	Bygningsklasse 2020
Energiramme* Boliger, kollgier hoteller m.m. [kWh/m² pr. år]	< 52,5 + 1650 / A_{opv}	< 30,0 + 1000 / A_{opv}	< 20
Energiramme** Kontorer, Skoler, institutioner m.m. [kWh/m² pr. år]	< 71,3 + 1650 / A_{opv}	< 41,0 + 1000 / A_{opv}	< 25
Dimensionerende varmetab (ΔT=32K) pr. m² klimaskærm ekskl. vinduer og døre.	Etage [W/m²] 1 5,0 2 6,0 3 og derover 7,0	Etage [W/m²] 1 4,0 2 5,0 3 og derover 6,0	Etage [W/m²] 1 3,7 2 4,7 3 og derover 5,7
Krav til mindste isoleringsniveau på komponentniveau	Ja	Ja	Ja
Energifaktor fjernvarme	1,0	0,8	0,6
Energifaktor El (bygningsdrift)	2,5	1,8	1,8
Lufttæthed ved prøvning ved 50 Pa. [l/s pr. m²]	1,5	1,0	0,5
Ventilation med varmegenvinding***	Boliger η > 0,80 Andre η > 0,70	Boliger η > 0,80 Andre η > 0,70	η > 0,85
Ventilation: Elforbrug til lufttransport** [J/m³]	Konstant < 1800 Variabel < 2100 Udsugningsanlæg < 800	Konstant < 1800 Variabel < 2100 Udsugningsanlæg < 800	< 800
Vinduer, E_{ref} [kWh/m² pr. år]	≥ -33	≥ -33 (-17 fra 2015)	≥ 0
Ovenlysvinduer, E_{ref} [kWh/m² pr. år]	-	(>0 fra 2015)	≥ 10
Ovenlyskuplers U-værdi [W/m²K]	-	(≤ 1,40 fra 2015)	≤ 1,20
Yderdøre og lemme U-værdi [W/m²K]	1,80	1,80	Uden glas U ≤ 0,80 Med glas U ≤ 1,0 (eller Eref ≥ 0 kWh/m²)
Porte U-værdi [W/m²K]	-	-	≤ 1,40
Glasareal i forhold til gulvareal ved en lystransmittans større end 0,75 for ruderne.	-	-	Boliger, kollegier, hoteller og opholdsrum i kontorer, skoler og institutioner m.m. ≥ 15%
Overtemperaturer	-	Dokumentation	Dokumentation
Elevatorer	-	Energiklasse A	Energiklasse A

*Til opvarmning, ventilation, køling og varmt brugsvand.

** Til opvarmning, ventilation, køling og varmt brugsvand og el til belysningsdrift.

*** Dette er et komponentkrav. Dvs. det er ikke et krav at der anvendes mekanisk ventilation i alle bygningstyper.

1

Byggede eksempler - enfamiliehuse

Bygningsklasse	Standard 2010	Lavenergi 2015	Bygningsklasse 2020
	Standard2010	LOW2015	NZEB2020
Opvarmet areal [m²]	178	170	122
Beregnet energibehov [kWh/m²]	50,5	34,0	17,6
Lofter	U = 0,11 W/m²K	U = 0,08 W/m²K	U = 0,06 W/m²K
Ydervægge	U = 0,18 W/m²K	U = 0,14 W/m²K	U = 0,085 W/m²K
Gulve	U = 0,10 W/m²K	U = 0,08 W/m²K	U = 0,06 W/m²K
Vinduer	U = 1,3 W/m²K	U = 0,8 W/m²K	U = 0,8 W/m²K
Varmeforsyning	Fjernvarme	Fjernvarme	Varmepumpe
Ventilation med varmegenvinding	Ja	Ja	Ja

2

Figure 21: “Building Display Sheet” of the exemplary SFH <DK> [SBi 2014]

Table 61: Three different exemplary SFH – Results of the energy balance calculation; Procedure: The calculation procedure in the according to the Danish building code, BR10 [BR10]

Variant N°		**001**	**002**	**003**
Label of the variant triplet		“SFH”		
Variation level		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
Energy standard		Standard	LOW2015	NZEB2020
Calculation method		[Be10]		
National reference area (heated gross floor area)	m²	178	170	122
Dimensioning (T_{out}=-12°C) thermal transfer coefficient by transmission. related to envelope area (not including windows and doors)	W/(m²)	4.3	3.6	2.7
Relation to requirement		86%	72%	54%
Energy need for heating	kWh/(m²a)	8.8	6.5	7.3
Delivered energy				
Fossil fuels	kWh/(m²a)	8.8	6.5	0
Renewable fuels	kWh/(m²a)	0	0	0
Electricity	kWh/(m²a)	2	2.5	9.4
Auxiliary energy	kWh/(m²a)	2	2.5	2.4
Primary energy demand	kWh/(m²a)	51	34	18
Relation to requirement		82.5%	54.6%	27.3%

*) Please note that the SFHs are not a variation of the same building but instead it is three different real examples of single-family houses built in Denmark.

TABULA calculation results for all exemplary buildings

Table 62 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 62: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	**Var. N°**	**Performance Level**	**h_Transmission** W/(m^{2}K)	**q_h_nd** kWh/(m^{2}a)	**q_ve_rec_h_usable** kWh/(m^{2}a)	**q_h_nd_net** kWh/(m^{2}a)	**q_g_h_out** kWh/(m^{2}a)	**q_w_nd** kWh/(m^{2}a)	**q_g_w_out** kWh/(m^{2}a)	**q_del_sum_gas** kWh/(m^{2}a)	**q_del_sum_oil** kWh/(m^{2}a)	**q_del_sum_coal** kWh/(m^{2}a)	**q_del_sum_bio** kWh/(m^{2}a)	**q_del_sum_el** kWh/(m^{2}a)	**q_del_sum_dh** kWh/(m^{2}a)	**q_del_sum_other** kWh/(m^{2}a)	**q_exp_sum_el** kWh/(m^{2}a)
SFH  ReEx.001	01	Minimum Requirement	0.73	70	30	40	39	10	17	0	0	0	0	7	58	0	0
	02	Improved Standard	0.53	55	28	27	27	10	13	0	0	0	0	26	0	0	0
	03	Ambitious Standard / NZEB	0.37	43	27	16	16	10	13	0	0	0	0	23	0	0	0
TH  ReEx.001	01	Minimum Requirement	0.53	59	31	29	28	10	17	0	0	0	0	7	47	0	0
	02	Improved Standard	0.48	48	27	21	21	10	13	0	0	0	0	24	0	0	0
	03	Ambitious Standard / NZEB	0.36	39	26	13	13	10	13	0	0	0	0	22	0	0	0
AB  ReEx.001	01	Minimum Requirement	0.41	51	22	29	28	15	25	0	0	0	0	13	56	0	0
	02	Improved Standard	0.33	36	25	12	11	15	25	0	0	0	0	10	37	0	0
	03	Ambitious Standard / NZEB	0.31	34	24	10	11	15	18	0	0	0	0	28	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m^{2}K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m^{2}a)	energy need for heating
q_ve_rec_h_usable	kWh/(m^{2}a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m^{2}a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m^{2}a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m^{2}a)	net energy need domestic hot water
q_g_w_out	kWh/(m^{2}a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, …_el	kWh/(m^{2}a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m^{2}a)	sum produced electricity (negative value)

3.6.3 Sources / References Denmark

Table 63: Sources / References Denmark

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Be10]	Aggerholm, S. & Grau, K. Bygningers energibehov – Beregningsvejledning (In Danish). SBi-Direction 213, 2. edition. Danish Building Research Institute, Aalborg University. Hørsholm, 2010.	Users guide for the Danish compliance and energy performance certification tool, Be10.
[BR10]	Danish Building Regulations 2010 (BR10). Danish Energy Agency, Copenhagen, 2014. www.bygningsreglementet.dk	Danish Building Regulation, current and previous versions. A version is available in English.
[SBi 2014]	SBi (ed.) (2014): BYGNINGSTYPOLOGIER	Danish Building Typology Brochure

3.7 <ES> Spain

(by EPISCOPE partner IVE)

The first law to include building insulation requirement was enacted in 1979, which took some time to propagate through the whole building sector, so the first buildings including insulation were built in the early 80s. Over 60 % of the Spanish building stock was built prior to 1980, before the advent of any technical buildings standards or codes designed to regulate the quality of buildings built in Spain [Working Group for Rehabilitation "GTR", 2011].

It was not until 2006 when a more demanding legislation on energy saving was approved in the Spanish building sector. It was the "Basic Document: Energy Saving" titled CTE-HE from the "Technical Code of Buildings (CTE)". The CTE is a comprehensive legislation on building regulations that come into force in 2006. The "Technical Code of Buildings (CTE)" was the answer to the Energy Performance of Buildings Directive published in 2002 that gave the Spanish Government the chance to include more stringent energy criteria into this review, not just for the fulfilment of the EU obligations, but also for the implementation of other National Energy Policies, such as the National Energy Efficiency Plan – Energy Strategy E4 - and the Renewable Energy Plan.

Recently, in 2013, as part of the national road map for NZEB buildings, the national government conducted a review of the energy efficiency legislation and a new "Basic Document: Energy Saving" included in the "Technical Code of Buildings (CTE)" was enacted with stricter requirements for buildings. The regulation is expected to come into force during 2014. The new measures are intended to ensure that buildings constructed are of class C or higher. The approach chosen by the Spanish government to achieve a level of NZEB in 2020 is a progressive regulatory hardening, where three steps, in 2012, 2015 and 2019 were expected; however the regulatory modifications are suffering delays as the one planned in 2012 was not published until 2013.

However, even though the legislation does not currently require the levels of a NZEB there are some new constructed nZE buildings all around Spain, most of them as demonstration projects, others are official public buildings. No information about any samples of nZEB renovation is reported.

Due to the economical crisis, cuttings have seriously impacted the energy efficiency sector. There is no kind of funding for nZE buildings, moreover the grants concerning the energy saving, at national, regional and local level have been eliminated.

However, on the regional level the I.D.A.E. (Institute for the Diversification and Saving of Energy) of the Ministry of Economy of Spain provides direct aid as repayable grant through the Autonomous Communities (ACs) for investments in certain types of projects that promote energy efficiency or renewable energy. These aids include those actions that are part of the Renewable Energy Plan 2005-2010 (PER) and the 2008-2012 Action Plan of the Strategy of Energy Saving and Efficiency in Spain (E4). The respective Autonomous Communities are responsible for the development of public aid programs, but to date no program was developed for the construction or rehabilitation of nZE buildings.

3.7.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Spain

Nearly zero-energy buildings (NZEBs) have not yet been officially defined, but there are reasons to assume that NZEB buildings would be equivalent to A class.

A revision of the Spanish Energy Saving law came into force in 2013. As a next step towards nearly zero-energy buildings, it includes a tightening of the requirements for new buildings.

Minimum requirements for new residential buildings in Spain

The implementation of the Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) in Spain is the responsibility of the Ministry of Industry, Energy and Tourism, and of the Ministry of Public Works and Transport.

Since the publication of the EPBD, Spain has worked to implement its transposition into national law. The initial transposition of this Directive consisted of the following official documents:

- The Technical Building Code (TBC) initially approved by the Royal Decree 314/2006, of the 17th of March, and modified by the Royal Decree 238/2013 of the 13th of April [Ministry of Housing, 2006] [Ministry of development, 2013]. This document sets the minimum requirements that must be met by all new buildings (residential, non-residential, public and private buildings), as well as by existing buildings undergoing a renovation of more than 25 % of their surface.
- The procedure for the energy certification of buildings initially approved by the Royal Decree 47/2007 Ministry of the Presidency, 2007], of the 19th of January and modified by the Royal Decree 235/2013 [Ministry of the Presidency, 2013] of the 13th of April for taking into consideration the energy certification of existing buildings and the 2010/31/EU Directive (recast of the EPBD).
- The Thermal Building Regulations initially approved by the Royal Decree 1027/2007, of the 20th of July, and modified by the Royal Decree 1826/2009, of the 27th of November, this document introduced the concept of periodic inspections on energy efficiency to be implemented by the Autonomous Communities.

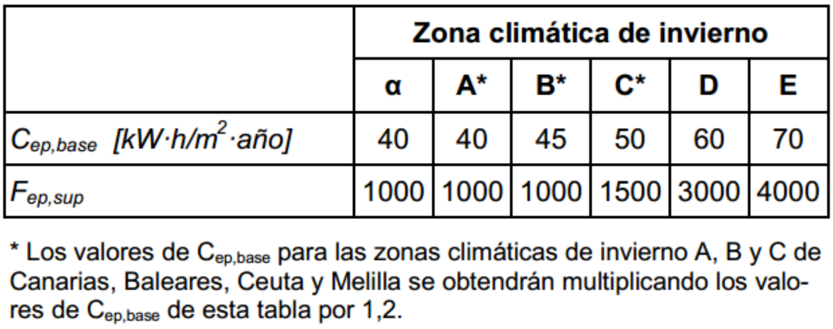
In parallel, the roadmap to guide Spain towards the objectives established in the recast EPBD in terms of all new buildings becoming Nearly Zero-Energy Buildings (NZEB) from the year 2020 onwards, is already under way. The cost optimal analysis described in the recast of the EPBD has been sent to the commission.

The current energy requirements for new buildings have been introduced in the “Basic Document: Energy Saving” (Documento básico de ahorro de energía) included in the The Technical Building Code (TBC) approved in 2006. In 2013 a recast came into force including a considerable change of the requirement level. The second reinforcement of the requirements imposed by the three Royal Decrees will take place in 2016. In 2006, the use of Renewable Energy Sources (RES) became compulsory in order to meet part of the energy needs of buildings, either to produce sanitary hot water (for both residential and non-residential buildings), as set forth in the TBD DB HE4, or to produce electric power in tertiary buildings as set in the TBC DB HE5. In 2012, by the first time, the non-renewable energy consumption of residential buildings is limited as stated in the TBC DB HE 0.

The most important requirements included for residential new buildings in the 2006 Royal Decree are:

Limiting energy consumption

Table 64: Base value and energy consumption correction factor per surface



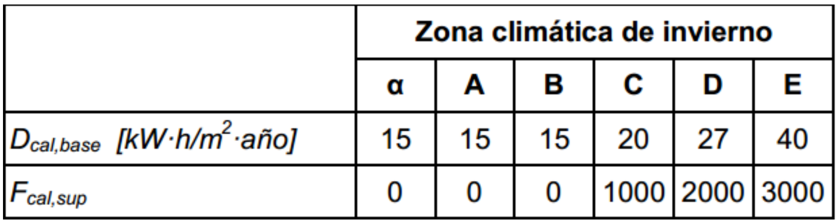
	Zona climática de invierno					
	α	A*	B*	C*	D	E
$C_{ep,base}$ [kW·h/m^2·año]	40	40	45	50	60	70
$F_{ep,sup}$	1000	1000	1000	1500	3000	4000

* Los valores de $C_{ep,base}$ para las zonas climáticas de invierno A, B y C de Canarias, Baleares, Ceuta y Melilla se obtendrán multiplicando los valores de $C_{ep,base}$ de esta tabla por 1,2.

Table extracted from the “Basic Document: Energy Saving” included in the “Technical Code of Buildings (CTE)” [Ministry of Housing, 2006]

Limitation of energy demand

Table 65: Base value and heating energy demand correction factor per surface



	Zona climática de invierno					
	α	A	B	C	D	E
$D_{cal,base}$ [kW·h/m^2·año]	15	15	15	20	27	40
$F_{cal,sup}$	0	0	0	1000	2000	3000

Table extracted from the “Basic Document: Energy Saving” included in the “Technical Code of Buildings [Ministry of Housing, 2006]

Spanish calculation method to comply with new building regulations for residential buildings

In Spain, the implementation of the EPDB is the responsibility of the Ministry of Industry, Energy and Tourism, and the Ministry of Public Works. The Institute for Energy Diversification and Saving (IDAE) also contributes to this process.

Regarding the legislation about energy certification of buildings, the Royal Decree 235/2013 approves the basic method for the energy certification of new and existing buildings. The Decree came into force on 1st of June 2013, modifying the previous legislation for new buildings that came into force in November 2007.

This procedure was carried out by the responsible organism in each Autonomous Community, who are also responsible for the registration of EPCs in his territory, external control and inspection.

The energy rating scale in Spain ranges from A, very high performance, to G, which represents low performance. In Spain, the global rating is assessed according to the global CO2 emitted by the building (in kg CO2/m2.year), regardless of the existing partial ratings related to the several consuming energy services (heating, cooling, sanitary hot water and lighting in case of tertiary buildings) in terms of demand and final and primary energy consumption (kWh/m2.year) and in terms of emissions.

The fact that energy rating A involves a very low demand along with the contribution of renewable energies in power supply could be seen as a good starting point to specify in a precise way what could be a "nearly zero-energy building" in each of the Spanish climate areas.

There is not a mandatory minimum energy class; the Royal Decree 235/2013 only establishes the obligation to obtain an energy performance certificate to know the building rating, but in any case establishes the obligation to reach a letter. Although a new building that strictly abides by the current regulations, the Technical Building Code [Ministry of development, 2013], will be rated on the limit between B and C, due to the demand and final energy limits imposed by that legislation.

For dwellings, the calculated values of the CO2 emissions of the object building are compared with a series of reference values that vary according to the local climate, and the type of use (single-family or block of apartments), obtained from dwellings that strictly fulfils with the 2006 Technical Building Code. Thus, the energy certificate for dwelling takes into account the “design” of the building in terms of shape, compactness as well as the thermal-quality of the walls, roofs, windows and ceilings and the performance of the conditioning and DHW production systems. In the Royal Decree 235/2013 of the 13th of April the procedure was modified, in the new approach the energy certification is related to the climatic zone instead of the location, thus the reference value were recalculated for the 12 climatic zones in Spain. The next figure shows a comparison between the requirements of both versions of the Technical Building Code in terms of primary energy consumption. A new building that strictly fulfils the 2013 TBC requirements will be rated between B and C depending on its climate zone [ENCERTICUS consortium, 2013].

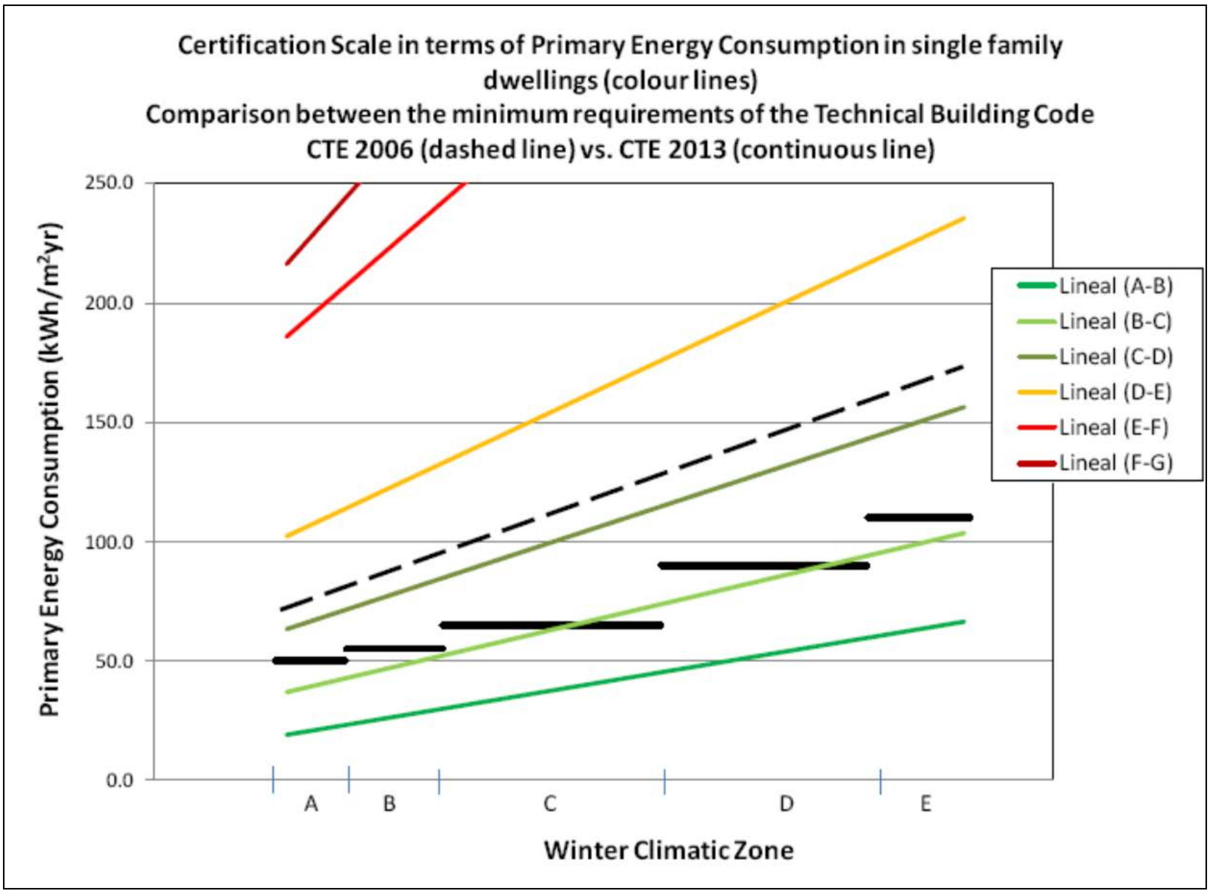


Figure 22: **Scale for the energy certification of single family dwellings in all the Winter Climatic Zones in terms of the Primary Energy Consumption. Comparison of the minimum requirements of the Building Technical Codes 2006 and 2013. Source: Grupo Termotecnia – University of Seville.**

As has been shown in order to obtain the energy certification in a given location it is necessary to know the climatic zone as the energy performance requirements depends on it. The climatic zoning of a location depends on the winter and summer climatic severity of this location [Salmerón et al., 2013].

The National Basic Procedure for energy certification foresees two possible ways: a simplified one (that includes any validated procedure approved by the Certification Commission) and another complex one. The last one requires the use of a software tool “CALENER”, being the official one. CALENER has been developed with IDAE’s sponsorship and following CEN standards to large extent. It is the reference procedure for both, new and existing buildings.

Table 66: **National Basic Procedure for energy certification of new building**

PROCEDURES – NEW BUILDINGS		**USES**	**POSSIBLE RATING**
GENERAL OPTION	CALENER VyP	Housing	From A to E
		Small and medium tertiary buildings	
	CALENER GT	Small and medium tertiary buildings (complex systems)	
		Great tertiary buildings	
SIMPLIFIED OPTIONS	Calculation procedure 1. Simplified option	Housing (only if it is applicable the simplified option of the CTE-HE1)	D and E
	Ce2		From A to E
	CERMA	Housing	

Status of NZEB definition for residential buildings in Spain

An official definition of the NZEB standard has not yet been published by the Spanish government.

The fact that energy rating A involves a very low demand along with the contribution of renewable energies in power supply could be seen as a good starting point to specify in a precise way what could be a "nearly zero-energy building" in each of the Spanish climate areas. So, despite the lack of an official definition, the A class seems to be an appropriate benchmark for the definition of the NZEB level for residential buildings in Spain.

Table 67: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the assumed NZEB definition in Spain

<table>
<tr><th colspan="9">Calculation Method New Building Regulations – (part 1)</th></tr>
<tr><td>Country</td><td>ES</td><td colspan="5">Spain</td><td>Status</td><td>07/2014</td></tr>
<tr><td colspan="7">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the assumed National NZEB Definition</td></tr>
<tr><td colspan="7">Legislation / Standards</td><td colspan="2" rowspan="3">No official Spanish NZEB definition until now. The NZEB standard will presumably be comparable to an A class.</td></tr>
<tr><td colspan="7">The procedure for the energy certification of buildings was initially approved by the Royal Decree 47/2007 of the 19th of January and modified by the Royal Decree 235/2013 of the 13th of April for taking into consideration the energy certification of existing buildings and the 2010/31/EU Directive (recast of the EPBD).</td></tr>
<tr><td colspan="7">Explanation / Comments</td></tr>
<tr><td colspan="7">Energy Services</td><td colspan="2" rowspan="6"></td></tr>
<tr><td>x</td><td>Heating</td><td>x</td><td>DHW</td><td></td><td colspan="2">Appliances</td></tr>
<tr><td>x</td><td>Cooling</td><td></td><td>Auxiliary</td><td></td><td>Other:</td><td></td></tr>
<tr><td>x</td><td>Ventilation</td><td></td><td>Lighting</td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Explanation / Comments</td></tr>
<tr><td colspan="7">Lighting is taken into account in tertiary building</td></tr>
<tr><td colspan="5">Calculation Procedure</td><td colspan="2">Calculation period</td><td colspan="2" rowspan="5"></td></tr>
<tr><td>x</td><td colspan="4">Calculation of energy need for heating (building)</td><td colspan="2">Hour</td></tr>
<tr><td>x</td><td colspan="4">Calculation of delivered energy (system)</td><td colspan="2">Hour</td></tr>
<tr><td colspan="7">Explanation / Comments</td></tr>
<tr><td colspan="7">Furthermore, the calculation methodology shall provide the calculation of the hour by hour final energy consumption, by calculating the hourly demand and calculating the average performance of the systems.</td></tr>
<tr><td colspan="7">Consideration of Special Technologies</td><td colspan="2" rowspan="12"></td></tr>
<tr><td colspan="7">Thermal Systems</td></tr>
<tr><td></td><td colspan="6">Ventilation system with heat recovery</td></tr>
<tr><td>x</td><td colspan="6">Thermal solar system</td></tr>
<tr><td></td><td colspan="2">Other special systems:</td><td colspan="4"></td></tr>
<tr><td colspan="3">On-Site Electricity Production</td><td>Feed-in</td><td>Self-use[1]</td><td>Balance period to determine self-use[1]</td><td>Self-use considered for H-C-W-HE[1]</td></tr>
<tr><td></td><td colspan="2">On-site CHP</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">On-site PV</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="6">Other energy generation systems:</td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td></td><td colspan="6">[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity</td></tr>
<tr><td colspan="7">Explanation / Comments</td></tr>
</table>

Table 67 (continuation)

Calculation Method New Building Regulations – (part 2)

Country	**ES**	Spain	Status	07/2014

National Requirements for New Residential Buildings

Type of Requirements (new buildings)

x	U-values of building elements	x	Primary energy	non- renewable
	Heat transfer coefficient by transmission			
x	Energy need for heating		Carbon dioxide emissions	
x	Delivered energy		Other	

Explanation / Comments

The main or global energy indicator will correspond to the annual emissions of CO2, expressed in kg per m^2 of floor space in the building. Complementary indicators will be prioritized as follows:

a) Annual non-renewable primary energy in kWh per m^2 of building surface.
b) Total annual primary energy in kWh per m^2 of floor space in the building.
c) Percentage of annual primary energy from renewable energy sources respect to the total annual primary energy.
d) Annual primary energy from renewable sources, in kWh per m^2 of floor space in the building.
e) Primary energy use disaggregated by total annual heating, cooling, domestic hot water and lighting in kWh per m^2 of floor space in the building.
f) Annual heating energy demand in kWh per m^2 of floor space in the building.
g) Annual energy demand for cooling, in kWh per m^2 of floor space in the building.
h) Annual emissions of CO2, expressed in kg per m^2 of floor space of the building, disaggregated by use of heating, cooling, hot water production health and enlightenment.

There is not a mandatory minimum energy class; the Royal Decree 235/2013 only establishes the obligation to obtain an energy performance certificate to know the building rating, but in any case establishes the obligation to reach a letter. Although a new building that strictly abides by the current regulations, the Technical Building Code [Ministry of development, 2013], will be rated between B and C, due to the demand and final energy limits imposed by that legislation. In the Technical Building Code recommended U-values are given, but the values necessary to meet the demand limits are usually lower than those recommended.

Special Aspects with regard to the assumed National NZEB Definition

Although there is not a mandatory minimum energy class, the new legislation on energy saving approved in 2013 give a set of reference U-values by element types and establishes a maximum value for energy demand and consumption. So it is expected that future legislation to be applied will continue with the same criteria but different values.

Assessment of energy carriers in Spain

Tabled values of primary energy, final energy and CO2 emission conversion factors are published regularly by Institute for the Diversification and Saving of Energy (IDAE). IDAE is a public company depending on the Ministry of Industry, Tourism and Commerce. The last document was published in 2011 [IDAE, 2011]. However, the tool published by the government [Ministry of Development, 2014] to meet the requirements of the “Basic Document: Energy Saving” included in the “Technical Code of Buildings” (CTE) [Ministry of Development, 2013] includes a table of conversion factors used by the tool. Both factors are shown below.

Furthermore, at this moment there is a proposal of the Ministry of Industry, Tourism and Commerce about “CO2 emission and primary energy factors of different sources of final energy consumed in the building sector in Spain” which is being discussed.

Table 68: Conversion factors of final energy to total primary energy, to non-renewable primary energy and to CO_2 emissions included in the tool published by the government [Ministry of Development, 2014] to meet the requirements in force

Label / type of factor	**Total Primary Energy Factor Spain**	**Non-Renewable primary energy factor Spain**	**CO_2 Emissions Factor Spain**
used for EPC rating			
used for building regulations requirements		x	
Label (national language)	Factores de paso de energía final a energía primaria total	Factores de paso de energía final a energía primaria no renovable	Factores de paso de energía final a emisiones de CO_2
Factor is multiplied by delivered energy based on the	net calorific value H_i	net calorific value H_i	net calorific value H_i
Reference	[Ministry of Development, 2014]	[Ministry of Development, 2014]	[Ministry of Development, 2014]
Unit	primary kWh / final kWh	primary kWh / final kWh	kg CO_2 / final kWh
Natural gas E	1.011	1.011	0.204
Liquid gas	1.081	1.081	0.244
Oil	1.081	1.081	0.287
Heating oil	1.000	1.000	0.280
Firewood	1.000	0.034	0.000
Wood pellets	1.000	0.085	0.000
Electricity	2.603	2.603	0.649

Table 69: Spanish primary energy and CO_2 Emissions factors published by IDAE [IDAE, 2011]

Label / type of factor	**Primary Energy Factor Spain**	**CO_2 Emissions Factor Spain**
used for EPC rating	x	x
used for building regulations requirements		
Label (national language)	Factores de conversión energía final - energía primaria	Factores de emisión de CO_2
Description / type of weighting factor	Total primary energy; Includes losses in transformations for obtaining fuel and / or fuel and transporting it.	In point of consumption. Used the oxidation factor according to Decision 2004/156 / EC for each of the fuels analyzed.
Factor is multiplied by delivered energy based on the	net calorific value H_i	net calorific value H_i
Reference	[IDAE 2011a]	[IDAE 2011a]
Unit	primary toe / final toe	tCO_2 / final toe
Natural gas E	1.07	2.34
Liquid gas	1.05	2.72
Heating oil	1.12	3.06
Firewood	1.25	0
Wood pellets	1.25	0
Electricity	2.35 primary MWh / final MWh	4.00

Methodological points for discussion in Spain

Interesting discussion points:

- The climatic differences throughout the country represent a great challenge in defining NZEB. Currently the legislation provides different requirements depending on the climate zone, but many experts disagree with the limits for each zone as buildings in climate zones of lesser severity are forced to use more costly measures (e.g. thicker insulation) than climatic zones with greater severity.
- The Spanish government along with a majority of experts believe necessary to link the definition of NZEB to optimal cost studies to establish optimal intervention levels that are economically viable. Government is currently working on that line.
- Linked to the previous point there is an open discussion in the forums about the possibility that NZEB not have as a prerequisite to use renewable energy as the demand constraint is being proved more effective long-term.
- The CO_2 Emissions Factors are now being discussed as energy certification is based on a CO_2 emission scale. Biomass factor, now 0, and electricity current values are the figures that are being most discussed.

3.7.2 Integration of National Requirements for New Buildings and NZEB Standards in the National Residential Building Typology

A first version of a Spanish regional residential building typology was already developed by Valencia Institute of building in 2011 on the basis of the knowledge achieved during the past two decades through different research projects developed in the Valencia Region. The Spanish building typology was updated by Valencia Institute of building in 2014 according to new developments.

Valencia Institute of Building has proposed three typological classifications, one for each of the three climatic zones established by the Institute for Diversification and Energy Saving (IDAE) in the "SPAHOUSEC project (Analysis of the Energy Consumption in the Spanish Households)". This work was sponsored and funded by Eurostat. These three climatic zones have also been used for the Spanish energy retrofitting strategy developing Article 4 of Directive 2012/27/EU.

Figure 23: Territorial Distribution of Climatic Zones in Spain [IDAE, 2011b]

The current version of the Spanish building typology consists of 72 residential building types, 24 in each climate zone, classified by construction year and building size. However, as example buildings have just been defined for one climatic zone (Mediterranean), in this report only this climatic zone is discussed.

Classification scheme for the Spanish residential building stock ("Building Type Matrix")

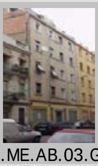
	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
13	Mediterranean climate (Clima Mediterráneo)	… 1900	generic	 ES.ME.SFH.01.Gen	 ES.ME.TH.01.Gen	 ES.ME.MFH.01.Gen	 ES.ME.AB.01.Gen
14	Mediterranean climate (Clima Mediterráneo)	1901 … 1936	generic	 ES.ME.SFH.02.Gen	 ES.ME.TH.02.Gen	 ES.ME.MFH.02.Gen	 ES.ME.AB.02.Gen
15	Mediterranean climate (Clima Mediterráneo)	1937 … 1959	generic	 ES.ME.SFH.03.Gen	 ES.ME.TH.03.Gen	 ES.ME.MFH.03.Gen	 ES.ME.AB.03.Gen
16	Mediterranean climate (Clima Mediterráneo)	1960 … 1979	generic	 ES.ME.SFH.04.Gen	 ES.ME.TH.04.Gen	 ES.ME.MFH.04.Gen	 ES.ME.AB.04.Gen
17	Mediterranean climate (Clima Mediterráneo)	1980 … 2006	generic	 ES.ME.SFH.05.Gen	 ES.ME.TH.05.Gen	 ES.ME.MFH.05.Gen	 ES.ME.AB.05.Gen
18	Mediterranean climate (Clima Mediterráneo)	2007 …	generic	 ES.ME.SFH.06.Gen	 ES.ME.TH.06.Gen	 ES.ME.MFH.06.Gen	 ES.ME.AB.06.Gen

Figure 24: Classification scheme ("Building Type Matrix") of the Spanish residential building typology – region "Mediterranean Climate" (one of 3 climatic zones), including new buildings (post 2007)

Table 70: **Exemplary new buildings representing the latest construction year classes (2007 …)**

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 ES.ME.SFH.06.Gen	 ES.ME.TH.06.Gen	 ES.ME.MFH.06.Gen	 ES.ME.AB.06.Gen
Number of dwellings		1	1	15	78
Number of full storeys (conditioned)		2	3	4	7
Number of directly attached neighbour buildings		0	2	2	0
National reference area (conditioned useful floor area)	m²	108	130	1290	6204
TABULA reference area (conditioned floor area, internal dimensions)	m²	119	143	1419	7508

Building example: variants meeting three energy performance levels for new buildings

In the frame of TABULA concept three energy performance levels were defined for new buildings constructed since 2007 in Spain. They are specified as follows:

1. **Minimum requirement**

   This level corresponds to the current state of the building designed complying with the DB-HE of the Technical Building Code approved in 2006.

2. **Improved Standard**

   This level encompasses those measures applied on the thermal envelope that achieve boundary demand values laid down in the DB-HE of the Technical Building Code published on 12 September 2013 updating the DB-HE approved in 2006. This regulation will come into force during 2014. The measures of this first level consists of the implementation of thermal insulation in different building elements constituents of the thermal envelope as well as in improving the energy performance of windows.

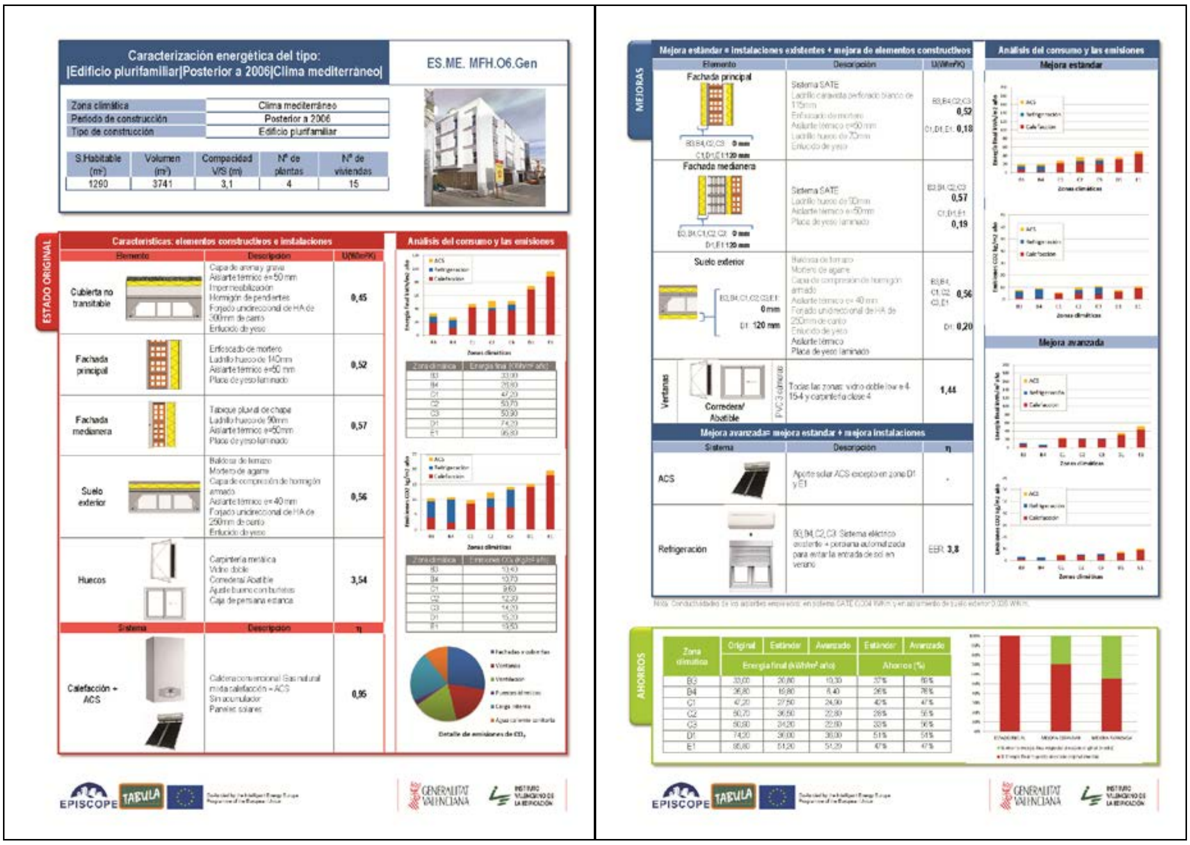
3. **Ambitious Standard / NZEB**

   The second level of improvement, called advanced level encompasses the first level measures, and additional measures required to achieve an A rating. This level could be assimilated to a NZEB. The measures encompassed in this advanced level are generally related to improving heating, cooling and DHW systems by installing cooling systems in warm areas where there were none, or by improving the existing installation for example adding renewable energy. In some types, due to parameters such as the orientation or compactness, to achieve an A, it was necessary, in addition to improving heating, cooling and DHW, the implementation of sunscreens scheduled according to the incident radiation and / or installing mechanical ventilation systems with heat recovery.

Table 71: Exemplary multi-family house (MFH) – definition of variants

 ES.ME.MFH.06.Gen		**“Natural gas”**		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
		DB-HE 06	DB-HE 13	A rating
U-values*				
Roof	W/(m^{2}K)	0.45	0.45	0.45
Wall	W/(m^{2}K)	0.52	0.18	0.18
Window	W/(m^{2}K)	3.54	1.44	1.44
Floor	W/(m^{2}K)	0.56	0.20	0.20
Thermal bridging supplement indication (as used in EPC software)		Inside insulation	Continuous exterior insulation	Continuous exterior insulation
Heat and cool supply System				
Heating		Gas new boiler (non-condensing)		
Cooling		-	-	Heat pump
Ventilation system		-	-	-
Thermal solar system		Solar panels for DHW	Solar panels for DHW	Increase d% of DHW demand covered by solar panels
Further system		-	-	Sunscreens scheduled according to the incident radiation

* U values applied in the improvement depends on the climate zone, the U values shown are those more restrictive (D1 Zone).



Caracterización energética del tipo:
|Edificio plurifamiliar|Posterior a 2006|Clima mediterráneo|

ES.ME. MFH.O6.Gen

Zona climática	Clima mediterráneo
Periodo de construcción	Posterior a 2006
Tipo de construcción	Edificio plurifamiliar

S.Habitable (m²)	Volumen (m³)	Compacidad V/S (m)	Nº de plantas	Nº de viviendas
1290	3741	3,1	4	15

Figure 25: "Building Display Sheet" of the exemplary MFH <ES> [IVE, 2014]

Table 72: Exemplary MFH – Results of the energy balance calculation; Procedure: National Basic Procedure for energy certification of new building

Variant N°		**001**	**002**	**003**
Label of the variant triplet		"Natural gas"		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		DB-HE 06	DB-HE 13	RD 235/2013
Calculation method		National Basic Procedure for energy certification of existing building Simplified option CERMA		
National reference area (conditioned useful floor area)	m²	1290	1290	1290
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.88	0.41	0.41
Relation to requirement	%	100 %	46 %	46 %
Energy need for heating	kWh/(m²a)	63.7	28.3	28.3
Relation to requirement	%	100 %	44 %	44 %
Delivered energy	kWh/(m²a)	74.2	36.0	36.0
Primary energy demand	kWh/(m²a)	75.0	36.4	36.4

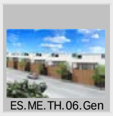
Note: the values depend on the climate zone; the values shown are those more restrictive (D1 Zone).

In this example the same supply system is used as with the demand requirements of DB-HE 13 and the existing system of DB-HE 06, the building comply the requirements of the Ambitious Standard / NZEB standard in D1 climatic zone. In other warmer climatic zones, as B3 or B4, primary energy demand is different in both levels as the supply system is different, however the differences in U-values are no so high.

TABULA calculation results for all exemplary buildings

Table 73 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 73: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	**Var. N°**	**Performance Level**	**h_Transmission** W/(m²K)	**q_h_nd** kWh/(m²a)	**q_ve_rec_h_usable** kWh/(m²a)	**q_h_nd_net** kWh/(m²a)	**q_g_h_out** kWh/(m²a)	**q_w_nd** kWh/(m²a)	**q_g_w_out** kWh/(m²a)	**q_del_sum_gas** kWh/(m²a)	**q_del_sum_oil** kWh/(m²a)	**q_del_sum_coal** kWh/(m²a)	**q_del_sum_bio** kWh/(m²a)	**q_del_sum_el** kWh/(m²a)	**q_del_sum_dh** kWh/(m²a)	**q_del_sum_other** kWh/(m²a)	**q_exp_sum_el** kWh/(m²a)
SFH  ES.ME.SFH.06.Gen	01	Minimum Requirement	2.38	7.9	0	8	25	10	19	42	0	0	0	3	0	0	0
	02	Improved Standard	1.13	3.5	0	3	7	10	19	20	0	0	0	3	0	0	0
	03	Ambitious Standard / NZEB	1.08	3.1	0	3	7	10	19	27	0	0	7	2	0	0	0
TH  ES.ME.TH.06.Gen	01	Minimum Requirement	1.20	3.1	0	3	21	10	19	37	0	0	0	3	0	0	0
	02	Improved Standard	0.96	2.5	0	3	6	10	19	20	0	0	0	3	0	0	0
	03	Ambitious Standard / NZEB	0.93	2.3	0	2	6	10	19	27	0	0	7	2	0	0	0
MFH  ES.ME.MFH.06.Gen	01	Minimum Requirement	1.07	4.5	0	4	22	15	24	42	0	0	0	3	0	0	0
	02	Improved Standard	0.53	2.2	0	2	6	15	24	23	0	0	0	3	0	0	0
	03	Ambitious Standard / NZEB	0.50	1.9	0	2	6	15	24	34	0	0	6	2	0	0	0
AB  ES.ME.AB.06.Gen	01	Minimum Requirement	0.96	3.0	0	3	21	15	24	41	0	0	0	3	0	0	0
	02	Improved Standard	0.49	1.5	0	2	6	15	24	23	0	0	0	3	0	0	0
	03	Ambitious Standard / NZEB	0.47	1.2	0	1	6	15	24	34	0	0	6	2	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, …_el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.7.3 Sources / References Spain

Table 74: Sources / References Spain

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[ENCERTICUS consortium, 2013]	ENCERTICUS consortium, National reports on energy certification of buildings, SPAIN, 2013	
[IDEA, 2011a]	IDAE, Factores de conversión energía final -energía primaria y factores de emisión de CO2 – 2011	
[IDAE, 2011b]	IDAE, Análisis del consumo energético del sector residencial en España, INFORME FINAL ; July 2011	
[IVE, 2014]	A. García-Prieto Ruiz, Begoña Serrano Lanzarote, Leticia Ortega Madrigal, Catálogo de tipologia edificatoria residencial. Àmbito: Espana. IVE, Septiembre, 2014	
[Ministry of Development, 2013]	Ministry of Development. Technical Building Code. Regulation, Madrid: Government of Spain, 2006	
[Ministry of Development, 2014]	Ministry of Development. LIDER-CALENER unified tool, Madrid: Government of Spain, 2014	
[Ministry of Housing, 2006]	Ministry of Housing. Technical Building Code. Regulation, Madrid: Government of Spain, 2006	
[Ministry of the Presidency, 2007]	Ministry of the Presidency, Royal Decree 47/2007, of 19 January, by which the basic procedure for certification of energy efficiency of new buildings was approved, Madrid: Government of Spain, 2007	
[Ministry of the Presidency, 2013]	Ministry of the Presidency, 235/2013 Royal Decree of 5 April, by which the basic procedure for the certification of the energy performance of buildings is approved, Madrid: Government of Spain, 2013	
[Salmerón et al., 2013]	J. Salmerón, S. Álvarez, JL Molina, A. Ruiz, F. Sánchez, Tightening the energy consumption of buildings depending on their tipology and on Climate Severity Indexes, Building and Environment 58 (2013) 372-377	
[Working Group for Rehabilitation “GTR”, 2011]	Working Group for Rehabilitation “GTR”, A National Perspective on Spain’s Buildings Sector. A Roadmap for a New Housing Sector. November 2011	

3.8 <FR> France

(by EPISCOPE partner Pouget)

France introduced the first thermal legislation in 1974 [RT 1974]. Before buildings were mostly not insulated and equipped with single glass windows. The level of energy requirements of this regulation was about one third lower than the average energy consumption of the existing building stock at this time.

However, in France scientific research about reduction of energy use in buildings already started in the fifties [ADEME 2011]. In 1971 the inter-ministerial program “Plan Construction” was installed, launching several ambitious research programs about solar and bioclimatic houses (since 1979: “Habitat original par la thermique (HOT)”, since 1983: “Habitat Économe en Énergie à l’horizon1985 (H2E85)” [Nicolas 1977] [Alexandroff 1979] [COMES 1981] [Daussy 1983] [Olive 1989].

In parallel low energy prices and the pushing of electric heating in the context of the development of a large nuclear plant stock slow down the dissemination and generalisation of energy efficient buildings. France building sector fell behind on energy efficiency progress in other European countries for a couple of decades.

This gap was closed with the introduction of the thermal legislation of 2012 [RT 2012]. It is considered as the second efficiency revolution in the building sector after introduction of first legislation in 1974, lowering the requirement level by half.

The RT 2012 was prepared by the energy label BBC (Bâtiment Basse Consommation) carried out by the NGO Effinergie and established as legal energy label in 2007. It was inspired by the Switzerland energy label Minergie. The approach and calculation method are based on thermal legislation of 2005 (RT 2005) and it fixed the maximum primary energy demand for heating, cooling, DHW, lighting and auxiliaries at 50 kWh/(m².yr), modulated by coefficients from 0.8 to 1.3 according to the 8 climate zones. Between 2007 and 2014, more than 335 000 new dwellings were certified BBC [Effinergie 2014]. The energy performance of those buildings can be compared to low energy houses in other European countries, announcing heating needs between 25 and 45 kWh/(m².yr)[24] depending on climate zone.

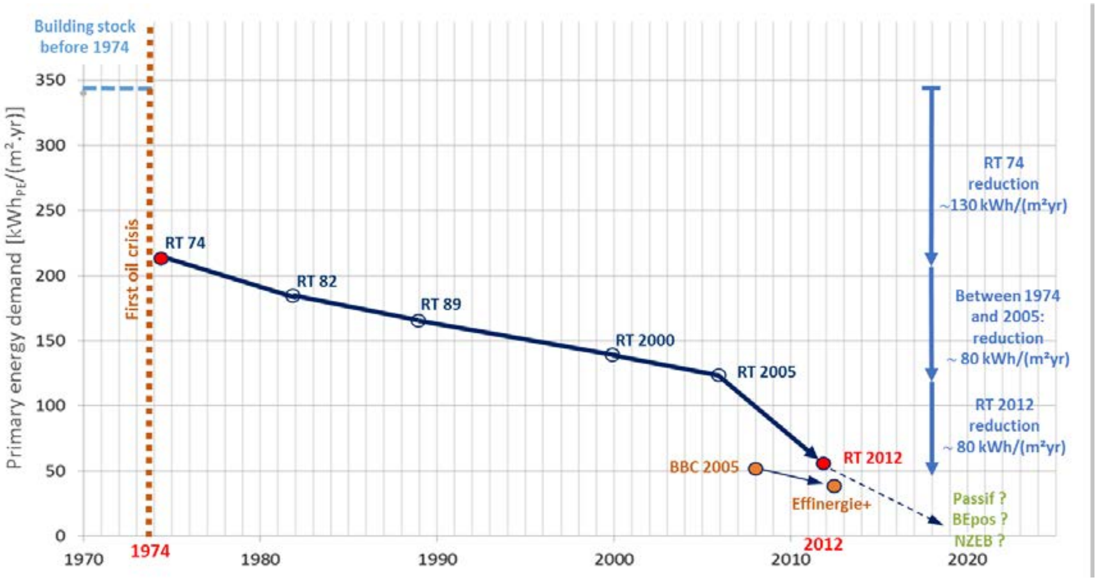


Figure 26: Evolution of primary energy demand for heating, cooling, DHW, lighting, ventilation and auxiliaries for residential buildings with fossil combustibles in climate zone H2 [Pouget 2014]

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[24] per m² of habitable surface

This requirement level was more or less integrated to the RT 2012. The new legislation introduced furthermore the bioclimatic need (Besoin bioclimatique Bbio) as a new requirement. It unites need for heating, cooling and lighting calculated with standard conditions into one parameter assessing the bioclimatic quality of the building.

New constructions going further than legal requirements towards energy efficiency are at present marginalized. It concerns mainly buildings respecting energy labels like Effinergie+, Passivhaus, Minergie-P or Bepos-effinergie. About 1 000 dwellings are already certified according to one of this labels and about 12 000 are under way.

There is no legal energy label associated to the RT 2012. French government installed a work group to elaborate the basis of a new environmental label for new buildings which will integrate energy performance and other environmental criteria. Results are expected by next year (2015) [PRB 2013].

French government estimates in its report to the European Commission of 16th of January 2013 that the requirement level of RT 2012 corresponds to NZEB [France 2013]. Apart from that indication in this specific report, there is, for the moment, no other documents in France mentioning an official definition of Nearly Zero-Energy Buildings (NZEBs).

On the other hand there is a large discussion about Bâtiments à Énergie POSitive (BEPOS, Buildings with positive energy) which were announced in the Act Grenelle 1 [Grenelle 1 2009]. Generally speaking it describes a building producing more energy than it needs. But more detailed definitions differ considerably in requirements toward the building performance and the energy uses taken into account (see below).

3.8.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in France

The last amendment of French Thermal Regulation came into force for all new constructions in January 2013.

The situation of thermal legislation and EPC calculation in France is quite complicated regarding requirements towards new constructions and refurbishments, legal texts and calculation methods. The following figures (Figure 27 and Figure 28) explain the main differences.

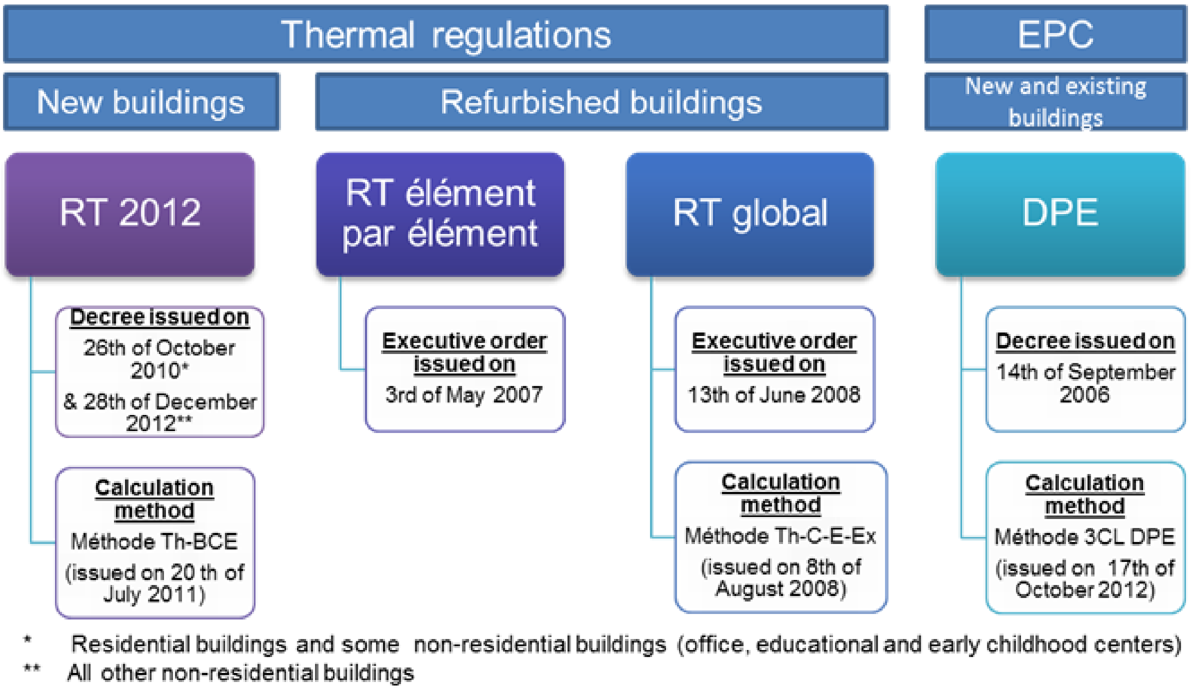
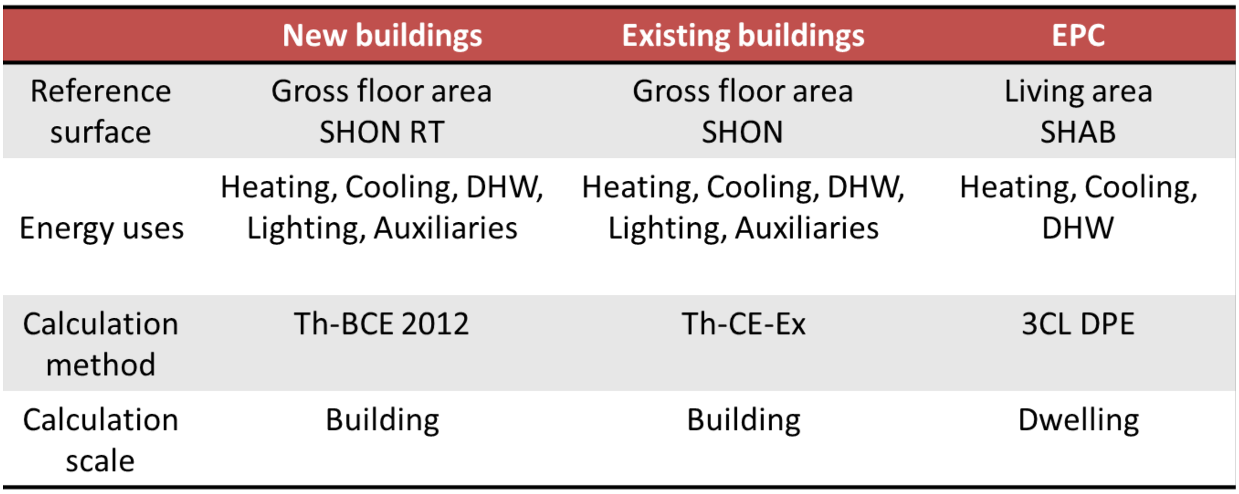


Figure 27: Legal status of thermal regulations and EPC [Pouget 2014]



	New buildings	Existing buildings	EPC
Reference surface	Gross floor area SHON RT	Gross floor area SHON	Living area SHAB
Energy uses	Heating, Cooling, DHW, Lighting, Auxiliaries	Heating, Cooling, DHW, Lighting, Auxiliaries	Heating, Cooling, DHW
Calculation method	Th-BCE 2012	Th-CE-Ex	3CL DPE
Calculation scale	Building	Building	Dwelling

Figure 28: Differences between thermal regulations and EPC calculation [Pouget 2014]

By reasons of the shown differences, the results of EPC and thermal regulation calculations can't be compared.

Minimum requirements for new residential buildings in France

The French Thermal Regulation of 2012 for new constructions includes essential changes comparing to the last regulation of 2005:

- RT 2012 abandon the approach of comparison with a reference building to define the requested level like it was done in RT 2005. In contrast it imposes maximum values for primary energy demand depending on the climate zone, building use, average scale of dwellings and use of renewable energy carriers.
- RT 2012 introduces the bioclimatic need (Besoin bioclimatique Bbio) as a new requirement to assess the bioclimatic quality of the building.
- A new calculation method was elaborated (Th-BCE-2012).
- Climatic data of the 8 climate zone were adapted to the global warming what leads to higher average temperatures.
- A new reference surface was introduced ($Shon_{RT}$) which is about 5 % to 15 % larger than the previous one (Shon). $Shon_{RT}$ is the gross floor area. In residential buildings it is between 20 % and 35 % larger than the habitable surface.

RT 2012 fixes three global requirements:

- Respect of a maximum primary energy demand for heating, cooling, DHW, lighting and auxiliaries. It's the Cep,max (Consommations en énergie primaire) expressed in $kWh_{PE}/(m^2.yr)$.
- Respect of a maximum number of points of the bioclimatic need taking into account heating, cooling and lighting. It's the Bbio,max (Besoin bioclimatique) expressed in points.
- Respect of a maximum conventional interior temperature to justify admissible summer comfort. It's the Tic,réf (Température intérieure conventionnelle) expressed in °C.

Definition of Cep,max :

$$Cep,max = 50 \times Mc\ type \times (Mc\ géo + Mc\ alt + Mc\ surf + Mc\ GES)\ [kWh_{PE}/(m^2.yr)]$$

Mc type: Depends on the building use and the belonging to categories CE1 or CE2 (without / with cooling). Mc type = 1.0 (CE1) or 1.2 (CE2) for residential buildings

Mc géo: Depends on climate zone

Zone	H1a	H1b	H1c	H2a	H2b	H2c	H2d	H3
Mc géo	1.2	1.3	1.2	1.1	1.0	0.9	0.9	0.8

Mc alt: Depends on altitude of the site

Mc surf: Depends on average size of the dwellings. Takes into account higher specific DHW need in small dwellings

Mc GES: Depends on main energy carrier for heating and DHW. Use of wood or urban heat out of renewable energy allow higher primary energy consumption.

The initial value for multi-family houses is 57.5 instead of 50 until 31st of December 2014.

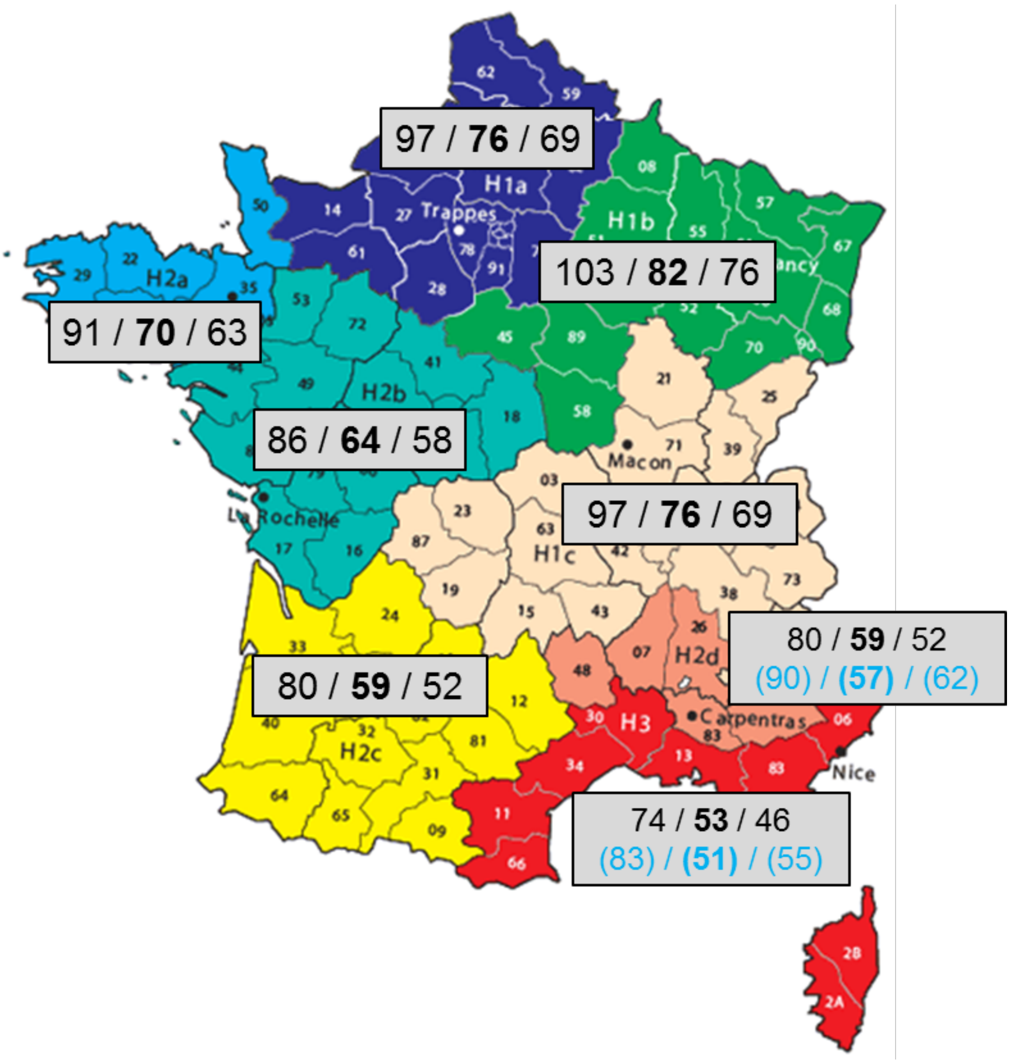


Figure 29: Values of Cep,max in kWh$_{PE}$/(m².yr) for multi-family houses in the 8 climate zones
(Mc GES = 0, average size of dwellings 30 / **60** / 90 m², altitude <400 m, **CE1** / **CE2**) [Pouget 2011]

The calculation of the Cep of the project can take into account electricity production on site issued of PV or cogeneration up to an amount of 12 kWh$_{PE}$/(m².yr).

Definition of Bbio,max :

$$Bbio,max = Bbio,max\ moyen \times (Mb\ géo + Mb\ alt + Mb\ surf)$$

Bbio,max moyen depends on the building use and the belonging to categories CE1 or CE2 (without / with cooling). Bbio,max moyen = 60 (CE1) or 80 (CE2) for residential buildings

Mb géo:	Depends on climate zone
Mb alt:	Depends on altitude of the site
Mb surf:	Depends on size of the dwelling (only single family houses)

The calculation of the Bbio of the project takes into account the need for heating, cooling and lighting:

$$Bbio = 2\ x\ heating\ demand + 2\ x\ cooling\ demand + 5\ x\ lighting\ demand$$

Additional requirements

In parallel to the three global requirements RT 2012 has several specific requirements:

- Single family houses has to use renewable energy for a part of their energy demand:
  - o by solar thermal system for DHW with a collector size corresponding to 2 m² orientated south
  - o by using urban heat issued of more than 50 % of renewable energy or heat recovery
  - o by demonstrating that renewables energies contribute with at least 5 $kWh_{PE}/(m^2.yr)$ to the Cep
  - o As alternative to those points the requirement is fulfilled if the building use a thermodynamic system for DHW production with COP>2.0 or a mini-cogeneration with thermal efficiency > 90 % and CHP coefficient > 0.1
- Residential buildings have to proof the airtightness of the envelope by pressure test. Maximum values for q_4 at 4 Pa are 0.6 $m^3/(h.m^2)$ for SFH and 1.0 $m^3/(h.m^2)$ for MFH.
- Residential buildings need a minimum window surface of 1/6 of habitable surface.
- Requirements toward solar protections and minimum opening surfaces
- Requirements towards measurement of energy consumption and information of the occupants.
- Several requirements towards regulation of heating or cooling systems and lighting in common areas of multi-family houses.

Calculation method of the Thermal Regulation RT 2012 for new residential Buildings

The legal calculation method is called Th-BCE 2012 [Th-BCE 2012]. It's a complete scheme for the calculation of residential and non-residential buildings and includes calculation modules for heating, cooling, DHW production, artificial lighting and ventilation systems and a primary energy based energy carrier assessment. It also includes a module to calculate the conventional interior temperature for the reference and the real project. Multi-zone calculations are possible.

Calculation is based on hourly energy balance for one year. The method is using climatic data according to EN ISO 15927-4 for the reference stations of 8 climatic zones.

The primary energy factors to be used for calculation issuing are the agreed weighting factors for energy carriers in France:

2.58 kWh_{PE}/kWh_{FE} for electricity
1.0 kWh_{PE}/kWh_{FE} for all other energy carriers

Energy delivered by solar thermal systems on side is directly subtracted from the energy demand. Electricity out of PV or cogeneration on site is weighted with 2.58 kWh_{PE}/kWh_{elec}.

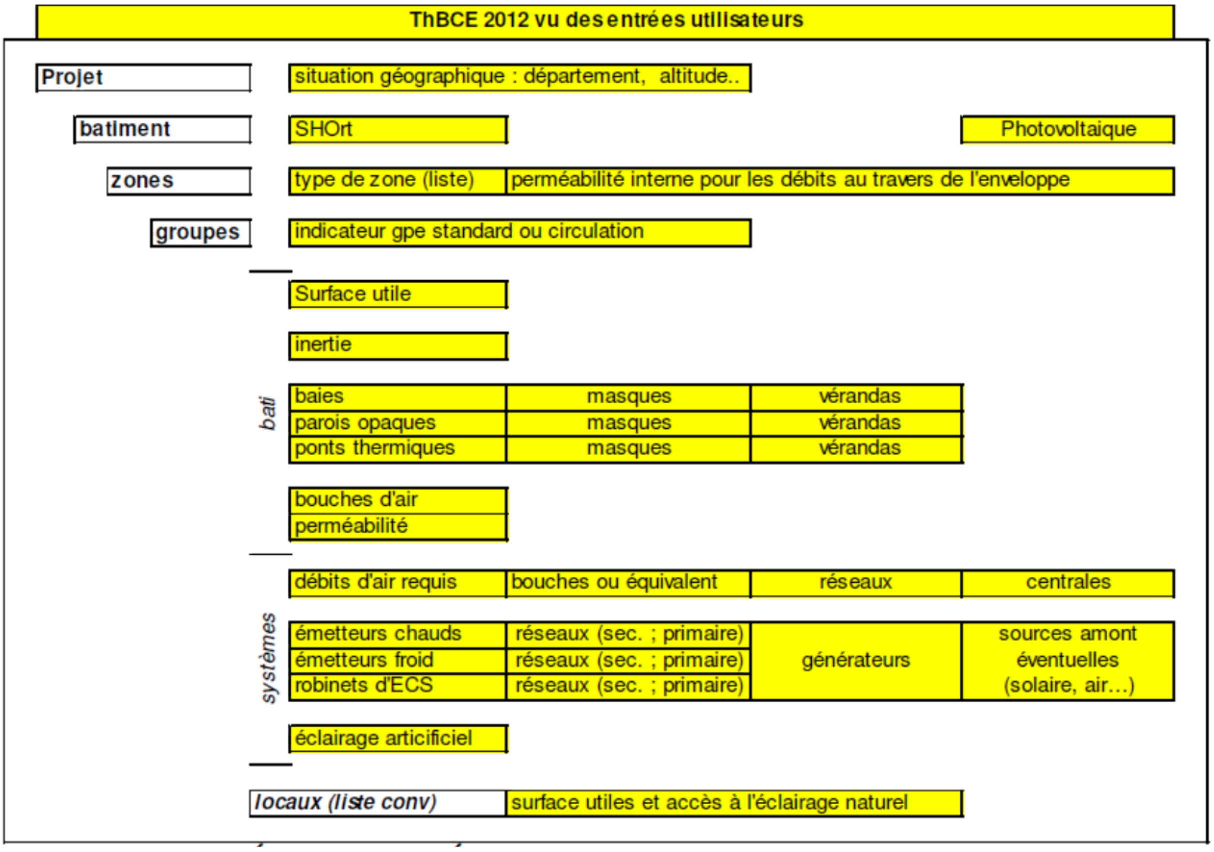


Figure 30: Schema of the structuring of input data of Th-BCE 2012 calculation method [Th-BCE 2012]

French EPC calculation method for new residential Buildings

Like described in the introduction, EPC calculation is quite different from Thermal Regulation calculation.

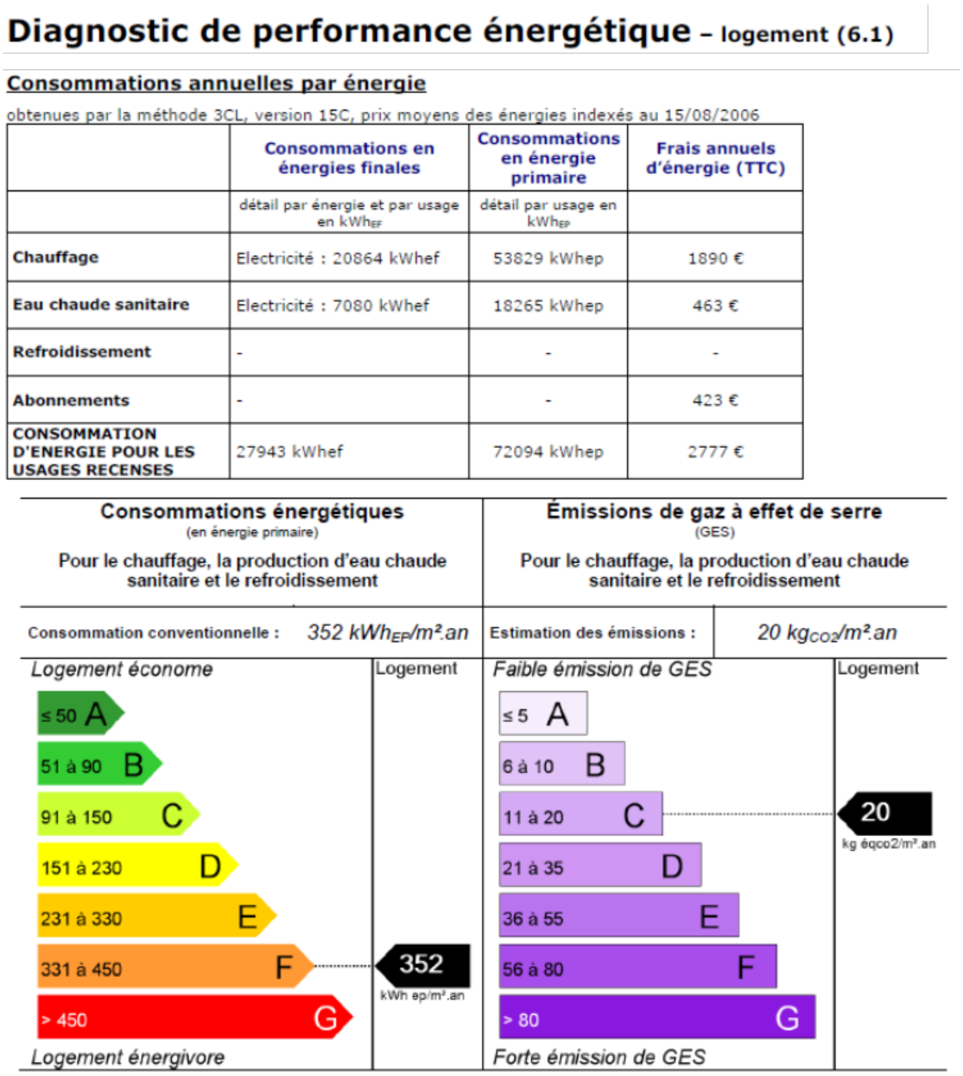
- The calculation takes into account only heating, cooling and DHW production
- The result is expressed per m² of habitable surface and not of gross floor area
- The calculation is realised for each dwelling and not for the whole building
- The calculation method is different from the method for Thermal Regulation

Three calculation methods are applicable, introduced by Executive Order of 9th of November 2006:

- DEL6-DPE and Comfie-DPE, which are based on hourly simulation
- 3CL-DPE, much less complex than the other ones and mostly used for EPC calculations. Latest actualisation of 3CL-DPE is from 17th of October 2012 [3CL-DPE 2012].

The results of the calculation are expressed in

- Delivered energy in kWh/yr
- Annual energy cost in EUR/yr
- Primary energy demand in kWh_{PE}/yr
- Primary energy demand in kWh_{PE}/(m².yr)
- GHG emissions in kg_{CO2}/(m².yr)



Diagnostic de performance énergétique – **logement (6.1)**

Consommations annuelles par énergie

obtenues par la méthode 3CL, version 15C, prix moyens des énergies indexés au 15/08/2006

	Consommations en énergies finales	Consommations en énergie primaire	Frais annuels d'énergie (TTC)
	détail par énergie et par usage en kWh_{EF}	détail par usage en kWh_{EP}	
Chauffage	Electricité : 20864 kWhef	53829 kWhep	1890 €
Eau chaude sanitaire	Electricité : 7080 kWhef	18265 kWhep	463 €
Refroidissement	-	-	-
Abonnements	-	-	423 €
CONSOMMATION D'ENERGIE POUR LES USAGES RECENSES	27943 kWhef	72094 kWhep	2777 €

Consommations énergétiques
(en énergie primaire)
Pour le chauffage, la production d'eau chaude sanitaire et le refroidissement

Consommation conventionnelle : 352 $kWh_{EP}/m^2.an$

Émissions de gaz à effet de serre
(GES)
Pour le chauffage, la production d'eau chaude sanitaire et le refroidissement

Estimation des émissions : 20 $kg_{CO2}/m^2.an$

Figure 31: Example for results out of EPC calculation [DPE OPHM 2009]

Status of NZEB definition for residential buildings in France

For the moment there is no official definition of Nearly Zero-Energy Buildings (NZEBs) in France. Discussions are mainly focused on what is called "Bâtiments à Énergie POSitive" (BEPOS, Buildings with positive energy).

Different approaches to define a BEPOS are observed:

- Buildings respecting RT 2012 requirements with compensation of primary energy demand of heating, cooling, DHW, lighting and auxiliaries by renewable electricity generation on site with annual balancing. Calculation with calculation method Th-BCE 2012. Most BEPOS projects in France use this definition.
- Buildings respecting a more ambitious energy level than RT 2012 (e.g. Cep ≤ 0.9 x Cep,max) with compensation of primary energy demand of heating, cooling, DHW, lighting and auxiliaries by renewable electricity generation on site with annual balancing. Calculation with calculation method Th-BCE 2012. This definition was used for a call of projects by the ADEME Ile-de-France [ADEME 2014].

- The association Effinergie[25] developed last year the label Bepos-effinergie [Effinergie 2013]. It has three main requirements:
  1. The building has to respect requirements of the energy label Effinergie+ what corresponds mainly to a reduction of 20% of the Cep,max and Bbio,max according to RT 2012:
     $\text{Cep,max}_{\text{effinergie+}} = 0{,}8 \text{ x } \text{Cep,max}_{\text{RT2012}}$
     $\text{Bbio,max}_{\text{effinergie+}} = 0{,}8 \text{ x } \text{Bbio,max}_{\text{RT2012}}$
  2. The embodied energy and the potential of eco-mobility must be evaluated
  3. The balance between non-renewable energy demand and energy production on site ($\text{Bilan}_{\text{epnr}}$) mustn't exceed a maximum permitted difference ($\text{Ecart}_{\text{autorisé}}$):
     $\text{Bilan}_{\text{epnr}} \leq \text{Ecart}_{\text{autorisé}}$

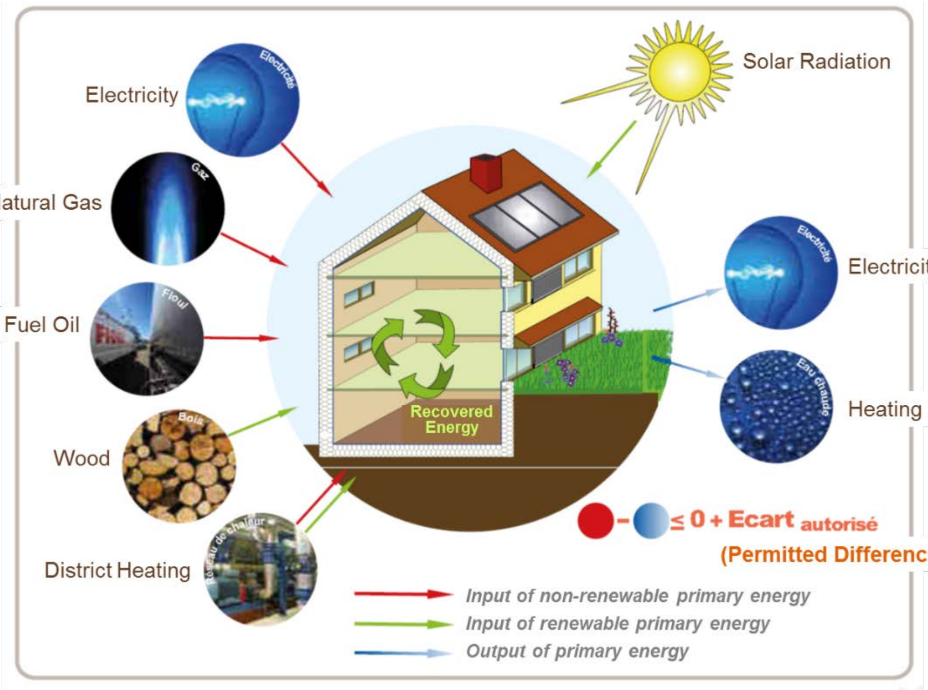


Figure 32: Principe of energy balance for Bepos-effinergie label [Effinergie 2013]

Following primary energy factors are used for the balance calculation:

Energy	Energy input	Energy output
Electicity	2,58	-2,58
Wood	0	
District heating out of renewable energies	0,5 or part of non-renewable	
Other district heating	1,0	
Gas, fuel, other	1,0	

Figure 33: Primary energy factors Bepos-effinergie [Effinergie 2013]

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[25] Effinergie association in France is comparable to Minergie in Suisse and Passivhaus Institute in Germany. It was created in 2006 and promotes low energy buildings, in new constructions or refurbishments. They were at the origins of the “BBC-Effinergie” label in France, in 2007.

The permitted difference $Ecart_{autorisé}$ is calculated by adding the maximum primary energy demand according to Effinergie+ label and the reference consumption of primary energy for all uses which are not taken into account by regulation (specific demand for household appliances, consumer electronics…) and by subtracting the reference production corresponding to the potential of renewable energy production on site:

$Ecart_{autorisé} = Cep,max_{effinergie+} + Aue_{réf} – Prod_{réf}$

	$Aue_{réf}$ [$kWh_{PE}/(m^2.yr)$]
Residential buildings	70
Office buildings	100
Educational buildings, schools, crèches	30

Figure 34: Values for reference consumption of primary energy for all uses which are not taken into account by regulation for Bepos-effinergie [Effinergie 2013]

The potential of renewable energy production on site depends of number of building levels and on climate zone:

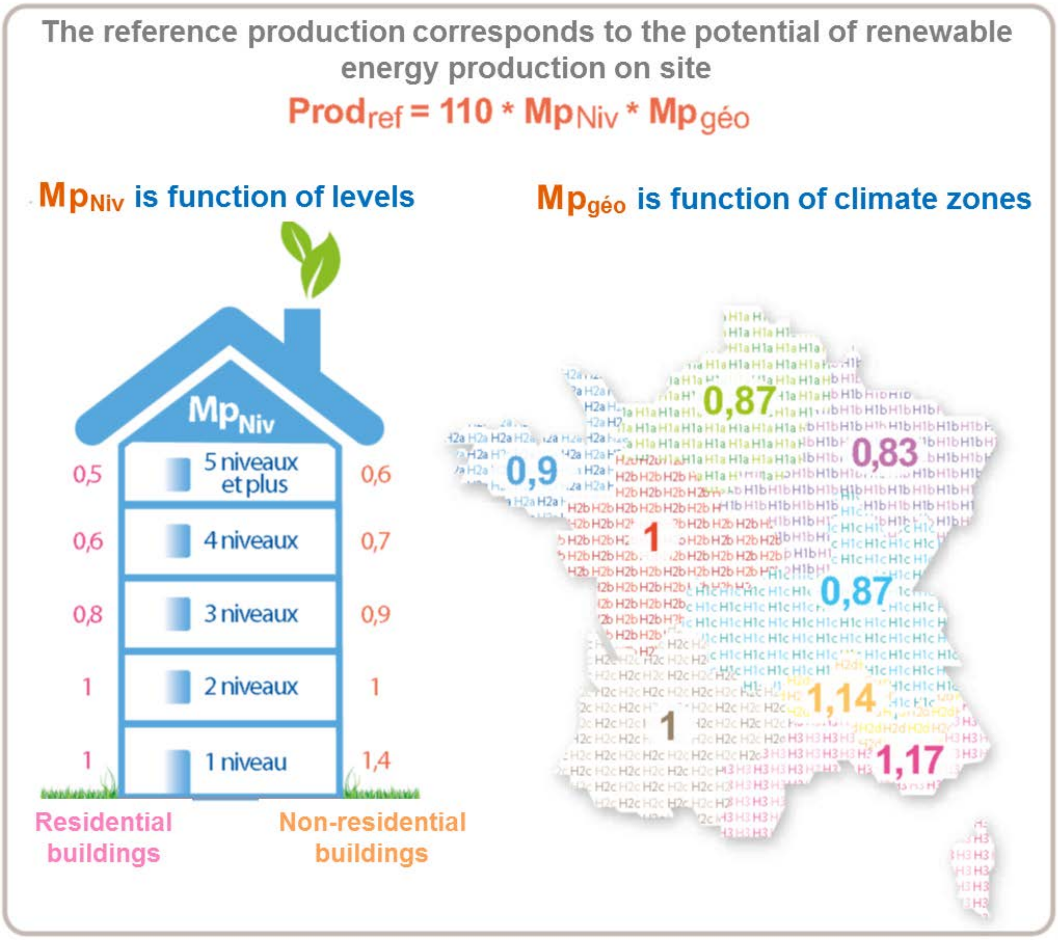


Figure 35: Calculation of renewable energy potential for Bepos-effinergie label [Effinergie 2013]

The label is based on legal calculations of RT 2012. It takes into account all energy uses on site. The perimeter can be one or more buildings concerned by one building license or a development plan.

First buildings are certified “Bepos-effinergie”.

- Another approach considers that energy demand of the buildings has to be reduced further down to passive house level what allows easier to cover the energy demand of all energy uses by renewables energy produced on site or nearby [Rochard 2012]. A passive single family house in the north-east of France only needs about 40 m^2 of PV panels to cover the whole primary energy demand.

  Passive house standard requires a maximum heating demand of 15 $kWh/(m^2.yr)$ and a primary energy demand for all energy uses in the building of 120 $kWh_{PE}/(m^2.yr)$. The values have to be calculated with the Passive House Planning Package (PHPP) for the local climate.

  Considering the wide range of climate conditions in France, the energy performances of the thermal envelope and the HVAC systems of a passive house differs considerably between the north-east and the south of France. Three major zones – almost identical to the 3 superordinate climate zones of thermal regulation H1, H2 and H3 – can be defined regarding the required performances to meet passive house level:

Figure 36: **French climatic zones and segmentation for different passive house variants** [Pouget 2014]

  - North, east and centre of France (climate zone H1 + H2b-NE, lightly bluish coloured): Quality of thermal envelope and systems correspond to build passive houses in Middle Europe (Germany, Switzerland…): U-values of opaque envelope between 0.10 and 0.15 $W/(m^2K)$, triple-glazed windows, balanced ventilation with high efficient heat recovery.
  - Western and south-western France (climate zone H2 without H2b-NE, yellowy coloured): Reduced envelope performance is possible, e.g. using of double-glazed windows.
  - Southern France (climatic zone H3, in red): Passive house level corresponds to effinergie+ label, what means further reduced envelope performance and no need of balanced ventilation with heat recovery.

  If that way energy demand stays more or less at the same level in each zone, it is all the easier to compensate energy demand by PV when going to the south.

Table 75: Overview features current Thermal Regulation Calculation Method compared to the assumed NZEB definition for residential buildings in France

<table>
<tr><th colspan="2">Calculation Method New Building Regulations – (part 1)</th></tr>
<tr><td><table><tr><td>Country</td><td>FR</td><td>FRANCE</td></tr></table></td><td><table><tr><td>Status</td><td>15/07/2014</td></tr></table></td></tr>
<tr><td>National Requirements for New Residential Buildings</td><td>Special Aspects with regard to the assumed French NZEB Definition</td></tr>
<tr><td>Legislation / Standards
Réglementation Thermique 2012 [RT 2012]

Explanation / Comments
RT 2012 is applied in France since 1st of January 2013 for all new residential buildings</td><td>No official French NZEB definition until now. One possible approach is the privately developed label “BEPOS-Effinergie” developed by the association Effinergie.</td></tr>
<tr><td>Energy Services
<table>
<tr><td>x</td><td>Heating</td><td>x</td><td>DHW</td><td></td><td colspan="2">Appliances</td></tr>
<tr><td>x</td><td>Cooling</td><td>x</td><td>Auxiliary</td><td></td><td>Other:</td><td></td></tr>
<tr><td>x</td><td>Ventilation</td><td>x</td><td>Lighting</td><td></td><td></td><td></td></tr>
</table>
Explanation / Comments
All the energy uses on site are taken into account.</td><td>The BEPOS Effinergie label also takes into account all energy uses not considered by regulation with a reference consumption of primary energy (for example: residential buildings: 70 kWhPE/m².yr ; Office buildings 100 kWHPE/m².yr). (this method is on process and is not definitive)</td></tr>
<tr><td><table>
<tr><th colspan="2">Calculation Procedure</th><th>Calculation period</th></tr>
<tr><td>x</td><td>Calculation of energy need for heating (building)</td><td>Hour</td></tr>
<tr><td>x</td><td>Calculation of delivered energy (system)</td><td>Hour</td></tr>
</table>
Explanation / Comments
The calculation period is entirely based on an hourly period for a whole year.</td><td>Same calculation method than thermal regulation 2012.</td></tr>
<tr><td>Consideration of Special Technologies
Thermal Systems
<table>
<tr><td>x</td><td colspan="5">Ventilation system with heat recovery</td></tr>
<tr><td>x</td><td colspan="5">Thermal solar system</td></tr>
<tr><td>x</td><td>Other special systems:</td><td colspan="4">Biomass stoves</td></tr>
<tr><td colspan="2">On-Site Electricity Production</td><td>Feed-in</td><td>Self-use¹</td><td>Balance period to determine self-use¹</td><td>Self-use considered for H-C-W-HE¹</td></tr>
<tr><td>x</td><td>On-site CHP</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>x</td><td>On-site PV</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="5">Other energy generation systems:</td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>
¹ "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments
On-Site Electricity Production:
- The thermal regulation doesn’t make differentiation between “feed-in” and “self-use”.
- In the thermal regulation, for residential buildings, a maximum amount of primary energy of 12 kWh_{PE}/m².yr by on-site PV production can be taken into account</td><td>Same calculation method than thermal regulation 2012.</td></tr>
</table>

Table 75 (continuation)

<table>
<tr><td colspan="7">Calculation Method New Building Regulations – (part 2)</td></tr>
<tr><td>Country</td><td>FR</td><td colspan="3">France</td><td>Status</td><td>15/07/2014</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6">Label BEPOS-Effinergie:
Main requirement:
Balance of non-renewable primary energy ≤ permitted difference
$\text{Bilan}_{epnr} \leq \text{Ecart}_{autorisé}$
The permitted difference is the sum of three elements:
$Cep_{ref} + Aue_{ref} - Prod_{ref}$
Cepréf is the reference consumption of primary energy according to the Effinergie+ label for the uses taken into account by regulation
(Heating, DHW, Room cooling, Lighting, Auxiliary electricity for HVAC)
Aueréf is the reference consumption of primary energy for all uses which are not taken into account by regulation (e.g. 70 $kWh_{PE}/(m^2yr)$ for dwellings)
Prodréf is the reference production corresponding to the potential of renewable energy production on site</td></tr>
<tr><td></td><td>U-values of building elements</td><td rowspan="2">x</td><td rowspan="2">Primary energy</td><td rowspan="2">Agreed weighting factors</td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>Bbio*, Tic</td></tr>
<tr><td colspan="5">Explanation / Comments
* Bbio means bioclimatic need (Besoin bioclimatique) and assess the bioclimatic quality of the building; Tic means summer climate control temperature (Température intérieure conventionnelle).</td></tr>
</table>

Table 76: **Overview features current EPC calculation method compared to the assumed NZEB definition for residential buildings in France**

EPC Calculation Method New Buildings				
Country	**FR**	FRANCE	Status	15/07/2014

Calculation Method for Energy Performance Certificates of New Residential Buildings	**Special Aspects with regard to the assumed National NZEB Definition**
Legislation / Standards	
3-CL-DPE (EPC calculation method)	
Explanation / Comments	
The EPC calculation method differs from the thermal regulation calculation method.	

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling		Auxiliary		Other:	
	Ventilation		Lighting			

Explanation / Comments

Calculation Procedure		Calculation period
x	Calculation of energy need for heating (building)	Year
x	Calculation of delivered energy (system)	Year
	No calculation procedure / only separate requirements for components	

Explanation / Comments

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
x	Other special systems:	Biomass stoves

On-Site Electricity Production		Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
	On-site CHP				
	On-site PV				
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Type of Energy Carrier Assessment			
x	Delivered energy		
x	Primary energy demand	Agreed weighting factor	
x	Carbon dioxide emissions	Non-renewable	
x	Energy costs		
	Other:		

Explanation / Comments

The primary energy demand is calculated with agreed weighting factors (electricity: 2.58 ; other energy: 1).

Assessment of energy carriers in France

French Thermal Regulation in 2000 [RT 2000] defined for the first time legal factors to convert delivered energy to primary energy in context of thermal regulation calculations. Since then the official primary energy factors didn't change and the values were reconfirmed in the legal texts for the following thermal regulations and the EPC calculation method.

There are only two factors:

2.58 kWh_{PE}/kWh_{DE} for electricity
1.0 kWh_{PE}/kWh_{DE} for all other energy carriers

Those factors don't reflect physical reality, they are only agreed factors. No distinction is made between renewable and non-renewable part. Concerning combustibles, the factor is based on delivered energy with net calorific value. Table 77 also reflects a conversion with regards to gross calorific values. The ratio between both has to be taken into account for each combustible:

Natural gas:	gross calorific value = **1.11** net calorific value
Liquid petrol gas	gross calorific value = **1.09** net calorific value
Fuel oil:	gross calorific value = **1.07** net calorific value
Coal:	gross calorific value = **1.04** net calorific value

Table 77: French primary energy factors

Label / type of factor	Primary Energy Factors France	Primary Energy Factors France (converted)
used for EPC rating	x	
used for building regulations requirements	x	
Label (national language)	Coefficient de conversion de l'énergie primaire en énergie finale PCI	Coefficient de conversion de l'énergie primaire en énergie finale PCS
Description / type of weighting factor	Agreed factors, no distinction between renewable and non-renewable parts	Agreed factors, no distinction between renewable and non-renewable parts
Factor is multiplied by delivered energy based on the	Net calorific value	Gross calorific value
Reference	[RT 2012]	[RT 2012]
Fuel	1.0	0.935
Natural gas	1.0	0.900
Liquid gas	1.0	0.917
Electricity	2.58	2.58
Biomass	1.0	1.0
District heating without CHP	1.0	1.0
District heating with 67 % CHP	1.0	1.0
District heating with 100 % CHP	1.0	1.0
District heating biomass without CHP	1.0	1.0

Methodological points for discussion in France

The most relevant discussion points are:

- The introduction of RT 2012 with its strong tightening of requirements obligates to change a lot on traditional way of design and construction methods in the building sector. This happens not without difficulties encountered by building-owners, planers and building companies. In the context of an important slowdown of the construction sector in France the last years this leads to a discussion about complexity of regulations in the building sector and legal calculations. A workgroup was implemented by the government to simplify legislation [France 2014]. Several propositions to lighten requirements of the RT 2012 are analysed, e.g. changing modulation for little buildings, extend exception for multi-family houses to consume 15 % more primary energy, lighten requirement toward minimal window surface and thermal bridges.

- Direct electrical heating is still widespread in French buildings. Part of stakeholders in the energy and building sector blame the RT 2012 for penalising electric heating. They argue that French electricity production has very low greenhouse gas emissions (75 % of electricity production are out of nuclear plants and 15 % out of hydrodynamic power) what is not taken into account by Thermal Regulation [EDEN 2014]. It seems very probable that criteria on greenhouse gas emissions will be introduced in parallel to primary energy criteria in the future environmental label and legislation.
- Regarding the implementation of NZEB and Bepos there is a large discussion about the preconditions to integrate electricity from renewable sources into the French energy system [CRE 2014]. Main points are:
    - Reflections about the scale of Bepos projects. At the moment the approach is basically focused on one building. But the tendency goes to a bigger scale like city block or urban quarter.
    - Reflections who to manage disparity between PV production in summer and higher energy need in winter. Eventual adaptation of balancing periods instead of yearly balance.
    - Valorisation of self-use of electricity produced in connection with buildings.
    - Development of energy storage capacities on each level, for short, medium or long periods and valorisation of storage capacities in the building.
    - Development and generalisation of smart grid in order to manage disparities of demand and production and valorisation of energy management on building level.
- At the moment priority is given by the government to actualise the thermal regulation for energy refurbishments and to harmonise the calculation methods for new and existing buildings. Work on that amendment is in progress and results are expected next year.

  In parallel a workgroup elaborates the basis of a new environmental label for new buildings witch will prepare the future legislation [PRB 2013].

3.8.2 Integration of National Requirements for New Buildings and NZEB Standards in the French Residential Building Typology

A complete version of the national residential building typology was developed in 2012 within the scope of the program RAGE (Règles de l'Art Grenelle de l'Environnement 2012) [RAGE 2012]. It describes a total of 26 types of building families, their urbanistic and architectural characteristics, typical construction methods and elements and major building equipment.

During the TABULA project a French residential building typology was developed within the common TABULA concept. During the EPISCOPE project this typology was actualized and datasets of existing buildings for each building category were entered to the TABULA data structure. The existing set of building pictures was replaced by photos of the existing buildings. The actual typology represents only partly the real building stock with regard to the large diversity of French building stock.

Classification scheme for the French residential building stock (“Building Type Matrix”)

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	National	… 1914	generic	 FR.N.SFH.01.Gen	 FR.N.TH.01.Gen	 FR.N.MFH.01.Gen	 FR.N.AB.01.Gen
2	National	1915 … 1948	generic	 FR.N.SFH.02.Gen	 FR.N.TH.02.Gen	 FR.N.MFH.02.Gen	 FR.N.AB.02.Gen
3	National	1949 … 1967	generic	 FR.N.SFH.03.Gen	 FR.N.TH.03.Gen	 FR.N.MFH.03.Gen	 FR.N.AB.03.Gen
4	National	1968 … 1974	generic	 FR.N.SFH.04.Gen	 FR.N.TH.04.Gen	 FR.N.MFH.04.Gen	 FR.N.AB.04.Gen
5	National	1975 … 1981	generic	 FR.N.SFH.05.Gen	 FR.N.TH.05.Gen	 FR.N.MFH.05.Gen	 FR.N.AB.05.Gen
6	National	1982 … 1989	generic	 FR.N.SFH.06.Gen	 FR.N.TH.06.Gen	 FR.N.MFH.06.Gen	 FR.N.AB.06.Gen
7	National	1990 … 1999	generic	 FR.N.SFH.07.Gen	 FR.N.TH.07.Gen	 FR.N.MFH.07.Gen	 FR.N.AB.07.Gen
8	National	2000 … 2005	generic	 FR.N.SFH.08.Gen	 FR.N.TH.08.Gen	 FR.N.MFH.08.Gen	 FR.N.AB.08.Gen
9	National	2006 … 2012	generic	 FR.N.SFH.09.Gen	 FR.N.TH.09.Gen	 FR.N.MFH.09.Gen	 FR.N.AB.09.Gen
10	National	2012 …	generic	 FR.N.SFH.10.Gen	 FR.N.TH.10.Gen	 FR.N.MFH.10.Gen	 FR.N.AB.10.Gen

Figure 37: Classification scheme ("Building Type Matrix") of the French residential building typology including new buildings since 2012

During the IEE Project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current legal requirements. Figure 37 shows the respective matrix. Three further examples buildings have been identified which are now used for showcase calculations reflecting possible practical implementations of new buildings according to the national minimum requirements and future NZEB standards (Table 78).

Table 78: Exemplary new buildings representing the latest construction year classes (2012 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 FR.N.SFH.10.Gen	 FR.N.TH.10.Gen	 FR.N.MFH.10.Gen	 FR.N.AB.10.Gen
Number of dwellings		1	1	9	29
Number of full storeys (conditioned)		2	1	3	6
Number of directly attached neighbour buildings		0	1	0	0
National reference area (Shon_{RT} / gross floor area)	m^2	131.4	104	591	2606
TABULA reference area (conditioned floor area, internal dimensions)	m^2	103.4	93	539	2210

Building example: variants meeting three energy performance levels for new buildings

In the frame of TABULA concept three energy performance levels were defined for new buildings constructed since 2013 in France. They are specified as follows:

Energy Performance levels France

1. **“Minimum Requirements”** (“RT 2012”)
   Combination of building and supply system that exactly complies with the current minimum legal requirements of RT 2012 in all 8 climate zones. Zone H2 is the critical one and values in Table 80 correspond to zone H2b. The relation to requirement doesn’t vary a lot in the other zones. Lowest value is 92 % in H1c.
2. **“Improved Standard”** (“effinergie+”)
   Level of effinergie+ label corresponding to an improvement of 20 % compared to legal requirements. Valuable for all climatic zones.
3. **“Ambitious Standard / NZEB”** (“Passive House”)
   Level of passive houses. The adjustment was made by PHPP calculation and the described quality of thermal envelope is valid for climate zone H1a witch can be considered as average climate for climate zone H1. The thermal quality of thermal envelope can be reduced in climate zone H2 towards values for effinergie+ standard but maintaining balanced ventilation with heat recovery. In climate zone H3 passive house standard is identical to effinergie+ standard.

The distribution of dwellings between the 3 superordinate climate zones is very unequal. Regarding the existing building stock more than half of total dwellings and three-fourths of dwellings in multi-family houses are in zone H1. Only about 15 % of the dwellings are in zone H3.

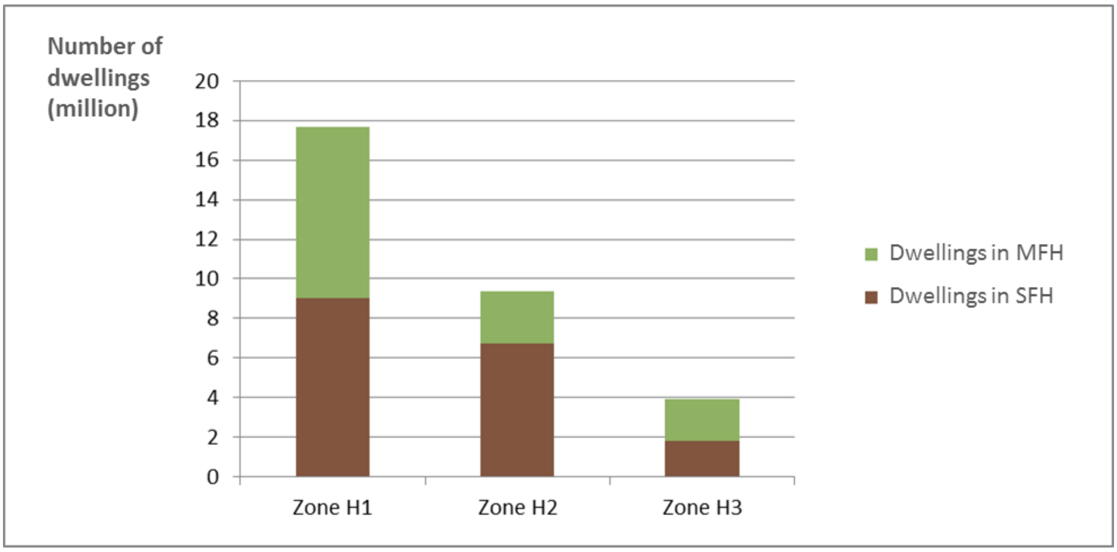
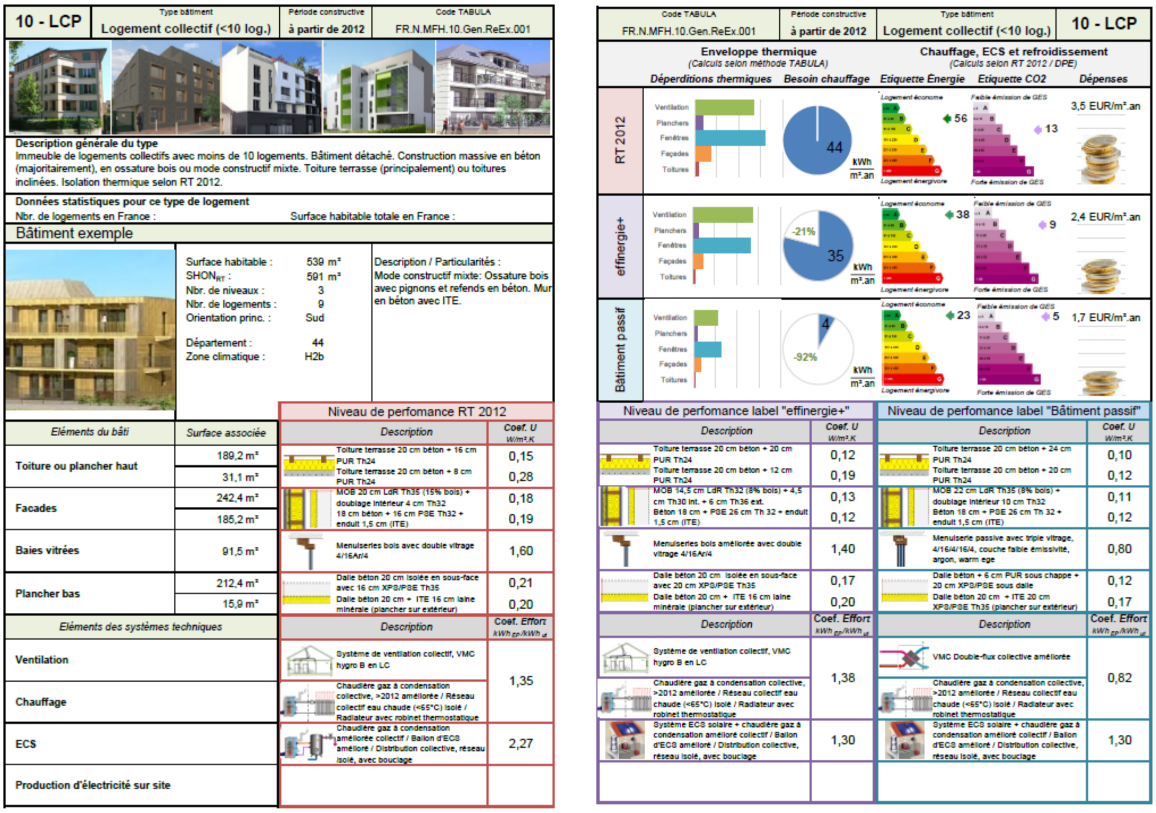


Figure 38: Distribution of dwellings depending on climate zones in France [INSEE 2006]

In the following the exemplary multi-family house is demonstrated in more detail. Table 79 shows the building features for different performance levels. The real building is realised as passive house.



10 - LCP	Type bâtiment Logement collectif (<10 log.)	Période constructive **à partir de 2012**	Code TABULA FR.N.MFH.10.Gen.ReEx.001

Description générale du type
Immeuble de logements collectifs avec moins de 10 logements. Bâtiment détaché. Construction massive en béton (majoritairement), en ossature bois ou mode constructif mixte. Toiture terrasse (principalement) ou toitures inclinées. Isolation thermique selon RT 2012.

Données statistiques pour ce type de logement
Nbr. de logements en France : Surface habitable totale en France :

Bâtiment exemple

Surface habitable :	539 m²
$SHON_{RT}$:	591 m²
Nbr. de niveaux :	3
Nbr. de logements :	9
Orientation princ. :	Sud
Département :	44
Zone climatique :	H2b

Description / Particularités :
Mode constructif mixte: Ossature bois avec pignons et refends en béton. Mur en béton avec ITE.

Niveau de perfomance RT 2012

Eléments du bâti	*Surface associée*	*Description*	*Coef. U* W/m².K
Toiture ou plancher haut	189,2 m²	Toiture terrasse 20 cm béton + 16 cm PUR Th24	0,15
	31,1 m²	Toiture terrasse 20 cm béton + 8 cm PUR Th24	0,28
Facades	242,4 m²	MOB 20 cm LdR Th35 (15% bois) + doublage intérieur 4 cm Th32	0,18
	185,2 m²	18 cm béton + 16 cm PSE Th32 + enduit 1,5 cm (ITE)	0,19
Baies vitrées	91,5 m²	Menuiseries bois avec double vitrage 4/16Ar/4	1,60
Plancher bas	212,4 m²	Dalle béton 20 cm isolée en sous-face avec 16 cm XPS/PSE Th35	0,21
	15,9 m²	Dalle béton 20 cm + ITE 16 cm laine minérale (plancher sur extérieur)	0,20

Eléments des systèmes techniques	*Description*	*Coef. Effort* kWh $_{ep}$/kWh $_{ut}$
Ventilation	Système de ventilation collectif, VMC hygro B en LC	1,35
Chauffage	Chaudière gaz à condensation collective, >2012 améliorée / Réseau collectif eau chaude (<65°C) isolé / Radiateur avec robinet thermostatique	
ECS	Chaudière gaz à condensation améliorée collectif / Ballon d'ECS amélioré / Distribution collective, réseau isolé, avec bouclage	2,27
Production d'électricité sur site		

Code TABULA FR.N.MFH.10.Gen.ReEx.001	Période constructive **à partir de 2012**	Type bâtiment Logement collectif (<10 log.)	**10 - LCP**

Enveloppe thermique *(Calculs selon méthode TABULA)*
Chauffage, ECS et refroidissement *(Calculs selon RT 2012 / DPE)*

	Déperditions thermiques	*Besoin chauffage*	*Etiquette Énergie*	*Etiquette CO2*	*Dépenses*
RT 2012	Ventilation Planchers Fenêtres Façades Toitures	44 kWh/m².an	56	13	3,5 EUR/m².an
effinergie+	Ventilation Planchers Fenêtres Façades Toitures	-21% 35 kWh/m².an	38	9	2,4 EUR/m².an
Bâtiment passif	Ventilation Planchers Fenêtres Façades Toitures	-92% 4 kWh/m².an	23	5	1,7 EUR/m².an

Niveau de perfomance label "effinergie+"		Niveau de perfomance label "Bâtiment passif"	
Description	*Coef. U* W/m².K	*Description*	*Coef. U* W/m².K
Toiture terrasse 20 cm béton + 20 cm PUR Th24	0,12	Toiture terrasse 20 cm béton + 24 cm PUR Th24	0,10
Toiture terrasse 20 cm béton + 12 cm PUR Th24	0,19	Toiture terrasse 20 cm béton + 20 cm PUR Th24	0,12
MOB 14,5 cm LdR Th32 (8% bois) + 4,5 cm Th30 int. + 6 cm Th36 ext.	0,13	MOB 22 cm LdR Th35 (8% bois) + doublage intérieur 10 cm Th32	0,11
Béton 18 cm + PSE 26 cm Th 32 + enduit 1,5 cm (ITE)	0,12	Béton 18 cm + PSE 26 cm Th 32 + enduit 1,5 cm (ITE)	0,12
Menuiseries bois améliorée avec double vitrage 4/16Ar/4	1,40	Menuiserie passive avec triple vitrage, 4/16/4/16/4, couche faible émissivité, argon, warm ege	0,80
Dalle béton 20 cm isolée en sous-face avec 20 cm XPS/PSE Th35	0,17	Dalle béton + 6 cm PUR sous chappe + 20 cm XPS/PSE sous dalle	0,12
Dalle béton 20 cm + ITE 16 cm laine minérale (plancher sur extérieur)	0,20	Dalle béton 20 cm + ITE 20 cm XPS/PSE Th35 (plancher sur extérieur)	0,17
Description	*Coef. Effort* kWh $_{ep}$/kWh $_{ut}$	*Description*	*Coef. Effort* kWh $_{ep}$/kWh $_{ut}$
Système de ventilation collectif, VMC hygro B en LC	1,38	VMC Double-flux collective améliorée	0,82
Chaudière gaz à condensation collective, >2012 améliorée / Réseau collectif eau chaude (<65°C) isolé / Radiateur avec robinet thermostatique		Chaudière gaz à condensation collective, >2012 améliorée / Réseau collectif eau chaude (<65°C) isolé / Radiateur avec robinet thermostatique	
Système ECS solaire + chaudière gaz à condensation amélioré collectif / Ballon d'ECS amélioré / Distribution collective, réseau isolé, avec bouclage	1,30	Système ECS solaire + chaudière gaz à condensation amélioré collectif / Ballon d'ECS amélioré / Distribution collective, réseau isolé, avec bouclage	1,30

Figure 39: “Building Display Sheet” of the exemplary MFH.10 <FR>

Table 79: Exemplary multi-family house (MFH) – definition of variants

 FR.N.MFH.10.Gen		„Natural Gas“		
Variant N°		1	2	3
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
		RT 2012	Effinergie+	Passive House in zone H1
U-values				
Roof	W/(m²K)	0.17	0.13	0.10
Wall	W/(m²K)	0.18	0.13	0.11
Window	W/(m²K)	1.60	1.40	0.80
Door	W/(m²K)	2.00	2.00	1.20
Floor	W/(m²K)	0.21	0.17	0.12
Thermal bridging supplement (whole envelope)	W/(m²K)	0.10	0.05	0.02
Heat Supply System				
Heat generator		Central condensing boiler		
Specification / Supplemental system				
Ventilation system		Exhaust air	Exhaust air	Heat recovery
Thermal solar system			DHW	DHW

In Table 80 results of the national energy balance calculation (second method, see above) are displayed.

Table 80: Exemplary MFH – Results of the energy balance calculation; Procedure: Method Th-BCE 2012

Variant N°		**1**	**2**	**3**
Label of the variant triplet		„Natural Gas“		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		RT 2012 climate zone H2b	Effinergie+ climate zone H2b	Passive House climate zone H1
Calculation method		RT 2012 / Method Th-BCE 2012		
National reference area Shon$_{RT}$*	m²	591		
Besoin bioclimatique Bbio	Points	56.4	44.5	33.6
Relation to requirement		94%	74%	46%
Relation to reference standard		-	93 %	100 %**
Energy need for heating	kWh/(m²yr)	25.2	19.7	11.6
Energy need for DHW	kWh/(m²yr)	25.3	13.5	16.6
Delivered energy				
Fossil fuels	kWh/(m²yr)	50.5	33.2	24.9
Lighting	kWh/(m²yr)	2.0	2.0	2.1
Auxiliary energy	kWh/(m²yr)	2.1	2.8	6.5
Primary energy demand	kWh/(m²yr)	61.8	46.8	48.6
Relation to requirement		99 %	75 %	66 %

*) Surface hors œuvre nette RT 2012

**) relation to requirement of 15 kWh/(m².yr) for heating demand, calculated with PHPP

TABULA calculation results for all exemplary buildings

Table 51 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all four exemplary buildings.

Table 81: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions, climate zone: FR.N)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  FR.N.SFH.10.Gen	01	Minimum Requirement	1.00	57	0	57	50	10	10	0	0	0	0	31	0	0	0
	02	Improved Standard	0.90	50	0	50	43	10	10	0	0	0	0	28	0	0	0
	03	Ambitious Standard / NZEB	0.70	41	16	25	22	10	10	0	0	0	0	18	0	0	0
TH  FR.N.TH.10.Gen	01	Minimum Requirement	1.10	64	0	64	57	10	10	75	0	0	0	9	0	0	0
	02	Improved Standard	0.70	44	0	44	37	10	10	49	0	0	0	9	0	0	0
	03	Ambitious Standard / NZEB	0.50	32	15	17	12	10	10	16	0	0	0	11	0	0	0
MFH  FR.N.MFH.10.Gen	01	Minimum Requirement	0.70	44	0	44	44	15	17	96	0	0	0	3	0	0	0
	02	Improved Standard	0.50	35	0	35	35	15	16	65	0	0	0	4	0	0	0
	03	Ambitious Standard / NZEB	0.30	18	14	4	4	15	16	22	0	0	0	6	0	0	0
AB  FR.N.AB.10.Gen	01	Minimum Requirement	0.50	37	0	37	37	15	15	0	0	0	0	3	76	0	0
	02	Improved Standard	0.40	30	0	30	30	15	15	0	0	0	0	3	68	0	0
	03	Ambitious Standard / NZEB	0.20	18	15	3	3	15	15	0	0	0	0	5	35	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.8.3 Sources / References France

Table 82: Sources / References France

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[3CL-DPE 2012]	Ministry of Energy and Sustainable Development (2012): Arrêté du 17 octobre 2012 modifiant la méthode de calcul 3CL-DPE introduite par l'arrêté du 9 novembre 2006 portant approbation de diverses méthodes de calcul pour le diagnostic de performance énergétique en France métropolitaine	Executive order modifying "3-CL DPE" calculation method
[ADEME 2011]	ADEME (2011): Histoire de la recherche sur l'enveloppe du bâtiment	Research study on building envelope
[ADEME 2014]	ADEME (2014): Appel à projets Session 3 : BEPOS : Bâtiments à Energie Positive et BEPAS : Bâtiments Passifs, Règlement de l'appel à projets	Call for a project on NZEB and passive buildings, rules of the call
[Alexandroff 1979]	Alexandroff, G.; Liebard, A (1979): L'habitat solaire: comment?, L'équerre Editeur, Editions Apogée, Paris	Solar habitats
[COMES 1981]	Ministère de l'environnement et du cadre de vie, COMES, Plan Construction (Editions du Moniteur) (1981): Des maisons solaires dès aujourd'hui	Solar individual houses
[CRE 2014]	Commission de régulation de l'énergie (2014): Synthèse de la consultation publique de la Commission de régulation de l'énergie sur le développement des réseaux électriques intelligents en basse tension	Synthesis on the development of electric intelligent network of the public consultation of the energy regulation commission
[Daussy 1983]	Daussy, J.; Trichard, M. (1983): Pour une meilleure maîtrise de l'énergie dans le secteur résidentiel et tertiaire	Mastering energy in residential and non-residential buildings
[DPE OPHM 2009]	Extrait d'un DPE réalisé pour l'OPH Montreuillois réalisée par ACETEC (2009)	Energy Performance Certificate's extract from an OPHM's building
[EDEN 2014]	Association Equilibre des Energies (2014): Communiqué de presse de l'association Equilibre des Energies	Press release of Equilibre des Energies association
[Effinergie 2013]	Collectif Effinergie (2013): Règles techniques applicables aux bâtiments faisant l'objet d'une demande de label Bepos-effinergie, version 1	BEPOS Effinergie label's technical rules
[Effinergie 2014]	Collectif Effinergie (2014): TABLEAU DE BORD 2014 de la labellisation BBC-Effinergie	BBC-Effinergie label's
[France 2013]	Ministry of Energy and Sustainable Development, DHUP (2013): Plan d'action pour la généralisation des bâtiments dont l'énergie est quasi nulle	National plan for Nearly Zero-Energy buildings Report submitted to the European Commission in 2013
[France 2014]	Working group of Plan Bâtiment Durable on "Objectif 500 000" topic (2014): Objectif 500 000, Simplifier la réglementation et l'élaboration des normes de construction et de rénovation, Rapport du groupe de travail n°1	Working group of Plan Bâtiment Durable on "Building 500 000 new buildings", first report of the group
[Grenelle 1 2009]	Ministry of Energy and Sustainable Development (2009): LOI n° 2009-967 du 3 août 2009 de programmation relative à la mise en œuvre du Grenelle de l'environnement	Grenelle de l'Environnement's official law document
[INSEE 2006]	INSEE (2006): Enquête Nationale Logement réalisée par l'INSEE	French national building enquiry
[Nicolas 1977]	Nicolas, F.; Vaye, M. (1977): Recherches sur les enveloppes bioclimatiques, la face cachée du soleil	Research study on bioclimatic design
[Olive 1989]	Olive, G; Bornarel, A. (1989): Quelques techniques innovantes pour l'habitat	A review of innovative construction techniques for buildings
[PRB 2013]	Working group of Plan Bâtiment Durable on "Réflexion Bâtiment Responsable 2020-2050" topic (2013): Embarquement immédiat pour un bâti sobre, robuste et désirable ; Rapport d'étape du groupe « Réflexion Bâtiment Responsable 2020-2050	Working group of Plan Bâtiment Durable on "Responsible Building Reflexions" (next thermal regulation), first report of the group

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Pouget 2011]	Pouget A., production en interne pour présentations (2011)	Internal production for presentations
[Pouget 2014]	Rochard U., Shanthirabalan S., production en interne pour présentations et/ou pour le présent rapport (2014)	Internal production for presentations
[Rochard 2012]	Rochard, U. (2012): Vers des bâtiments zéro énergie grâce aux bâtiments passifs – La discussion internationale sur les Net Zero Energy Buildings et la situation en France, Paris	Contribution to the Passibat conference: passive buildings towards NZEB
[RT 1974]	Ministry of Energy and Sustainable Development (1974): Arrêté du 10 avril 1974 relatif à l'isolation thermique et au réglage automatique des installations de chauffage dans les bâtiments d'habitation, 1974	Executive order of 1974's French thermal regulation for newly built constructions
[RT 2000]	Ministry of Energy and Sustainable Development (2000): Arrêté du 29 novembre 2000 relatif aux caractéristiques thermiques des bâtiments nouveaux et des parties nouvelles de bâtiments, 2000	Executive order of 2000's French thermal regulation for newly built constructions
[RT 2012]	Ministry of Energy and Sustainable Development (2010): Arrêté du 26 octobre 2010 relatif aux caractéristiques thermiques et aux exigences de performance énergétique des bâtiments nouveaux et des parties nouvelles de bâtiments, 2010	Executive order of 2010's French thermal regulation for newly built constructions
[Th-BCE 2012]	Ministry of Energy and Sustainable Development (2013): Arrêté du 30 avril 2013 portant approbation de la méthode de calcul Th-BCE 2012 prévue aux articles 4, 5 et 6 de l'arrêté du 26 octobre 2010 relatif aux caractéristiques thermiques et aux exigences de performance énergétique des bâtiments nouveaux et des parties nouvelles de bâtiments, 2013	Executive order of 2012's French thermal regulation's calculation method

3.9 <GB> England

(by EPISCOPE partner BRE)

The UK Government has a target for all new homes in England to be ‘zero carbon’ from 2016. This policy is aligned with the Energy Performance of Buildings Directive, which requires all new buildings to be near Zero Energy Buildings (nZEB) from 2020.

NZEB’s build on the history of low energy buildings in the UK. Since the 1970s a wide variety of low energy housing projects have been developed in different parts of the country (including notable early projects at Milton Keynes). In 2005 an ‘Innovation Park’ was established on the Building Research Establishment’s (BREs) main site at Garston, providing demonstration of a number of low to zero carbon homes, showcasing and providing a test bed for innovative construction and technologies. This, together with other projects around the country, are further promoting and helping the construction industry to deliver low to zero carbon homes.

Energy efficiency standards are described in the UK using the Government’s Standard Assessment procedure (SAP) [DECC/BRE, 2014], which also forms the basis of the Energy Performance Certificates (EPCs). These standards have been improved with each revision of Building Regulations, with the intention of fulfilling the commitment of Zero Carbon new homes being built by 2016.

3.9.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in England

Energy conservation was introduced into Building Regulations around the 1970s, initially in terms of insulation U-values. Requirements have been improved in successive revisions of Approved Document Part L1 of the Regulations, and in 1995 a SAP calculation was introduced as a method of compliance. The latest revision of AD L1A came into force in April 2014 [HM Government, 2013], and is another step towards Government commitment of Zero Carbon homes by 2016.

England calculation method to comply with new building regulations for residential buildings

The Government’s Standard Assessment Procedure (SAP) is used for assessing the energy performance of dwellings. The indicators of energy performance are Fabric Energy Efficiency (FEE), energy consumption per unit floor area, energy cost rating (the SAP rating) and Dwelling CO_2 Emission Rate (DER).

The SAP rating is based on the energy costs associated with space heating, water heating, ventilation and lighting, less cost savings from energy generation technologies. It is adjusted for floor area so that it is nearly independent of dwelling size for a given built form. The SAP rating is expressed on a scale of 1 to 100, the higher the number the lower the running costs.

The Dwelling CO_2 Emission Rate is used for testing compliance with building regulations. It is equal to the annual CO_2 emissions per unit floor area for space heating, water heating, ventilation and lighting, less the emissions saved by energy generation technologies, expressed in $kgCO_2/m^2/year$.

The SAP methodology is compliant with the Energy Performance of Buildings Directive, and the indicator of energy performance used for issuing Energy Performance Certificates (EPCs) is the SAP rating, on a scale of 1 to 100.

Reduced Data SAP (RdSAP) was introduced in 2005 as a lower cost method of assessing the energy performance of existing dwellings. Since this report is about new dwellings it is not considered here.

Minimum requirements for new residential buildings in England

Practical guidance about compliance with the requirements of the Building Regulations 2010 for England is given in a series of documents which have been approved by the Secretary of State (AD L1A) [HM Government, 2013].

The Target CO_2 Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE) are minimum energy performance requirements for a new dwelling, calculated using the latest version of SAP (SAP2012) [DECC/BRE, 2014].

- The TER is a target CO_2 emissions per square metre of floor area per year (kg $CO_2/m^2/yr$)
- The TFEE is a target energy demand per square metre of floor area per year ($kWh/m^2/yr$)

The TER is calculated for a dwelling of the same size and shape as the actual dwelling, using a set of reference values (e.g. U-values, airtightness, gas fuel, heating system efficiency and controls). The space heating and hot water CO_2 emissions value is adjusted using a fuel factor (e.g. gas 1.0, oil 1.17, electricity 1.55), before adding the CO_2 emissions values for pumps, fans and lighting. This total gives the TER.

The TFEE is also calculated for a dwelling of the same size and shape as the actual dwelling, using the same set of reference values (e.g. U-values, airtightness, gas fuel, heating system efficiency and controls). This is multiplied by 1.15 to give the TFEE.

The Dwelling CO_2 Emission Rate (DER) and Dwelling Fabric Energy Efficiency (DFEE) must be no worse than the TER and TFEE, to meet the requirements of Building Regulations.

In addition to this, there are four further requirements.

- The performance of individual fabric elements (e.g. walls, roof, floor) and fixed building services (e.g. heating system) must be no worse than a set of defined values listed in AD L1A.
- The dwelling should have appropriate passive control measures to limit the effect of heat gains on indoor temperatures in summer. (Guidance is given in AD L1A).
- The performance of the dwelling as built should be consistent with the DER and DFEE. (Guidance is given in AD L1A).
- The necessary provisions for enabling energy efficiency operation of the dwelling should be put in place. (Guidance is given in AD L1A).

Status of NZEB definition for residential buildings in England

The UK Government already has a target for all new homes in England to be ‘zero carbon’ from 2016 and an ambition for all new non-domestic buildings in England to be zero carbon from 2019 (2018 for new public sector buildings).

The proposed definition of a Zero Carbon new home [ZCH, 2014] consists of three core requirements.

1. Reduce energy demand through fabric energy efficiency. The fabric performance of the property must, at a minimum, comply with the Fabric Energy Efficiency Standard (FEES). This is measured in terms of $kWh/m^2/year$ energy demand.
2. Any CO_2 emissions that remain after consideration of fabric performance, heating, cooling, fixed lighting and ventilation, must be less than or equal to the Carbon Compliance limit established for Zero Carbon homes. This is measured in $kg/m^2/year$ of CO_2.
3. Any remaining CO_2 emissions, from the use of regulated energy sources in the property, must be reduced to zero. This requirement can be met by either overperforming on requirements 1 & 2, or by investing in off-site carbon reduction projects via Allowable Solutions [DCLG, 2014].

Further details are not yet available, but are likely to follow the existing methods already in use for building regulations and the EPC methodology (i.e. SAP based calculations for CO_2 and energy use.

Table 83: **Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition in England**

Calculation Method New Building Regulations – (part 1)

Country	GB	England	Status	July 2014

National Requirements for New Residential Buildings	Special Aspects with regard to the (assumed) National NZEB Definition
Legislation / Standards The Government's Standard Assessment Procedure for Energy Rating of Dwellings 2012 edition (SAP2012 version 9.92), dated October 2012 (rev February 2014 to include TER calculation for Wales) [DECC/BRE, 2014]. **Explanation / Comments**	The UK Government consider that the approach they are adopting for Zero Carbon Homes from 2016 will meet the definition of NZEB.

Energy Services

x	Heating	x	DHW		Appliances
x	Cooling	x	Auxiliary		Other:
x	Ventilation	x	Lighting		

Explanation / Comments

Cooling systems are not usually installed in English residential buildings.

Does not include non-fixed lighting, cooking, other electrical items, appliances.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Month

Explanation / Comments

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
x	Other special systems:	See SAP Appendix Q for more details [DECC/BRE, 2014].

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x	x	Year	H-C-W-HE*
x	On-site PV	x	x	Year	H-C-W-HE*
x	Other energy generation systems:				
	Hydro-electric, Wind turbines	x	x	Year	H-C-W-HE*

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

*Household electricity only includes fixed lighting and energy for pumps and fans in SAP.

Table 83 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>Country</td><td>GB</td><td colspan="3">England</td><td>Status</td><td>July 2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the (assumed) National NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6"></td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2"></td><td rowspan="2">Primary energy</td><td rowspan="2"></td></tr>
<tr><td>x</td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td>Energy need for heating</td><td>x</td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>air permeabilityheating efficiency & controls</td></tr>
<tr><td colspan="5">Explanation / Comments
The Target CO2 emissions (TER, kg $CO_2/m^2/yr$), is calculated for a dwelling of the same size and shape as the actual dwelling, using a set of reference values (e.g. U-values, airtightness, gas fuel, heating system efficiency and controls). The space heating and hot water CO2 emissions value is adjusted using a fuel factor (e.g. gas 1.0, oil 1.17, electricity 1.55), before adding the CO2 emissions values for pumps, fans and lighting. This total gives the TER.
The Target Fabric Energy Efficiency (TFEE, $kWh/m^2/yr$) is also calculated for a dwelling of the same size and shape as the actual dwelling, using the same set of reference values (e.g. U-values, airtightness, gas fuel, heating system efficiency and controls). This is multiplied by 1.15 to give the TFEE.
In addition, the performance of individual fabric elements (e.g. walls, roof, floor) and fixed building services (e.g. heating system) must be no worse than a set of defined values

The EU has suggested primary energy consumption ($kWh/m^2/year$) as a common metric across Member States. The UK EPC rating is in terms of total fuel cost, and also shows a rating in terms of CO_2 emissions and primary energy.
The EPC also states the primary and delivered energy demand.</td></tr>
</table>

Assessment of energy carriers in England

In the UK the energy performance of buildings is normally assessed using the following.

- The ‘SAP rating’, based on annual energy costs and adjusted for floor area to be nearly independent of dwelling size for a particular house type; used for EPCs.
- CO_2 equivalent emissions per unit floor area per year ($kgCO_2/m^2/yr$); for Building Regulations.
- Primary energy may also be calculated but is not often used.

The SAP rating is the ‘Energy Efficiency’ rating on UK Energy Performance Certificates, and for each fuel (energy carrier) takes account of the cost per kWh and standing charge. These costs are averages for the previous three years, to reduce the effect of short term fluctuations. They are derived using information from a specialist consultant and updated every six months.

CO_2 equivalent annual emissions are used for calculation of the DER and TER to determine compliance with Building Regulations. The kg CO_2/kWh factors for each fuel (energy carrier) are updated with each revision of SAP, approximately every three years. The following describes some key issues relating to their derivation.

CO_2 equivalent emissions

Carbon dioxide (CO_2) is one of the main products of fuel combustion, however, N_2O and CH_4 are also side products of the fuel combustion process or released directly from the energy supply chain. N_2O and CH_4 have global warming potentials of 21 and 310, compared to 1 for CO_2. The global warming impact of CH_4 and N_2O is generally small compared to that of CO_2 for most fossil fuels, but can be significant, in particular for fuels from biomass sources. Taking account of CH_4 and N_2O provides a more accurate reflection of the impacts of energy use, therefore the current SAP 2012 emission factor methodology includes the impacts of CO_2, CH_4 and N_2O measured as CO_2e (CO_2 equivalent).

Upstream transport emissions and emissions sources outside of the UK within the system boundary

In addition to the emissions released directly from fuel combustion there are other emission sources that occur upstream of the final user. These include fugitive emissions, such as natural gas leakage, and emissions arising from fuel and electricity used during production and distribution. The system boundary starts when production begins: for fossil fuels this will be extraction, and for fuels derived from biomass this will be cultivation. For waste products this will be transportation from the location where the waste is produced. The final stage included in the boundary is energy use in the building.

Taking account of emissions associated with transporting fuels and extending the coverage of upstream emissions beyond the UK boundary is appropriate because GHG emissions have a global impact and this methodology more accurately reflects the total environmental impacts. This could be particularly important for imports of liquefied natural gas where upstream emissions from compression and shipping are significant. The emission factor methodology therefore includes transport emissions and emissions that occur outside of the UK for energy imports in so far as data availability allows.

Grid supply fuels displaced by onsite generation (e.g. electricity exported to the grid)

In previous versions of SAP, a marginal emission factor was applied to electricity exported to the grid, whilst the system average value was applied to grid electricity supply. This was to encourage greater take up of on-site electricity generation. It was justified on the basis that it would lead to additional energy savings in comparison to those included in the system average emission factors as, at that time, on-site renewable electricity generation was not explicitly included in the energy projections.

This use of a marginal emission factor has been removed in the current SAP 2012 methodology as policies are in place to support the uptake of on-site electricity generation and these are included in the electricity generation projections and hence the system average values. Furthermore, it removes the inconsistency in the treatment of different types of carbon saving technologies[26]. System average emission factors are therefore applied to both energy use and to avoided grid supply energy generation, for example electricity exported to the grid from on-site generation.

Emission factors apply to the relevant compliance period

For most energy sources the carbon impacts are not expected to change over time so the current emission factor may be used. This is not the case for grid supply energy sources, in particular for electricity where substantial changes in the generation mix can be anticipated. In addition it was necessary to consider the impact of increasing amounts of imported liquefied natural gas (LNG) in the UK gas grid on the emission factor for mains gas.

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[26] E.g. on site renewable electricity generation compared to increased equipment energy efficiency.

For the previous SAP methodology, SAP 2009, the electricity emission factor was based on the projected average value between 2010 and 2015. This reflected the timescale of its use for new build projects, i.e. three year compliance period plus two years between approval and completion.

A longer term forecast provides a better basis for considering future policy options, and from a design perspective it better reflects the lifetime of the building. However, disadvantages include increased uncertainty about the future mix of energy supply, and also changes to building services can significantly affect the actual energy performance. In addition there is a concern that an emission factor that expects decarbonisation of the grid could encourage building designers to choose an electric, rather than fossil fuel, heating system, and as a result increase the electricity demand so it greatly exceeds projections.

Exclusion of carbon dioxide emissions from combustion of bio-genic fuel sources

Carbon emissions that arise directly from the combustion of bio-genic materials (derived from plant or animal sources, provided they are derived from sustainable biomass sources) form part of the carbon cycle and so do not lead to a net increase in atmospheric CO_2 emissions over the long term. Thus, excluding carbon dioxide arising directly from combustion of bio-genic carbon is justified and in line with major end user carbon accounting methodologies e.g., GHG reporting protocol [WBCSD, 2005].

In the UK most biomass sources are from proven sustainable sources, much of which is derived from the waste stream, so excluding carbon dioxide emissions from bio-genic sources is entirely appropriate. However direct emissions of CH_4 and N_2O from combustion and all other non-bio-genic upstream GHG emission sources should be included. Carbon dioxide emissions from the combustion of bio-genic fuel sources are therefore excluded from the SAP emission factors.

Primary energy factors

SAP 2012 is required to calculate primary energy consumption in line with the requirements of the recast EPBD. The definition of primary energy used to calculate the SAP factors can be summarised as follows: Primary energy includes all energy found in nature that has not been subjected to any conversion or transformation process. It includes the energy contained in raw fuels as well as other forms of energy received as input to the energy supply system. Primary energy covers both renewable and non-renewable energy sources and the definition used here is in accordance with EN 15316-4-5 which states that "....Waste heat, surplus heat and regenerative heat sources are included by appropriate primary energy factors.“

Whilst for most fuels defining this is relatively straightforward there are some fuels where it is less clear. To treat the electricity generated by solar, hydro, wind generation, biomass sources and waste as primary energy a statistical convention assigns these a primary energy factor of 1 at the point of generation. Any subsequent energy use associated with the distribution of energy from renewable sources and losses are included in the primary energy factor.

Electricity generated from nuclear sources is often derived from plutonium which is not naturally occurring and is therefore classed as a secondary energy source. So the primary energy factor should also take account of energy use associated with nuclear fuel processing as well as thermal losses during steam generation and subsequent generation and supply of electricity.

In the current SAP 2012, primary energy factors include renewable and non- renewable sources and are determined using the same scope and timeframe used to calculate the CO_2 emission factors.

Table 84: Primary Energy Factors and CO2 emission factors

Label / type of factor	Primary Energy Factors GB / England	CO2 Equivalent Factors GB / England
used for EPC rating		x
used for building regulations requirements		x
Label (national language)	SAP 2012 methodology	SAP 2012 methodology
Description / type of weighting factor	Incorporating upstream losses etc. Full details can be found [BRE, 2011].	Based on CO_2e emissions, incorporating additional upstream losses etc. Full details can be found [BRE, 2011].
Factor is multiplied by delivered energy based on the	Gross calorific value H_s	Gross calorific value H_s
Reference	[DECC/BRE, 2014]	[DECC/BRE, 2014]
Unit		kg CO_2 per kWh
Natural gas	1.22	0.216
Liquid gas	1.09	0.241
Heating oil	1.10	0.298
Coal	1.00	0.394
Electricity	3.07	0.519

Methodological points for discussion in England

Allowable Solutions: The UK has a target for all new homes to meet the Zero Carbon Standard from 2016, however the government has recognised that it is not always technically feasible or cost effective to meet the zero carbon homes standard purely through measures on site, so while stretching on site standards from 2016, there will also be put in place a flexible mechanism to meet the remainder of the zero carbon target by allowing off-site carbon abatement termed ‘allowable solutions’ [DCLG, 2014].

3.9.2 Integration of National Requirements for New Buildings and NZEB Standards in the English Residential Building Typology

The basis of the data used for the English results is the English Housing Survey. The English Housing Survey is a survey carried out in England annually to collect information about householders, their housing condition and energy efficiency. The key aspects of information collected include dimensions/dwelling size, energy, disrepair and hazards and other household information. The Survey is split into 2 parts,

- A household interview – around 13,300 householders per year
- Physical inspection by a qualified surveyor of a sample of properties – 6200 properties per year

Analysis of the data is typically conducted on two or more years of combined data.

Classification scheme for the English residential building stock ("Building Type Matrix")

The building type matrix has been extended for new buildings, reflecting the current requirements for new build [HM Government, 2013], and also improved and exemplary buildings reflecting the target of zero carbon new build in 2016. Figure 40 shows the matrix of all dwelling types considered in the English typology.

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	England	… 1918	generic	 GB.ENG.SFH.01.Gen	 GB.ENG.TH.01.Gen	 GB.ENG.MFH.01.Gen	 GB.ENG.AB.01.Gen
2	England	1919 … 1944	generic	 GB.ENG.SFH.02.Gen	 GB.ENG.TH.02.Gen	 GB.ENG.MFH.02.Gen	 GB.ENG.AB.02.Gen
3	England	1945 … 1964	generic	 GB.ENG.SFH.03.Gen	 GB.ENG.TH.03.Gen	 GB.ENG.MFH.03.Gen	 GB.ENG.AB.03.Gen
4	England	1965 … 1980	generic	 GB.ENG.SFH.04.Gen	 GB.ENG.TH.04.Gen	 GB.ENG.MFH.04.Gen	 GB.ENG.AB.04.Gen
5	England	1981 … 1990	generic	 GB.ENG.SFH.05.Gen	 GB.ENG.TH.05.Gen	 GB.ENG.MFH.05.Gen	 GB.ENG.AB.05.Gen
6	England	1991 … 2003	generic	 GB.ENG.SFH.06.Gen	 GB.ENG.TH.06.Gen	 GB.ENG.MFH.06.Gen	 GB.ENG.AB.06.Gen
7	England	2004 … 2009	generic	 GB.ENG.SFH.07.Gen	 GB.ENG.TH.07.Gen	 GB.ENG.MFH.07.Gen	 GB.ENG.AB.07.Gen
8	England	2010 …	generic	 GB.ENG.SFH.08.Gen	 GB.ENG.TH.08.Gen	 GB.ENG.MFH.08.Gen	 GB.ENG.AB.08.Gen

Figure 40: Classification scheme ("Building Type Matrix") of the English residential building typology including new buildings (post 2010)

Table 85: Exemplary new buildings representing the latest construction year classes (2010 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 GB.ENG.SFH.08.Gen	 GB.ENG.TH.08.Gen	 GB.ENG.MFH.08.Gen	
Number of dwellings		1	1	16	
Number of full storeys (conditioned)		2	2	3	
Number of directly attached neighbour buildings		0	1	0	
National reference area (Conditioned floor area)	m²	149	98	994	
TABULA reference area (conditioned floor area, internal dimensions)	m²	149	98	994	

Building example: variants meeting three energy performance levels for new buildings

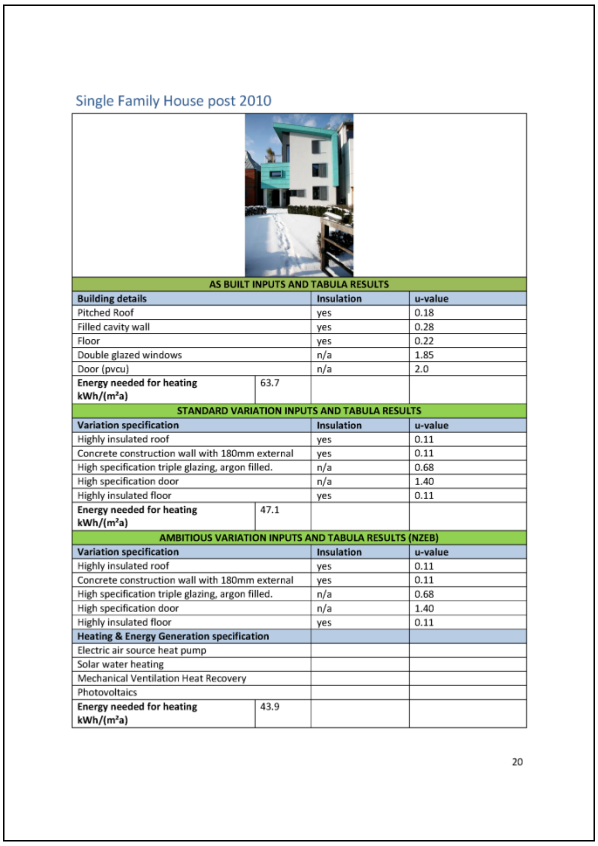
An exemplary single-family house is given in more detail below. Comparable information for the other building types can be found in the updated national typology brochure and the underlying work report.

Energy Performance Levels

1. **Minimum Requirements:** Combination of building fabric and heating system which meets the current building regulations Part L (2010).
2. **Improved Standard:** Current building regulation standards, with improved fabric performance.
3. **Ambitious Standard:** Meets the standard of the Code for Sustainable Homes Level 6 for energy which requires a net zero carbon emissions as calculated by the SAP methodology.

Table 86: Exemplary single-family house (SFH) – definition of variants

Label of the variant triplet		**SFH post 2010**		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values				
Roof	W/(m²K)	0.18	0.11	0.11
Wall	W/(m²K)	0.28	0.11	0.11
Window	W/(m²K)	1.85	0.68	0.68
Door	W/(m²K)	2.00	1.4	1.4
Floor	W/(m²K)	0.22	0.11	0.11
Thermal bridging supplement (whole envelope)	W/(m²K)	0.05	0.02	0.02
Heat Supply System				
Heat generator		Condensing boiler		electric heat pump
Specification / Supplemental system				
Ventilation system		natural	natural	Heat recovery
Thermal solar system		-	-	DHW
Further system				PV



Single Family House post 2010

AS BUILT INPUTS AND TABULA RESULTS			
Building details		**Insulation**	**u-value**
Pitched Roof		yes	0.18
Filled cavity wall		yes	0.28
Floor		yes	0.22
Double glazed windows		n/a	1.85
Door (pvcu)		n/a	2.0
Energy needed for heating kWh/(m²a)	63.7		
STANDARD VARIATION INPUTS AND TABULA RESULTS			
Variation specification		**Insulation**	**u-value**
Highly insulated roof		yes	0.11
Concrete construction wall with 180mm external		yes	0.11
High specification triple glazing, argon filled.		n/a	0.68
High specification door		n/a	1.40
Highly insulated floor		yes	0.11
Energy needed for heating kWh/(m²a)	47.1		
AMBITIOUS VARIATION INPUTS AND TABULA RESULTS (NZEB)			
Variation specification		**Insulation**	**u-value**
Highly insulated roof		yes	0.11
Concrete construction wall with 180mm external		yes	0.11
High specification triple glazing, argon filled.		n/a	0.68
High specification door		n/a	1.40
Highly insulated floor		yes	0.11
Heating & Energy Generation specification			
Electric air source heat pump			
Solar water heating			
Mechanical Ventilation Heat Recovery			
Photovoltaics			
Energy needed for heating kWh/(m²a)	43.9		

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Figure 41: Building Display Sheet” of the exemplary SFH <GB> [from BRE, 2014]

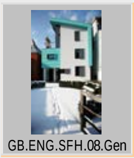
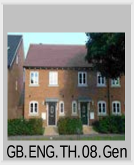
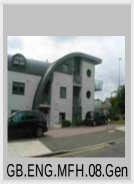
Table 87: Exemplary SFH – Results of the energy balance calculation; Procedure: SAP Methodology (2009) [DECC/BRE, 2011].

Variant N°		**001**	**002**	**003**
Label of the variant triplet		SFH post 2010		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		Current building regulations. Part L1A (2010)	Improved fabric only	Zero carbon (code for sustainable homes level 6)
Calculation method		SAP (2009) [DECC/BRE, 2011]		
National reference area (conditioned floor area)	m²	149	149	149
Total fabric heat loss	W/K	137	66	66
Space heating energy requirement	kWh/yr	6325	2666	244
Water heating energy requirement	kWh/yr	2708	2761	993
Pumps and fans energy requirement	kWh/yr	175	175	393
Lighting energy requirement	kWh/yr	503	505	505
PV energy generation	kWh/yr	0	0	-2404
SAP rating (1-100)		84	88	101
SAP band (G-A)		B	B	A
EI rating (1-100)		85	90	101
EI band (G-A)		B	B	A
Primary Energy	kWh/ m²/yr	75	50	-5

TABULA calculation results for all exemplary buildings

Table 88 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 88: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m^2K)	q_h_nd kWh/(m^2a)	q_ve_rec_h_usable kWh/(m^2a)	q_h_nd_net kWh/(m^2a)	q_g_h_out kWh/(m^2a)	q_w_nd kWh/(m^2a)	q_g_w_out kWh/(m^2a)	q_del_sum_gas kWh/(m^2a)	q_del_sum_oil kWh/(m^2a)	q_del_sum_coal kWh/(m^2a)	q_del_sum_bio kWh/(m^2a)	q_del_sum_el kWh/(m^2a)	q_del_sum_dh kWh/(m^2a)	q_del_sum_other kWh/(m^2a)	q_exp_sum_el kWh/(m^2a)
SFH  GB.ENG.SFH.08.Gen	01	Minimum Requirement	1.00	64	0	64	59	10	15.9	89	0	0	0	1	0	0	0
	02	Improved Standard	0.44	47	0	47	42	10	15.9	69	0	0	0	1	0	0	0
	03	Ambitious Standard / NZEB	0.44	44	22	22	18	10	15.9	0	0	0	0	27	0	0	0
TH  GB.ENG.TH.08.Gen	01	Minimum Requirement	0.98	65	0	65	60	10	15.9	91	0	0	0	1	0	0	0
	02	Improved Standard	0.43	47	0	47	42	10	15.9	69	0	0	0	1	0	0	0
	03	Ambitious Standard / NZEB	0.43	44	22	22	18	10	15.9	0	0	0	0	26	0	0	0
MFH  GB.ENG.MFH.08.Gen	01	Minimum Requirement	0.64	51	0	51	46	15	20.9	80	0	0	0	1	0	0	0
	02	Improved Standard	0.27	35	0	35	30	15	20.9	61	0	0	0	1	0	0	0
	03	Ambitious Standard / NZEB	0.27	32	20	12	8	15	20.9	0	0	0	0	28	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m^2K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m^2a)	energy need for heating
q_ve_rec_h_usable	kWh/(m^2a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m^2a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m^2a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m^2a)	net energy need domestic hot water
q_g_w_out	kWh/(m^2a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, …_el	kWh/(m^2a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m^2a)	sum produced electricity (negative value)

3.9.3 Sources / References England

Table 89: Sources / References England

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[BRE, 2011]	Pout, C.: Proposed Carbon Emission factors and Primary Energy Factors for SAP 2012. BRE, 2011. http://www.bre.co.uk/filelibrary/SAP/2012/STP11-CO204_emission_factors.pdf	Proposed Carbon Emission factors and Primary Energy Factors for SAP 2012. Pout, C. BRE, 2011.
[BRE, 2014]	BRE: EPISCOPE Building Typology Brochure, July 2014.	EPISCOPE Building Typology Brochure, July 2014.
[DCLG, 2014]	Department for Communities and Local Government: Next steps to zero carbon homes – Allowable Solutions. Government response and summary of responses to the consultation. July 2014: https://www.gov.uk/government/consultations/next-steps-to-zero-carbon-homes-allowable-solutions	Latest update on definition of 'Allowable Solutions' 8 July 2014
[DECC/BRE, 2011]	DECC/BRE: The Standard Assessment Procedure for the Energy Rating of Dwellings (SAP). 2009 edition, v9.90. http://www.bre.co.uk/sap2009	The Standard Assessment Procedure for the Energy Rating of Dwellings (SAP). 2009 edition, v9.90.
[DECC/BRE, 2014]	DECC/BRE: The Standard Assessment Procedure for the Energy Rating of Dwellings (SAP). 2012 edition, v9.92. http://www.bre.co.uk/sap2012	The Standard Assessment Procedure for the Energy Rating of Dwellings (SAP). 2012 edition, v9.92
[HM Government, 2013]	The Building Regulations 2010. Approved Document L1A. Conservation of fuel and power in new dwellings, 2013 Edition.	The Building Regulations 2010. Approved Document L1A. Conservation of fuel and power in new dwellings, 2013 Edition.
[WBCSD, 2005]	World Business Council for Sustainable Development: The GHG protocol for project accounting. 2005. www.ghgprotocol.org/standards/project-protocol	The GHG protocol for project accounting. World Business Council for Sustainable Development, 2005.
[ZCH, 2014]	Zero carbon homes & nearly zero energy buildings. UK Building Regulations & EU Directives. Zero Carbon Hub http://www.zerocarbonhub.org/sites/default/files/resources/reports/ZCHomes_Nearly_Zero_Energy_Buildings.pdf	Zero carbon homes & nearly zero energy buildings. UK Building Regulations & EU Directives. Zero Carbon Hub

3.10 <GR> Greece

(by EPISCOPE partner NOA)

About thirty-five years ago, the concept of “bioclimatic architecture” was introduced in Greece. Over the years, there have been several buildings that have been constructed in the framework of European (e.g. Altener, Thermie) and national programmes (e.g. the Operational Programme for Energy during the mid-90s) for demonstration purposes and some as a result of the owners’ initiative, which exhibit low energy performance. The majority are single family houses and some commercial exemplary buildings [KAPE 2002]. General guidelines and design principles [YPEKA Bioclimatic] are covered in a multitude of publications. The large scale application remains the Solar Village in Athens, an integration of active and passive solar systems for space and water heating in residential buildings for 1750 inhabitants, operating since the late 1980s.

The evolution of the technical regulatory framework has been very slow. The first Hellenic building thermal insulation regulation (TIR) was introduced at the end of 1979 (FEK362/4.7.1979). The maximum allowable U-value requirements for the building envelope remained in-force without any adaptation for about 30 years. They were finally revised in 2010 by the Hellenic regulation on the energy performance in the building sector (KENAK) in compliance with EPBD [Dascalaki et al. 2012]. As a result, the U-values for the building’s thermal envelope became more stringent and minimum specifications were also introduced for the electromechanical (E/M) installations.

Transposition of the EPBD recast into national law has been introduced by [N.4122/2013] that covers the general regulatory framework and provisions of the Directive. However, the work for the minimum energy performance requirements and nearly zero energy buildings (NZEBs) has not been initiated nor defined.

A relevant reference for buildings with minimum energy consumption and exceptional environmental performance is introduced in the new national building code [NOK 2012]. Accordingly, these buildings should have a maximum total annual primary energy consumption of 10 kWh/m^2 for HVAC, domestic hot water and lighting, without any differentiation (e.g. building end-use, climate zone). Apparently, this is a rather unrealistic benchmark.

The Passive House concept is currently being promoted in the Hellenic market by the Hellenic Passive House Institute [EIPAK] that collaborates with the International Passive House Association and the Passiv Haus Institut in Greece.

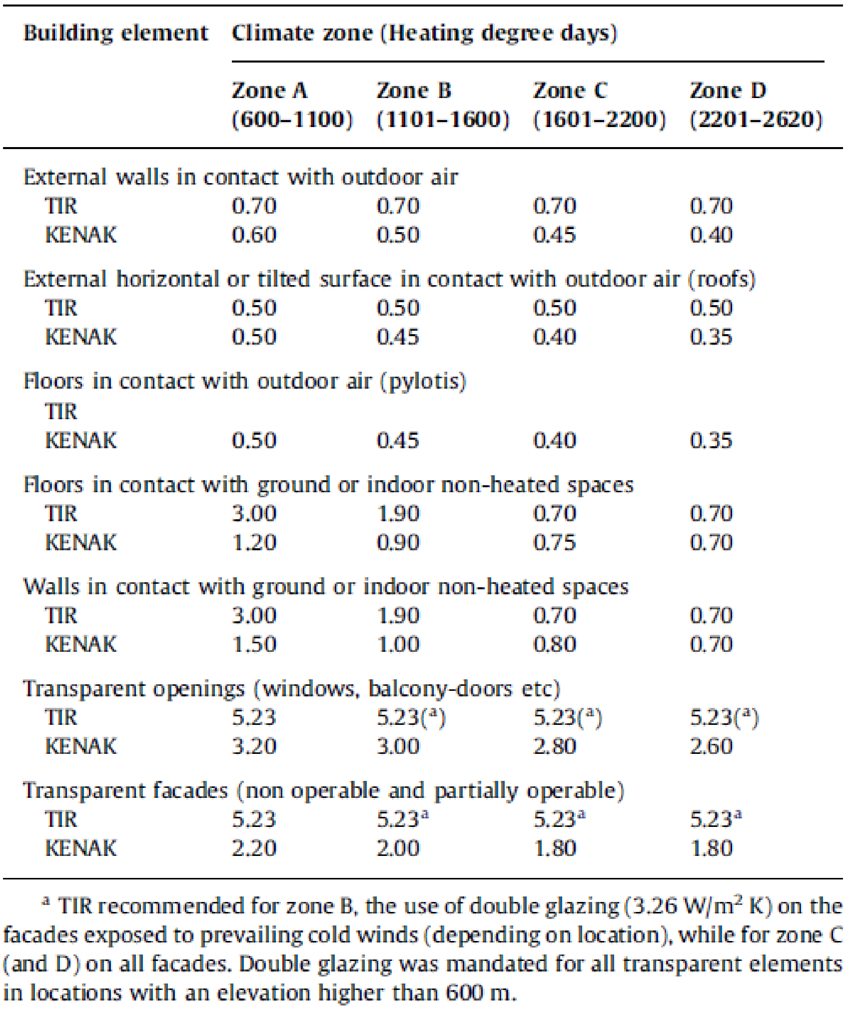
3.10.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Greece

Since 2010, new buildings are constructed according to the new Hellenic regulation on the energy performance in the building sector [KENAK]. As of July 2014, the work for evaluating minimum energy performance requirements, cost optimal levels, NZEB definition etc, has not yet been initiated.

Minimum requirements for new residential buildings in Greece

Since 2010, new Hellenic buildings are constructed in accordance to the regulation on the energy performance in the building sector [KENAK] in compliance with EPBD [Dascalaki et al. 2012]. The minimum specifications for the building’s thermal envelope is more stringent compared to the previous regulation (TIR). A comparative presentation of the building envelope specifications of the two regulations is given in the following table. For example, the U-value for external vertical walls in contact with outdoor air was 0.7 W/m^2 K with TIR and is reduced with KENAK by 14–43 % for the four national climate zones.

Table 90: Minimum allowable U-values (W/m2K) for different building elements at the Hellenic climate zones according to the old TIR and KENAK



Building element	Climate zone (Heating degree days)			
	Zone A (600–1100)	Zone B (1101–1600)	Zone C (1601–2200)	Zone D (2201–2620)
External walls in contact with outdoor air				
TIR	0.70	0.70	0.70	0.70
KENAK	0.60	0.50	0.45	0.40
External horizontal or tilted surface in contact with outdoor air (roofs)				
TIR	0.50	0.50	0.50	0.50
KENAK	0.50	0.45	0.40	0.35
Floors in contact with outdoor air (pylotis)				
TIR				
KENAK	0.50	0.45	0.40	0.35
Floors in contact with ground or indoor non-heated spaces				
TIR	3.00	1.90	0.70	0.70
KENAK	1.20	0.90	0.75	0.70
Walls in contact with ground or indoor non-heated spaces				
TIR	3.00	1.90	0.70	0.70
KENAK	1.50	1.00	0.80	0.70
Transparent openings (windows, balcony-doors etc)				
TIR	5.23	5.23([a])	5.23([a])	5.23([a])
KENAK	3.20	3.00	2.80	2.60
Transparent facades (non operable and partially operable)				
TIR	5.23	5.23[a]	5.23[a]	5.23[a]
KENAK	2.20	2.00	1.80	1.80

[a] TIR recommended for zone B, the use of double glazing (3.26 W/m^2 K) on the facades exposed to prevailing cold winds (depending on location), while for zone C (and D) on all facades. Double glazing was mandated for all transparent elements in locations with an elevation higher than 600 m.

Minimum specifications for the building's E/M installations are also implemented (e.g. use of outdoor temperature compensation systems, zone thermostatic control, along with heat recovery for central air-handling-units and energy efficient lighting for non-residential buildings, etc). For domestic hot water (DHW) production, in accordance to the national law [N.3851/2010] on RES, all new buildings should cover 60% of the load from renewables or substantiate technical difficulties for non-compliance. This requirement has been adapted in [KENAK].

A national obligation to implement various energy conservation measures (ECMs) in all energy end-use sectors, including buildings, was introduced in 2010 [N.3855/2010] in order to achieve by 2016 an overall national indicative target of 9% energy conservation. For the building sector, this implied about 1 Mtoe energy savings compared to 2007 data.

Hellenic calculation method to comply with new building regulations for residential buildings

Hellenic Energy Performance Certificates (EPCs) have been issued as of January 2011; the vast majority of them have been issued for buildings or building units rented out or sold and only 0.3 % for new buildings. [Dascalaki et al. 2013]. The calculations are performed using the official national software [TEE-KENAK] to issue an official EPC that is returned to the inspector. The general calculation method and overall approach is in accordance to European standards, with the main calculation procedure of the building energy demand according to EN 13790/2008 using the quasi-steady state monthly method. The labelling scheme is based on asset rating accounting for heating, cooling, ventilation and DHW (lighting is accounted only for non-residential buildings), the minimum energy performance requirements, thermal envelope heat loss constraints, etc.

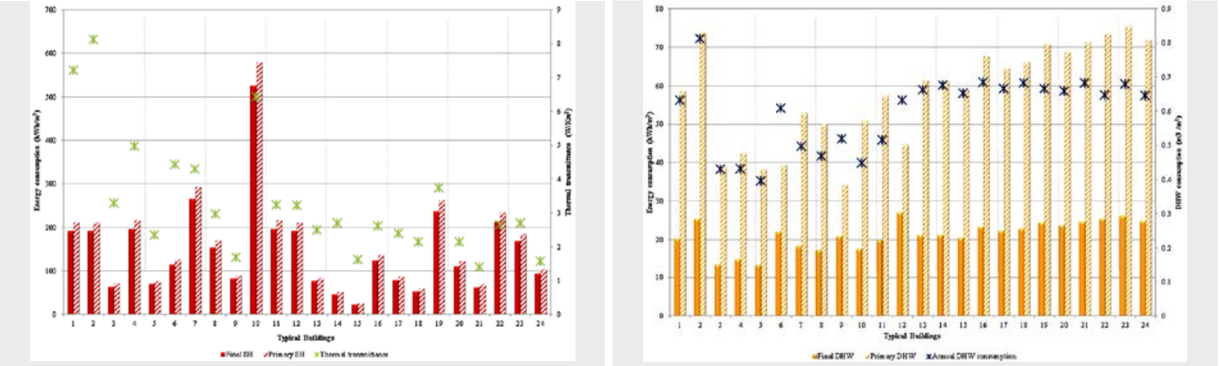
The ranking label (building class) is based on the calculated primary energy consumption compared to that of a “reference” building. The “reference” building is a carbon copy of the studied (real) building, with the characteristics of its envelope elements and E/M installations automatically adapted to meet the minimum energy efficiency requirements defined in the technical guidelines of KENAK The detailed characteristics of the reference building are revealed in a technical guideline by the Technical Chamber of Greece [TOTEE 20701-1/2010]. By definition, the “reference” building ranks B.

Status of NZEB definition for residential buildings in Greece

There is no national definition of nearly zero energy buildings (NZEBs). In accordance to the EPBD recast, the national law [N.4122/2013] calls for setting minimum energy performance requirements for achieving cost optimal levels and new buildings meet the minimum energy performance requirements, minimum requirements for technical building systems, and sets the target of NZEB for new buildings by the end of 2020.

As of July 2014, the relevant work has not been initiated.

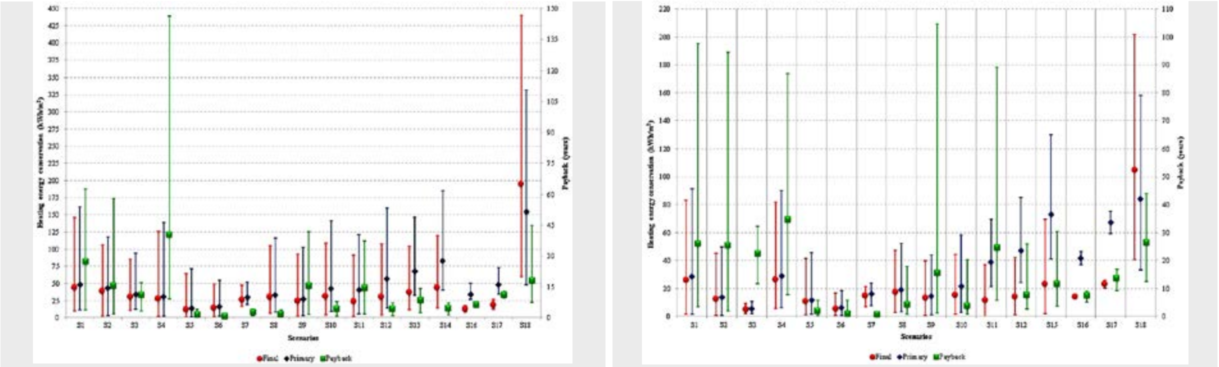
An investigation of individual energy conservation measures to reduce space heating (SH) and DHW energy consumption in Hellenic residential buildings, using the TABULA typology has revealed several priorities that have high primary heating energy savings and low payback period in case of refurbishment [Droutsa et al., 2014]. A total of 18 measures on building’s thermal envelope and E/M systems were investigated. Accordingly, the use of local natural gas boilers for space heating (SH) and DHW and geothermal heat pump for SH, always result in improved energy class. Due to the higher availability of solar radiation in southern Greece the use of geothermal HPs and solar collectors for 100% of DHW (primarily in climate zones A and B, can improve the energy ranking by up to three energy classes. The use of solar collectors for 60% and 100% of DHW is more effective for buildings that are thermally insulated. Reduced infiltration and room thermostatic controls are applicable for buildings with good thermal protection and system efficiencies. Although the use of oil-boilers remains the most popular heating systems, as a result of the increase tax on oil, there is a clear shift to alternative fuel sources throughout the country. The use of natural gas boilers and heat pumps has become more attractive.



(a) Space heating

(b) Domestic hot water

Calculated final and primary energy consumption (kWh/m^2) for (a) space heating and total building thermal transmittance (W/K m^2), (b) domestic hot water production and DHW consumption (m^3/m^2), for the 24 typical buildings [Droutsa et al. 2014].



Single-Family Houses

Multi-Family Houses

Figure 42: **Calculated average final and primary heating energy conservation (kWh/m^2) and payback period (years) for various energy conservation measures. The error bars correspond to the maximum and the minimum values [Droutsa et al. 2014].**

Three different standards for new buildings are considered within EPISCOPE: the “Current standard”, the “Improved standard” and the ‘NZEB standard”. The improved standard is considered as a short term goal, while the NZEB standard is the 2020 goal. In the absence of official national intermediate or NZEB requirements the corresponding definitions are based on the following considerations taking into account the evolution of the currently enforced regulation [KENAK] and results published in the literature from relevant investigations:

A. Thermal envelope

The U-values become more stringent for the Improved & NZEB standards compared with the current standard [KENAK] by 0.05 & 0.15 W/m^2.K for opaque elements and by 20 % & 40 % for transparent elements, respectively. The U-values are different for the four climatic zones of the country. Infiltration is reduced by 15 % and 30 %, respectively for the two standards. Finally, thermal bridges that correspond to 20% of ΣUA_{opaque} for [KENAK] are reduced to 5 % for the NZEB standard.

B. E/M installations:

Three main electromechanical systems are taken into account, which constitute the most popular installations and are tailored based on regional availability of energy carriers in the country (e.g. natural gas only available in Zones B & C) and progressively with improved performance for the improved and NZEB standard. The exploitation of solar thermal systems for DHW is increased from the current standard of 60 % to 75-100 % for the improved standard (depending on climatic zone) and in addition for supporting space heating for the NZEB standard (depending on climatic zone, different coverage for SFH & MFH). Photovoltaics to cover the reduced auxiliary electrical loads are used for the NZEB. According to the calculations using [TEE-KENAK], the need is for about 1 m^2 for SFH and 2 m^2 for MFH, due south and tilt angle of 26^o-31^o (progressively from the south - Zone A to the north Zone D). Finally, control systems are progressively improved from class-C in the current standard, to class-B for the improved and class-A for the NZEB.

Table 91: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the assumed NZEB definition in Greece

Calculation Method New Building Regulations – (part 1)

Country	GR	Greece	Status	07/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the assumed National NZEB Definition
Legislation / Standards Hellenic regulation on the energy performance in the building sector [KENAK] Technical guidelines [TOTEE 20701-1 to 4/2010] National Law [N.3851/2010] on RES **Explanation / Comments** Since 2010, new Hellenic buildings are constructed in accordance to the regulation on the energy performance in the building sector [KENAK] in compliance with EPBD. All new buildings should cover 60% of the load from RES [N.3851/2010] and [KENAK]. Transposition of EPBD recast has been initiated by national law [N.4122/2013], but relevant work has not been initiated yet (July 2014).	No official Hellenic NZEB definition (July 2014). The adopted approach was derived by considering the evolution of the currently enforced regulation [KENAK] and published literature from relevant investigations.

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

Mechanical ventilation systems are usually not installed in Hellenic residential buildings. Lighting and other plug loads are not accounted for in the calculations.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Month

Explanation / Comments

Calculation method and overall approach following the quasi-steady state monthly method [KENAK], [TEE-KENAK] [TOTEE 20701/2010].

The calculated energy delivered by each energy carrier is only reported as a share (percentage) of the individual carrier over the total (yearly).

The factors in Table 92 are used for the calculation of the total primary energy demand (yearly). The assessment of each energy carrier is an intermediate step in the calculation procedure but it is not reported per energy carrier in the EPC.

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP		x	Month	H-C-W
x	On-site PV		x	Month	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Photovoltaic is currently included in the balance as far as provisions are taken to use the produced electricity on-site and the calculated monthly electrical energy demand is directly covered – no bonus for exported energy in the EPC.

Table 91 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>Country</td><td>GR</td><td colspan="3">Greece</td><td>Status</td><td>07/2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the assumed National NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="6"></td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2">x*</td><td rowspan="2">Primary energy</td><td rowspan="2">total</td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>Thermal solar collectors for 60 % of DHW load</td></tr>
<tr><td colspan="5">Explanation / Comments
* Primary energy demand should be equal to or less than the “reference building’, a carbon copy of the studied building, rating B.</td></tr>
</table>

Assessment of energy carriers in Greece

The technical guideline [TOTEE 20701-1/2010] defines the conversion factors that are used for calculating the primary energy for different energy-carriers and CO_2 emissions. These conversion factors are also being used in the official national software [TEE-KENAK] for estimating the primary energy consumption and building class rating.

In general, the values used in the TABULA database are mainly adopted from [TOTEE 20701-1/2010] and are given in Table 3.

Electricity produced from on-site photovoltaic systems is only accounted for in the event that the PV system is used to cover auxiliary electrical loads. There is no credit or other bonus in the event that the PV is connected to the main grid for export (sale) of the produced electricity.

Table 92: Hellenic primary energy factors

Label / type of factor	**Total Primary Energy Factor Greece**
Used for EPC rating	x
Used for building regulations requirements	x
Label (national language)	Συντελεστές μετατροπής της κατανάλωσης ενέργειας σε πρωτογενή
Description / type of weighting factor	non-renewable + renewable energy amounts; upstream energy expenditures (transportation, transformation) included
Factor is multiplied by delivered energy based on the	lower (net) calorific value of each energy carrier
Reference	[TOTEE 20701-1/2010]
Natural gas	1.05
Heating oil	1.1
Electricity	2.9
District heating	0.7
District heating without CHP	0.5
District heating with 100 % CHP	0.7

Methodological points for discussion in Greece

The on-site electricity generation is promoted through a nationally funded program on photovoltaics (PVs) since 2009 [JMD 1079] for residential buildings. The program has boosted the installation of grid-connected PVs up to 10 kWp in the mainland and up to 5 kWp in the islands, on residential building roofs, by providing very attractive incentives with a remarkably high tax-free feed-in tariff (0.55 Euro/kWh for 25 years). An important provision is that in order to qualify for the PV roof program, a residential building should have a solar thermal collector or other RES for DHW. During the first three years, the program attracted over 50000 applications from individuals, very small companies, public and non-profit organizations (about 450 MWp), while about 29000 installations have already been installed in 2012, representing a cumulative capacity of 256 MWp. However, this is considered a financial transaction (investment) since the generated electricity is not directly used for covering the building electric loads and thus it is not credited in the EPC of the building.

3.10.2 Integration of National Requirements for New Buildings and NZEB Standards in the Hellenic Residential Building Typology

The first Hellenic residential building typology was developed in the framework of the TABULA project [NOA 2011]. The classification was made in accordance to the TABULA scheme using three parameters, namely: the size (single / multi family houses), the age (three age bands: prior to 1980, 1981-2000, 2001-2010) and the climate zone (four climate zones in total (A-D), in accordance to the Hellenic Building Energy Performance Regulation, KENAK). Accordingly, a total of 24 building types were defined, representative of the Hellenic residential building stock. Further details can be found in [NOA 2012]. The typologies were used to develop energy advice material in the form of electronic brochures and an on-line software tool, eKIA (www.energycon.org/ekia.html), which allows home owners for a preliminary assessment of the energy performance of their residence and its potential for improvement. The typology material is accessible in www.energycon.org and ever since it was released, in November 2012, it has been accessed by over 25000 visitors. In the framework of TABULA, the Hellenic typology was also used to set up a basic building stock model and demonstrate the applicability of the typology in scenario analysis. Further enhancement of the building stock model is foreseen in the framework of the EPISCOPE project. In the absence of “typical” buildings and the lack of reliable statistical data in Greece, the TABULA typology is expected to provide the necessary basis for the revision of the minimum requirements and the specification of cost-optimal solutions towards the NZEB goal.

Classification scheme for the Hellenic residential building stock (“Building Type Matrix”)

During the IEE Project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current legal requirements (KENAK2010). Accordingly, the Hellenic TABULA typology was complemented by eight new building types, two for each climate zone, to represent the current standard of constructions for the period after 2010. Figure 43 shows the respective Building Type Matrix. Eight example buildings were added in order to represent the new single family and multifamily house for the four climate zones. These buildings will be used as showcase examples of the new construction trends and the possible variations in the future towards NZEB. Two exemplary buildings, a single family and a multifamily house, are described in Table 93.

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	Zone A (κλιματική ζώνη A)	… 1980	generic	 GR.ZoneA.SFH.01.Gen		 GR.ZoneA.MFH.01.Gen	
2	Zone A (κλιματική ζώνη A)	1981 … 2000	generic	 GR.ZoneA.SFH.02.Gen		 GR.ZoneA.MFH.02.Gen	
3	Zone A (κλιματική ζώνη A)	2001 … 2010	generic	 GR.ZoneA.SFH.03.Gen		 GR.ZoneA.MFH.03.Gen	
4	Zone A (κλιματική ζώνη A)	2011 …	generic	 GR.ZoneA.SFH.04.Gen		 GR.ZoneA.MFH.04.Gen	
5	Zone B (κλιματική ζώνη B)	… 1980	generic	 GR.ZoneB.SFH.01.Gen		 GR.ZoneB.MFH.01.Gen	
6	Zone B (κλιματική ζώνη B)	1981 … 2000	generic	 GR.ZoneB.SFH.02.Gen		 GR.ZoneB.MFH.02.Gen	
7	Zone B (κλιματική ζώνη B)	2001 … 2010	generic	 GR.ZoneB.SFH.03.Gen		 GR.ZoneB.MFH.03.Gen	
8	Zone B (κλιματική ζώνη B)	2011 …	generic	 GR.ZoneB.SFH.04.Gen		 GR.ZoneB.MFH.04.Gen	
9	Zone C (κλιματική ζώνη Γ)	… 1980	generic	 GR.ZoneC.SFH.01.Gen		 GR.ZoneC.MFH.01.Gen	

Figure 43: **Classification scheme ("Building Type Matrix") of the Hellenic residential building typology, now extended towards new buildings**

10	Zone C (κλιματική ζώνη Γ)	1981 … 2000	generic	 GR.ZoneC.SFH.02.Gen		 GR.ZoneC.MFH.02.Gen	
11	Zone C (κλιματική ζώνη Γ)	2001 … 2010	generic	 GR.ZoneC.SFH.03.Gen		 GR.ZoneC.MFH.03.Gen	
12	Zone C (κλιματική ζώνη Γ)	2011 …	generic	 GR.ZoneC.SFH.04.Gen		 GR.ZoneC.MFH.04.Gen	
13	Zone D (κλιματική ζώνη Δ)	… 1980	generic	 GR.ZoneD.SFH.01.Gen		 GR.ZoneD.MFH.01.Gen	
14	Zone D (κλιματική ζώνη Δ)	1981 … 2000	generic	 GR.ZoneD.SFH.02.Gen		 GR.ZoneD.MFH.02.Gen	
15	Zone D (κλιματική ζώνη Δ)	2001 … 2010	generic	 GR.ZoneD.SFH.03.Gen		 GR.ZoneD.MFH.03.Gen	
16	Zone D (κλιματική ζώνη Δ)	2011 …	generic	 GR.ZoneD.SFH.04.Gen		 GR.ZoneD.MFH.04.Gen	

Continuation Figure 43: Classification scheme ("Building Type Matrix") of the Hellenic residential building typology, now extended towards new buildings

Table 93: Exemplary new buildings representing the latest construction year classes (2011 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
					
Number of dwellings		1		10	
Number of full storeys (conditioned)		1		5	
Number of directly attached neighbour buildings		0		0	
National reference area*	m²	300		950	
TABULA reference area (conditioned floor area, internal dimensions)	m²	255		808	

*) external dimensions in accordance to Technical Guideline of the Technical Chamber of Greece, TOTEE 20701-1/2010 “Analytic National Specifications of Parameters for the Calculation of the Energy Performance of Buildings and the Energy Performance Certificate**”**

Building example: variants meeting three energy performance levels for new buildings

Three variations of each new building type are considered by combining the envelope with three different types of heat supply systems, which are at present the most popular in the Hellenic market, namely, oil, natural gas and electricity.

The thermal characteristics of the envelope and the system performances are different for each of the four climate zones, as foreseen by KENAK.

In correspondence to the TABULA definition of refurbishment scenarios (base case-standard-ambitious), three energy performance levels (standards) are considered for new buildings within EPISCOPE: the “Current standard”, the “Improved standard” and the ‘NZEB standard”. The improved standard is considered as a short term goal, while the NZEB standard is the 2020 goal.

Accordingly, new building types are presented in three versions, each consisting of a triplet of performance standards (variants), specifically:

- “Oil“ (Variants 01, 02, 03):
- “Natural Gas“ (Variants 11, 12, 13):
- “Electricity“ (Variants 21, 22, 23):

- Variants 01, 11 and 21 correspond to envelope and system requirements in accordance to the current standard defined in the national regulation (KENAK) for the respective energy carrier (“Current standard”).
- Variants 02, 12 and 22 correspond to an improved envelope (more stringent U-values) and system using the specific energy carrier with an improved performance and increased exploitation of solar thermal systems for DHW (“Improved Standard”)
- Variants 03, 13 and 23 correspond to the most ambitious scenario with further improved envelope and system performance using the same energy carrier maximizing the exploitation of RES by using solar systems to cover 100 % of the DHW energy demand and a significant amount of space heating demand, as well as PV systems to cover auxiliary energy demand (“NZEB standard”).

The requirements of each standard are given in more detail in the following table.

Table 94: New building requirements per climate zone for three energy performance standards (current, improved and NZEB)

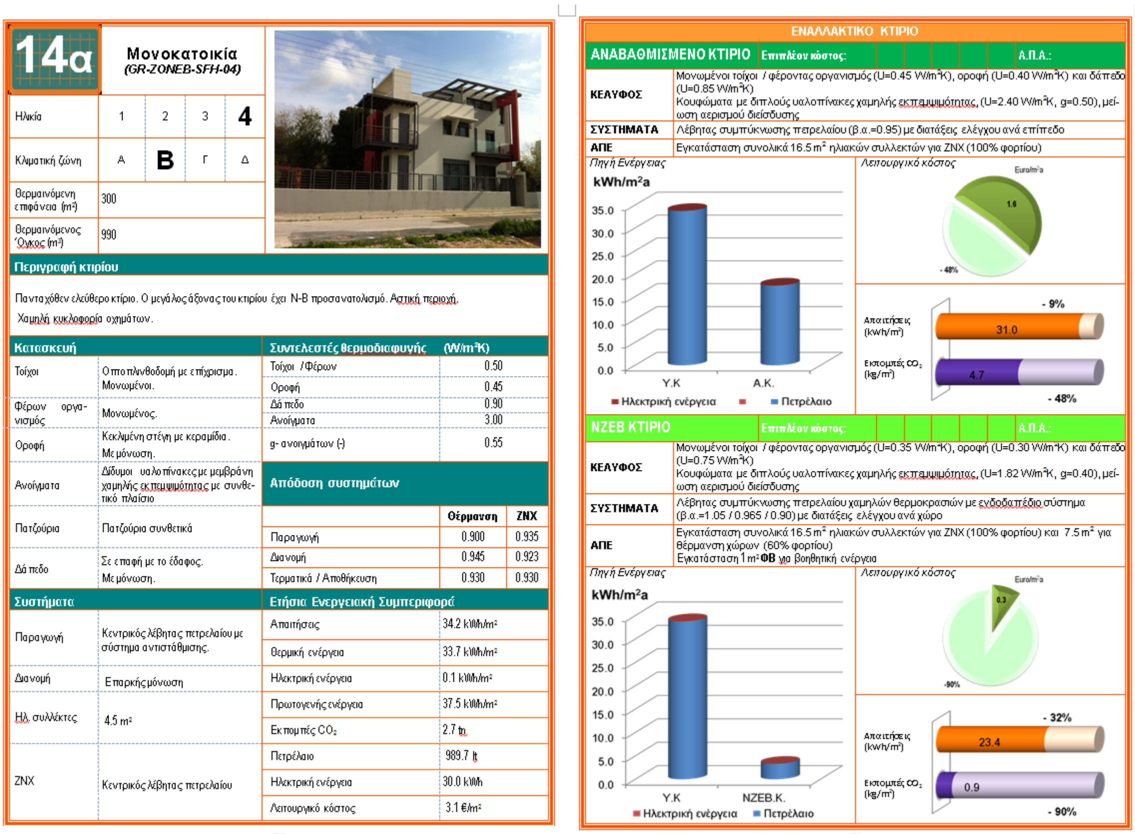
		Current Std [KENAK]	Improved Std	NZEB Std
Envelope				
U-values (*) $(W/m^2.K)$	Wall	0.60/0.50/0.45/0.40	0.55/0.45/0.40/0.35	0.45/0.35/0.30/0.25
	Roof-pylotis	0.50/0.45/0.40/0.35	0.45/0.40/0.35/0.30	0.35/0.30/0.25/0.20
	Floor	1.20/0.90/0.75/0.70	1.15/0.85/0.70/0.65	1.05/0.75/0.60/0.55
	Walls next to ground/ non-heated spaces	1.50/1.00/0.80/0.70	1.45/0.95/0.75/0.65	1.35/0.85/0.65/0.55
	Windows	3.20/3.00/2.80/2.60	2.56/2.40/2.24/2.08	1.93/1.82/1.72/1.57
Infiltration $(m^3/h)/m^2$ window area		5.50	4.68	3.85
Thermal bridges		20 % of ΣUA_{opaque}		5 % of [KENAK]
E/M Installations				
Natural-gas fired boiler performance	Thermal	0.92	0.97	1.08 (low temp floor heating, Zones B&C)
Oil fired boiler performance	Thermal	0.90	0.95	0.95 (Zone A), 1.05 (low temp floor heating, Zones B-D)
Central H.P. performance; high temp or geothermal(*)	COP (climate zone)	3.2	3.8(A), 3.6(B), 3.5(C), 3.4(D)	3.8(A), 5.6(B), 5.2(C), 4.7(D)
	Solar for DHW	60 %	75 %	100 %
	Solar for space heating **(*)** for SFH-MFH (climate zone)			80-75 % (A), 60-55 % (B), 45-35 % (C), 30-20 % (D)
	PV for auxiliary			100 %
Controls	Class	C	B	A

(*) reported by climate zone (A/B/C/D)

Table 95 summarises the variants defined for an exemplary new single family house in climate zone B. The “improved std” for fuel systems, includes a condensing boiler (C-boiler) with better controls than the “non-condensing boiler (NC-boiler) currently considered by KENAK and total coverage of the DHW needs. The “NZEB std” introduces a low-temperature condensing boiler with advanced controls combined with a subfloor system; the solar heating system covers total DHW needs and 60 % of the space heating needs. The auxiliary energy is also covered by PV. The “electricity” variation of the building is served by an electrical heat pump, which, in the case of the “NZEB Std” is low-temperature (LT) combined with a subfloor system.

Table 95: Exemplary single-family house (SFH), climate zone B – definition of variants

 GR.ZoneB.SFH.04.Gen		"Oil"			"Natural Gas"			"Electricity"		
Variant N°		001	002	003	011	012	013***	021	022	023
Energy Performance Level		Current Std	Improved Std	NZEB Std	Current Std	Improved Std	NZEB Std	Current Std	Improved Std	NZEB Std
U-values										
Roof	W/(m^{2}K)	0.45	0.40	0.30	0.45	0.40	0.30	0.45	0.40	0.30
Wall	W/(m^{2}K)	0.50	0.45	0.35	0.50	0.45	0.35	0.50	0.45	0.35
Window	W/(m^{2}K)	3.00	2.40	1.82	3.00	2.40	1.82	3.00	2.40	1.82
Floor	W/(m^{2}K)	0.90	0.85	0.75	0.90	0.85	0.75	0.90	0.85	0.75
Thermal bridging supplement (whole envelope)	W/(m^{2}K)	0.05	0.05	0.02	0.05	0.05	0.02	0.05	0.05	0.02
Heat Supply System										
Heat generator		NC-boiler Basic controls	C-boiler Improved controls	C-boiler (LT) & subfloor Advanced controls	NC-boiler Basic controls	C-boiler Improved controls	C-boiler (LT) & subfloor Advanced controls	Electrical Heat Pump		
								HT	HT	LT/GHP & subfloor
Specification / Supplemental system								ext.air	ext.air	ext air / ground
Ventilation system										
Thermal solar system		DHW 60%	DHW 100%	DHW& SH 100%/60%	DHW 60%	DHW 100%	DHW & SH 100%/60%	DHW 60%	DHW 100%	DHW & SH 100%/60%
Further system				PV			PV			PV



14α

Μονοκατοικία
(GR-ZONEB-SFH-04)

Ηλικία	1	2	3	**4**
Κλιματική ζώνη	Α	**B**	Γ	Δ
Θερμαινόμενη επιφάνεια (m^2)	300			
Θερμαινόμενος Όγκος (m^3)	990			

Περιγραφή κτιρίου

Πανταχόθεν ελεύθερο κτίριο. Ο μεγάλος άξονας του κτιρίου έχει Ν-Β προσανατολισμό. Αστική περιοχή. Χαμηλή κυκλοφορία οχημάτων.

Κατασκευή	
Τοίχοι	Οπτοπλινθοδομή με επίχρισμα. Μονωμένοι.
Φέρων οργανισμός	Μονωμένος.
Οροφή	Κεκλιμένη στέγη με κεραμίδια. Με μόνωση.
Ανοίγματα	Δίδυμοι υαλοπίνακες με μεμβράνη χαμηλής εκπεμψιμότητας με συνθετικό πλαίσιο
Πατζούρια	Πατζούρια συνθετικά
Δάπεδο	Σε επαφή με το έδαφος. Με μόνωση.

Συντελεστές θερμοδιαφυγής	(W/m^{2}K)
Τοίχοι / Φέρων	0.50
Οροφή	0.45
Δάπεδο	0.90
Ανοίγματα	3.00
g- ανοιγμάτων (-)	0.55

Απόδοση συστημάτων

	Θέρμανση	ΖΝΧ
Παραγωγή	0.900	0.935
Διανομή	0.945	0.923
Τερματικά / Αποθήκευση	0.930	0.930

Συστήματα	
Παραγωγή	Κεντρικός λέβητας πετρελαίου με σύστημα αντιστάθμισης.
Διανομή	Επαρκής μόνωση
Ηλ. συλλέκτες	4.5 m^2
ΖΝΧ	Κεντρικός λέβητας πετρελαίου

Ετήσια Ενεργειακή Συμπεριφορά	
Απαιτήσεις	34.2 kWh/m^2
Θερμική ενέργεια	33.7 kWh/m^2
Ηλεκτρική ενέργεια	0.1 kWh/m^2
Πρωτογενής ενέργεια	37.5 kWh/m^2
Εκπομπές CO_2	2.7 tn
Πετρέλαιο	989.7 lt
Ηλεκτρική ενέργεια	30.0 kWh
Λειτουργικό κόστος	3.1 €/m^2

ΕΝΑΛΛΑΚΤΙΚΟ ΚΤΙΡΙΟ

ΑΝΑΒΑΘΜΙΣΜΕΝΟ ΚΤΙΡΙΟ	Επιπλέον κόστος:	Α.Π.Α.:
ΚΕΛΥΦΟΣ	Μονωμένοι τοίχοι / φέροντας οργανισμός (U=0.45 W/m^{2}K), οροφή (U=0.40 W/m^{2}K) και δάπεδο (U=0.85 W/m^{2}K) Κουφώματα με διπλούς υαλοπίνακες χαμηλής εκπεμψιμότητας, (U=2.40 W/m^{2}K, g=0.50), μείωση αερισμού διείσδυσης	
ΣΥΣΤΗΜΑΤΑ	Λέβητας συμπύκνωσης πετρελαίου (β.α.=0.95) με διατάξεις ελέγχου ανά επίπεδο	
ΑΠΕ	Εγκατάσταση συνολικά 16.5 m^2 ηλιακών συλλεκτών για ΖΝΧ (100% φορτίου)	

ΝΖΕΒ ΚΤΙΡΙΟ	Επιπλέον κόστος:	Α.Π.Α.:
ΚΕΛΥΦΟΣ	Μονωμένοι τοίχοι / φέροντας οργανισμός (U=0.35 W/m^{2}K), οροφή (U=0.30 W/m^{2}K) και δάπεδο (U=0.75 W/m^{2}K) Κουφώματα με διπλούς υαλοπίνακες χαμηλής εκπεμψιμότητας, (U=1.82 W/m^{2}K, g=0.40), μείωση αερισμού διείσδυσης	
ΣΥΣΤΗΜΑΤΑ	Λέβητας συμπύκνωσης πετρελαίου χαμηλών θερμοκρασιών με ενδοδαπέδιο σύστημα (β.α.=1.05 / 0.965 / 0.90) με διατάξεις ελέγχου ανά χώρο	
ΑΠΕ	Εγκατάσταση συνολικά 16.5 m^2 ηλιακών συλλεκτών για ΖΝΧ (100% φορτίου) και 7.5 m^2 για θέρμανση χώρων (60% φορτίου) Εγκατάσταση 1 m^2 **ΦΒ** για βοηθητική ενέργεια	

Figure 44: "Building Display Sheet" of the exemplary SFH <GR> [NOA 2014]

Table 96: Exemplary SFH – Results of the energy balance calculation; Procedure: TEE-KENAK

Variant N°		**001**	**002**	**003**	**001**	**002**	**003**	**011**	**012**	**013**
Label of the variant triplet		Fuel Oil			Natural Gas			Electricity		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB	Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		KENAK			KENAK			KENAK		
Calculation method		EN 13790								
National reference area*	m²	300	300	300	300	300	300	300	300	300
Energy need for heating	kWh/(m²a)	34.2	31.0	23.4	34.2	31.0	23.4	34.2	31.0	23.4
Delivered energy										
Fossil fuels	kWh/(m²a)	33.7	17.4	3.3	33.1	17.1	3.2	8.7	0	0
Renewable fuels	kWh/(m²a)	8.7	16.0	22.7	8.7	16.0	22.7	8.7	16.0	22.7
Electricity	kWh/(m²a)	0.1	0.1	0	0.1	0.1	0	7.2	4.7	0.5
Primary energy demand	kWh/(m²a)	37.5	19.5	4.0	35.2	18.3	3.8	30.3	13.7	1.5
Relation to requirement	(^{2}*)	85 %	44 %	9 %	80 %	41 %	9 %	83 %	38 %	4 %

(*) external dimensions in accordance to Technical Guideline of the Technical Chamber of Greece, TOTEE 20701-1/2010 “Analytic National Specifications of Parameters for the Calculation of the Energy Performance of Buildings and the Energy Performance Certificate**”**

(^{2}*) Percentages refer to comparison of primary energy between the variant and the corresponding reference building in accordance to KENAK

TABULA calculation results for all exemplary buildings

Table 97 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for two exemplary buildings.

Table 97: Exemplary new buildings – Results of the TABULA calculation procedure (climate zone B; standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  GR.ZoneB.SFH.04.Gen	01	Minimum Requirement	1.75	35	0	35	32	10	15	0	45	0	0	6	0	0	0
	02	Improved Standard	1.39	28	0	28	30	10	16	0	28	0	0	6	0	0	0
	03	Ambitious Standard / NZEB	1.05	21	0	21	22	10	16	0	7	0	0	6	0	0	0
	11	Minimum Requirement	1.75	35	0	35	32	10	15	45	0	0	0	6	0	0	0
	12	Improved Standard	1.39	28	0	28	29	10	16	26	0	0	0	2	0	0	0
	13	Ambitious Standard / NZEB	1.05	21	0	21	21	10	16	6	0	0	0	6	0	0	0
	21	Minimum Requirement	1.75	35	0	35	33	10	15	0	7	0	0	16	0	0	0
	22	Improved Standard	1.39	28	0	28	29	10	16	0	0	0	0	12	0	0	0
	23	Ambitious Standard / NZEB	1.05	21	0	21	21	10	16	0	0	0	0	7	0	0	0
MFH  GR.ZoneB.MFH.04.Gen	01	Minimum Requirement	0.93	22	0	22	19	15	20	0	32	0	0	6	0	0	0
	02	Improved Standard	0.76	19	0	19	20	15	21	0	19	0	0	6	0	0	0
	03	Ambitious Standard / NZEB	0.58	14	0	14	15	15	21	0	5	0	0	6	0	0	0
	11	Minimum Requirement	0.93	22	0	22	19	15	20	32	0	0	0	6	0	0	0
	12	Improved Standard	0.76	19	0	19	19	15	21	17	0	0	0	2	0	0	0
	13	Ambitious Standard / NZEB	0.58	14	0	14	14	15	21	4	0	0	0	6	0	0	0
	21	Minimum Requirement	0.93	22	0	22	20	15	20	0	9	0	0	12	0	0	0
	22	Improved Standard	0.76	19	0	19	19	15	21	0	0	0	0	10	0	0	0
	23	Ambitious Standard / NZEB	0.58	14	0	14	14	15	21	0	0	0	0	6	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.10.3 Sources / References Greece

Table 98: Sources / References Greece

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Dascalaki et al. 2011]	E.G. Dascalaki, K.G. Droutsa, C.A. Balaras, S. Kontoyiannidis, Building Typologies as a Tool for Assessing the Energy Performance of Residential Buildings – A Case Study for the Hellenic Building Stock, Energy & Buildings, Vol. 43, No 12, p. 3400-3409, (2011).	Overview of the TABULA Hellenic residential building typology along with an assessment of various energy conservation measures for estimateing the energy performance of the building stock in Greece in an effort to meet the 9% indicative national energy savings target by 2016.
[Dascalaki et al. 2012]	E.G. Dascalaki, C.A. Balaras, A.G. Gaglia, K.G. Droutsa, S. Kontoyiannidis, Energy Performance of Buildings - EPBD in Greece, Energy Policy, Vol. 45, p. 469–477, (2012).	Overview of EPBD implementation in Greece
[Dascalaki et al. 2013]	E.G. Dascalaki, S. Kontoyiannidis, C.A. Balaras, K.G. Droutsa, Energy Certification of Hellenic Buildings: First findings, Energy & Buildings, Vol. 65, p. 429-437, (2013).	First data analysis of over 350,000 EPCs for gaining an insight of the energy performance of buildings in Greece, towards better understanding the Hellenic building stock. Includes data for residential and non-residential buildings.
[Droutsa et al. 2014]	K.G. Droutsa, S. Kontoyiannidis, E.G. Dascalaki, C.A. Balaras, Ranking cost effective energy conservation measures for heating in Hellenic residential buildings, Energy & Buildings, Vol. 65, p. 318-332, (2014).	Assessing the potential benefits and setting the priorities of individual energy conservation measures to reduce heating energy consumption in Hellenic residential buildings, including space heating and domestic hot water production. The analysis exploits the Hellenic TABULA typology. The focus is mainly on the implementation of measures that have low first-cost investment and short payback period. In order to prioritize ECMs that would be most attractive to building owners, two ranking criteria are used, namely primary heating energy savings and payback period. The preliminary results are used to provide an insight on the potential abatement of CO_2 emissions for the national residential building stock.
[JMD 1079]	Ειδικό Πρόγραμμα Ανάπτυξης Φωτοβολταϊκών Συστημάτων σε κτιριακές εγκαταστάσεις και ιδίως σε δώματα και στέγες κτιρίων (ΚΥΑ 1079/ Β/04.06.2009) http://www.ypeka.gr/LinkClick.aspx?fileticket=mz8ssdmgKhg%3d&tabid=541	Joint Ministerial Decision on the special program for the development of photovoltaics in buildings and in particular on building roofs upto 10 kWp, introduced in 2009
[KAPE 2002]	Βιοκλιματικός Σχεδιασμός στην Ελλάδα: Ενεργειακή Απόδοση και Κατευθύνσεις Εφαρμογής, Λάζαρη, Ε. και Τζανακάκη, Ε. (επιμ.), Κέντρο Ανανεώσιμων Πηγών Ενέργειας (ΚΑΠΕ), Πικέρμι, 2022 http://www.cres.gr/kape/education/bioclimatic_brochure.pdf	Design principles for bioclimatic buildings in Greece, by the Center for Renewable Energy Sources
[KENAK 2010]	Κανονισμός Ενεργειακής Απόδοσης Κτηρίων http://www.buildingcert.gr/nomiko_plaisio/kenak.pdf	Hellenic regulation on the energy performance in the building sector
[N.3661/2008]	Μέτρα για τη μείωση της ενεργειακής κατανάλωσης των κτιρίων και άλλες διατάξεις http://www.buildingcert.gr/nomiko_plaisio/3661_2008.pdf	National law for the transposition of the European Directive 2002/91/EC on energy end-use efficiency and energy services
[N.3851/2010]	Επιτάχυνση της ανάπτυξης των Ανανεώσιμων Πηγών Ενέργειας για την αντιμετώπιση της κλιματικής αλλαγής και άλλες διατάξεις σε θέματα αρμοδιότητας του Υπουργείου Περιβάλλοντος, Ενέργειας και Κλιματικής Αλλαγής http://www.ypeka.gr/LinkClick.aspx?fileticket=pnhppGnURds%3d&tabid=285	National law for the transposition of the European Directive 2009/28/EC on the promotion of the use of energy from renewable sources
[N.3855/2010]	Μέτρα για τη βελτίωση της ενεργειακής απόδοσης κατά την τελική χρήση, ενεργειακές υπηρεσίες και άλλες διατάξεις http://www.ypeka.gr/LinkClick.aspx?fileticket=AxgQsUVAUjA%3D&...	National law for the transposition of the European Directive 2006/32/EC on energy end-use efficiency and energy services

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[N.4122/2013]	Ενεργειακή Απόδοση Κτιρίων – Εναρμόνιση με την Οδηγία 2010/31/ΕΕ του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου και λοιπές διατάξεις https://www.buildingcert.gr/N4122_2013.pdf	National law for the transposition of the European Directive 2010/31/EC - EPBD recast
[NOA 2011]	NOA (ed.), Hellenic building Typology Brochure, TABULA project, WP3, D5.2, May 2011	National Hellenic typology brochure, developed during the IEE Project TABULA
[NOA 2012]	NOA (ed), National Scientific Report-Greece, TABULA project, D6.2, May 2012 http://episcope.eu/fileadmin/tabula/public/docs/scientific/GR_TABULA_ScientificReport_NOA.pdf	Hellenic scientific report in the framework of TABULA project
[NOA 2014]	Τυπολογία Ελληνικών Κτιρίων Κατοικίας – Δυναμικό Εξοικονόμησης Ενέργειας	New national Hellenic typology brochure
[NOK 2012]	Νέος Οικοδομικός Κανονισμός (N.4067/2012)	National building code
[TOTEE 20701-1/2010]	Αναλυτικές Εθνικές Προδιαγραφές Παραμέτρων για τον Υπολογισμό της Ενεργειακής Απόδοσης Κτηρίων και την Έκδοση του Πιστοποιητικού Ενεργειακής Απόδοσης, Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδας, Τ.Ο.Τ.Ε.Ε. 20701-1/2010, Α’ έκδοση Ιούλιος 2010, Β’ έκδοση Μάρτιος 2012, Αθήνα. (http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak)	Part of the series of the main four Hellenic technical guidelines (TOTEE 20701). In a total of over 480 pages, the four TOTEE reveal all the details for the implementation of KENAK. TOTEE 20701-1/2010 “Analytic National Specifications of Parameters for the Calculation of the Energy Performance of Buildings and the Energy Performance Certificate” was first published in July 2010 and revised in March 2012. The guideline outlines the quasi-steady state monthly calculation procedures and defines the calculation parameters for the energy design study and for facilitating the building energy audits. It also defines in detail the reference building for different end-use buildings, if necessary. The main objective is to minimize erroneous calculations as a result of a poor assessment of the design engineer or the inspector. The guidelines are available on-line by TEE.
[TOTEE 20701-2/2010]	Θεμροφυσικές Ιδιότητες Δομικών Υλικών και Έλεγχος της Θερμομονωτικής Επάρκειας των Κτηρίων, Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδας, Τ.Ο.Τ.Ε.Ε. 20701-2/2010, Α’ έκδοση Ιούλιος 2010, Αθήνα. http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak	Part of the series of the main four Hellenic technical guidelines (TOTEE 20701). In a total of over 480 pages, the four TOTEE reveal all the details for the implementation of KENAK. TOTEE 20701-2/2010 “Thermophysical Properties of Building Materials and the Adequacy Control of Thermal Insulation of Buildings” was first published in July 2010. It sets the minimum thermal insulation requirements and defines the calculation procedures for verifying compliance and adequacy of a building’s thermal envelope. The guidelines are available on-line by TEE.
[TOTEE 20701-3/2010]	Κλιματικά Δεδομένα Ελληνικών Περιοχών, Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδας, Τ.Ο.Τ.Ε.Ε. 20701-3/2010, Α’ έκδοση Ιούλιος 2010, Β’ έκδοση Μάρτιος 2012, Αθήνα.	Part of the series of the main four Hellenic technical guidelines (TOTEE 20701). In a total of over 480 pages, the four TOTEE reveal all the details for the implementation of KENAK. TOTEE 20701-3/2010 “Hellenic Climatic Data” was first published in July 2010 and revised in March 2012. The guideline defines the climatic data necessary for the calculations, at the four national climatezones and 62 Hellenic cities. The guidelines are available on-line by TEE.

Reference shortcut	**Concrete reference (in respective language)**	**Short description (in English)**
[TOTEE 20701-4/2010]	Οδηγίες και ‘Εντυπα Ενεργειακών Επιθεωρήσεων Κτιρίων, Λεβήτων και Εγκαταστάσεων Θέρμανσης και Εγκαταστάσεων Κλιματισμού, Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδας, Τ.Ο.Τ.Ε.Ε. 20701-1/2010, Α’ έκδοση Ιούλιος 2010, Β’ έκδοση Μάρτιος 2012, Αθήνα. (http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak)	Part of the series of the main four Hellenic technical guidelines (TOTEE 20701). In a total of over 480 pages, the four TOTEE reveal all the details for the implementation of KENAK. TOTEE 20701-4/2010 “Guidelines and Forms for Building Energy Audits, Inspection of Boilers & Heating Installations, and Inspection of Air-Conditioning Installations” was first published in July 2010 and revised in March 2012. The guideline defines the detailed contents, procedures and standardizeδ forms for performing building energy audits, preparing the EPC and performing boiler and heating system inspections and air-conditioning system inspections and for electronic submission to the official registry. The guidelines are available on-line by TEE.
[TOTEE 20701-5/2010]	Συμπαραγωγή Ηλεκτρισμού, Θερμότητας & Ψύξης: Εγκαταστάσεις σε Κτήρια, Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδας, Τ.Ο.Τ.Ε.Ε. 20701-1/2010, Α’ έκδοση Απρίλιος 2012, Αθήνα. http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak	The fifth addition to the series of the Hellenic technical guidelines (TOTEE 20701) that support KENAK. TOTEE 20701-5/2010 “Combined Electricity, Heat and cold Production: Installations in Buildings” was first published in April 2012. The guideline outlines the technical specifications for the installation and connection of different CHP systems with the main grid and the systems. The guidelines are available on-line by TEE.
[TEE-KENAK]	Λογισμικό TEE-KENAK http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak	The official national software (TEE–KENAK) was developed by the National Observatory of Athens (NOA) for the Technical Chamber of Greece (TEE), to support the implementation of KENAK in Greece and issue EPCs. For the building’s energy performance assessment, this is the common calculation tool that is used by commercial software, to avoid inconsistency problems that could have arised from using different software that may provide different results. The calculation engine of TEE–KENAK was based on the EPA-NR tool, which was developed within the framework of a European project (www.epa-nr.org). The tool was upgraded to meet national requirements and the final European standards, with a new interface, incorporating the relevant national technical libraries, weather data, user’s guide etc. The tool is periodically updated and is available on-line by TEE since November 2010.
[YPEKA Bioclimatic]	Προώθηση της Βιοκλιματικής Αρχιτεκτονικής στο κτίριο και ιδιαίτερα στην κατοικία http://www.ypeka.gr/Default.aspx?tabid=380&language=el-GR	For the advancement of bioclimatic architecture of buildings with an emphasis on dwellings. Overview of design principles for Regional Planning & Urban Development of the Hellenic Ministry of Environment, Energy & Climatic Change (YPEKA)

3.11 <HU> Hungary

(by EPISCOPE partner BME)

The attention towards low-energy buildings was initiated by the Solanova project completed in 2006, when a residential building built with prefabricated sandwich panels (a so-called “commi-block” building) has been retrofitted to a low-energy building. It was realized within an EU FP5 project, as a cooperation of the Uni-Kassel, the Passive House Institute Darmstadt and the Budapest University of Technology (among others).

Although since 2008 the building construction industry is in crisis, the interest for energy efficient buildings is relatively high. Since then some hundreds of family houses and a couple of multi-residential buildings have been built according to low-energy level. The number of certified passive houses is rather low, because there are no subsidies available for certified buildings, and the cost of the certification is relative high. Statistics are not available about the number of low-energy or passive houses.

3.11.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Hungary

Also 2006 was the date for the introduction of the new building energy requirements in accordance with the EPBD. Since then the requirements have remained unchanged. The requirements are far from what could be called NZEB. However in 2015, 2018 and 2021 significant changes will be introduced in order to strengthen the requirements. The latter date refers to the introduction of NZEB requirements for residential buildings.

Officially there is already a definition for the nearly zero-energy buildings (NZEBs), but it is not an accurately elaborated definition, just a one-paragraph long legal text. Therefore the elaboration of a detailed specification will be necessary in the future.

Minimum requirements for new residential buildings in Hungary

The first Ministerial Order (the 7/2006. (V. 24) Decree of Minister without Portfolio about Determination of Energy Efficiency of Buildings), which included the requirements, the design input data and the calculation method, was issued in May 2006 and has been in force since the 1st of September 2006.

Since that date, the fulfilment of energy requirements is a precondition for obtaining a building permit. Several calculation softwares were developed on a commercial basis. As a result, the thermal performance of buildings improved considerably. In terms of building envelopes, it corresponds to 36 %, 50 % and 43 % decreases of the U values of exposed walls, roofs and windows, respectively, relative to pre-EPBD values. The overall average U value of an envelope (including thermal bridge effects) ranges between 0.45 and 0.65 W/m2 K, depending on the surface to volume ratio (see next figure).

The requirement system has three facets, as far as new buildings and major renovations are concerned. Maximum permitted values are set for the U values of elements and the specific heating energy need (W/m3K), as a function of the surface to volume ratio. It is to be emphasized that, applying elements with the allowed U values does not guarantee the fulfilment of the specific heating energy need requirement: depending on the ratio of wall, window and roof area, stricter insulation requirements must often be applied. The losses from thermal bridges are also considered. Finally, the specific yearly primary energy need must not exceed a limit, which depends on the surface to volume ratio and the type of use of the building. Maximum permitted values are given for a few typical uses (residential, school, office), whilst, in case of mixed use, a reference building is to be considered. The primary energy needs include heating, domestic hot water, cooling and, for non-residential buildings, lighting needs.

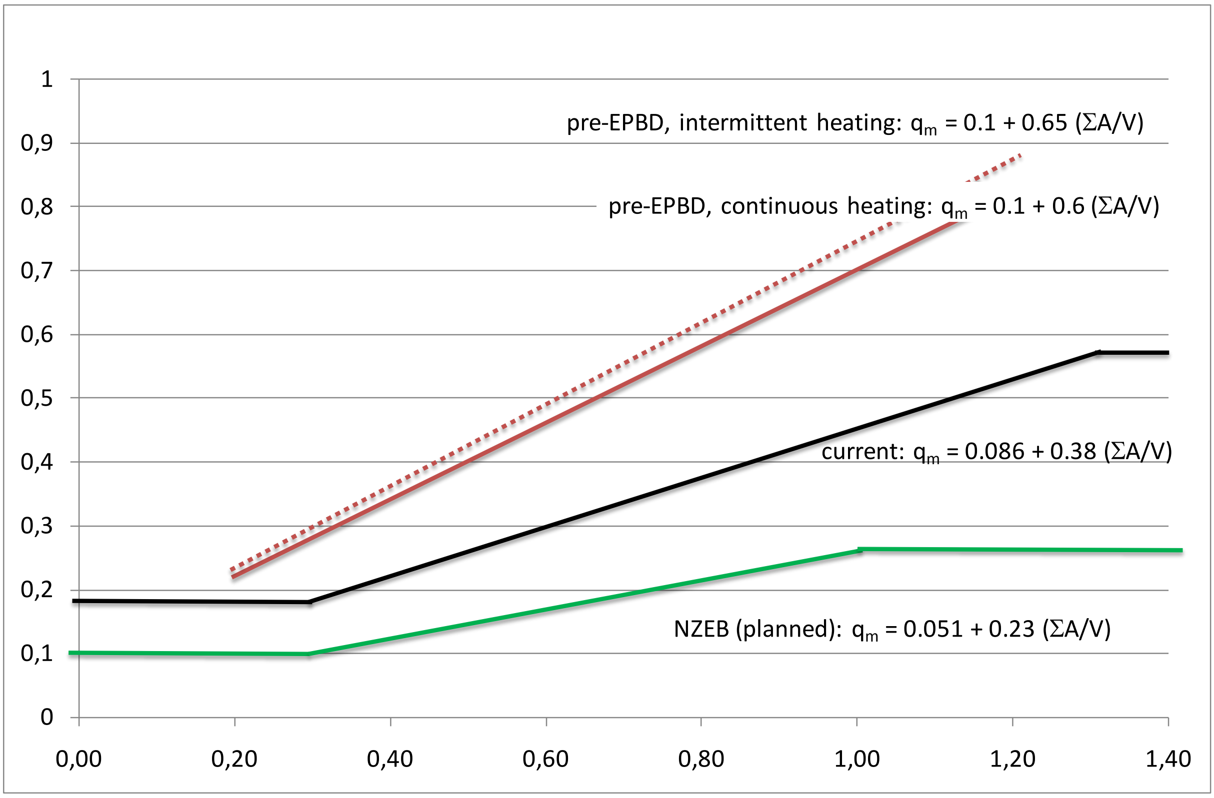


Figure 45: Development of the requirements on the specific heating energy need (W/m^{3}K), as a function of the surface to volume ratio [m^2/m^3]

These requirements were applicable for new buildings and major renovations above 1000 m^2 conditioned floor area.

But, since then, the Hungarian Decree of the Minister of Interior 40/2012 (VIII. 13.) and the amendment of the 7/2006. (V. 24) have introduced changes in the requirements:

- **For new buildings and major renovations**, the new requirements have been in force since the 9th of January 2013 for the building service system. These requirements are partly recommendations (application of condensing boilers; roomwise control system for heating; in case of a balanced ventilation system, a heat recovery efficiency above 70 %; ventilators set to the operation mode with maximum efficiency), and partly obligatory (balancing the heating, cooling, ventilation and DHW system; central control system in buildings above 100 m^2 conditioned floor area; circulation pumps must be operated according to a time schedule; hydraulic losses are limited for ventilation system elements; air tightness of ventilation ducts is to be maximised).
- If any building element or building service system element of a building is to be **retrofitted energetically** the element must fulfil the current requirements (regarding U-values or building service system elements). This rule does not apply in case of maintenance measures. This requirement has been in force since 9th of July 2013.
- In case of a **new building** it is obligatory to analyse the application possibilities of alternative systems considering environmental, technical and economic aspects. The analysis can be carried out for individual buildings or for a group of similar buildings or for buildings at the same location and with similar characteristics or in case of a group of buildings with common heating or cooling system. This requirement has been in force since the 9th of July 2013.

Hungarian calculation method to comply with new building regulations for residential buildings

The governmental order defining the method for the certification of buildings was issued in 2008. It included both the operational and the asset method and it was the subject of conciliation in the Chamber of Engineers. However, an official methodology was only developed for the asset method. Thus, in the practice, all the experts use the asset method. The same order postponed the deadlines for the initiation of the certification process: for new buildings, it started in January 2009, whilst compulsory certification of existing buildings was launched in January 2012, although it is already in effect since 2008 on a voluntary basis and in the case of subsidized energy conscious retrofit.

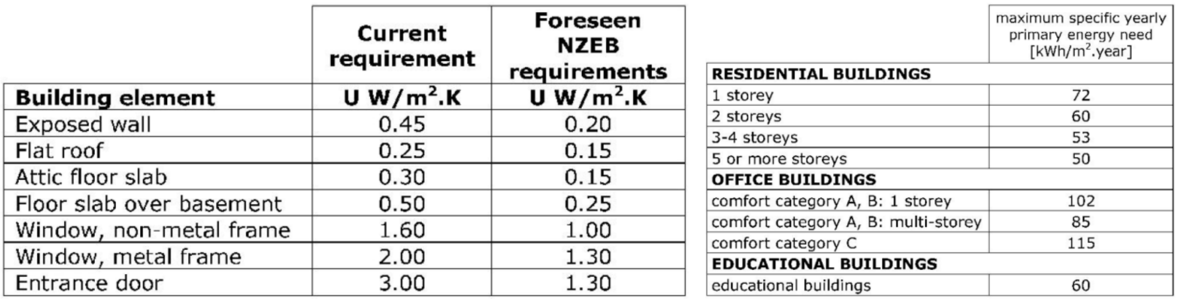
The calculation method is defined by the Ministerial Order (the 7/2006. (V. 24) Decree of Minister without Portfolio about Determination of Energy Efficiency of Buildings), which included the requirements, the design input data and the calculation method. It was originally issued in May 2006 and has been modified two times since then (in 2012 and in 2014) [BM, 2012], [BM, 2014].

Status of NZEB definition for residential buildings in Hungary

Officially, there is already a legislative definition for the nearly zero-energy buildings (NZEBs), but it is not an accurately elaborated definition, just a one-paragraph long legal text. Therefore the elaboration of a detailed specification will be necessary in the future. According to the regulation, a NZEB building is different from a building meeting cost optimum requirements in that 25 % of its primary energy demand needs to be met from renewable sources. The cost optimal requirements will be introduced in 2015 for buildings applying for any national or EU funds and in 2018 for all buildings.

A preliminary study to set the definition and the requirements of the NZEBs was carried out by the University of Debrecen in May 2012. A revised version, taking into account the results of the cost optimal requirements at the lowest global cost, was developed in January 2013. It has provided additional recommendations on the requirements for existing buildings. The official legislative definition was based on this study, but contains no technical details. Therefore the figures presented in this paper are based on the study. The recommended requirements are summarized in the following tables and the previous figure.

Table 99: Maximum permitted values for the U values of elements in the current and in the foreseen NZEB legislation



	Current requirement	Foreseen NZEB requirements
Building element	**U W/m².K**	**U W/m².K**
Exposed wall	0.45	0.20
Flat roof	0.25	0.15
Attic floor slab	0.30	0.15
Floor slab over basement	0.50	0.25
Window, non-metal frame	1.60	1.00
Window, metal frame	2.00	1.30
Entrance door	3.00	1.30

	maximum specific yearly primary energy need [kWh/m².year]
RESIDENTIAL BUILDINGS	
1 storey	72
2 storeys	60
3-4 storeys	53
5 or more storeys	50
OFFICE BUILDINGS	
comfort category A, B: 1 storey	102
comfort category A, B: multi-storey	85
comfort category C	115
EDUCATIONAL BUILDINGS	
educational buildings	60

Table 100: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition in Hungary

Calculation Method New Building Regulations – (part 1)

Country	**HU**	Hungary	Status	07/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the (assumed) National NZEB Definition

Legislation / Standards

[TNM, 2006] Ministerial Order (the 7/2006. (V. 24) Decree of Minister without Portfolio about Determination of Energy Efficiency of Buildings. Modified two times (in 2012 and in 2014).

[BM, 2014] Ministerial decree 20/2014 (III.7.) of Minister of Interior

Explanation / Comments

Official definition of NZEB since 7 March 2014 [BM, 2014]

Special Aspects:

Officially there is already a definition for the nearly zero-energy buildings (NZEBs), but it is not an accurately elaborated definition, just a one-paragraph long legal text: an nZEB building is different from a building meeting the ‘cost optimum requirements’ in that 25% of its primary energy demand needs to be met from renewable sources.

The elaboration of a detailed specification will be necessary in the future.

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

Special Aspects:

The NZEB calculation is methodically based on the Hungarian EPC procedure for new buildings.

Appliances and lighting are not considered in the regular EP requirements.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Year
x	Calculation of delivered energy (system)	Year

Explanation / Comments

Special Aspects:

The NZEB calculation is methodically based on the Hungarian EPC procedure for new buildings. No deviation compared to the calculation method for standard buildings.

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery	
x	Thermal solar system	
x	Other special systems:	any special systems can be incorporated without predefined calculation method

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x			
x	On-site PV	x	x	year	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Special Aspects:

The NZEB calculation is methodically based on the Hungarian EPC procedure for new buildings. No deviation compared to the calculation method for standard buildings.

Calculation methods for special technologies are not defined. Any software on the market can be used.

Off-site systems are expressed by the primary energy factors.

Type of Requirements (new buildings)

x	U-values of building elements	x	Primary energy	non-renewable
x	Heat transfer coefficient by transmission			
	Energy need for heating		Carbon dioxide emissions	
	Delivered energy		Other	

Explanation / Comments

The heat transfer coefficient and the primary energy demand requirements depend on the surface-to-volume ratio of the building.

For buildings other than residential, office and educational buildings the primary energy demand requirement is based on a reference building method.

Special Aspects:

The NZEB calculation is methodically based on the Hungarian EPC procedure for new buildings. No deviation compared to the calculation method for standard buildings.

Assessment of energy carriers in Hungary

The assessment of the energy performance of buildings by use of non-renewable primary energy factors (related to delivered energy) derived from the Ministerial Order (the 7/2006. (V. 24) Decree of Minister without Portfolio about Determination of Energy Efficiency of Buildings. Since its introduction (2006) the primary energy factors have been modified two times (in 2012 and in April 2014), particularly those for district heating.

Table 101: Hungarian primary energy factors

Label / type of factor	**Primary Energy Factors Hungary**
Used for EPC rating	x
Used for building regulations requirements	x
Label (national language)	**Primer energia tényezők [TNM, 2006] 2014-es változata szerint**
Description / type of weighting factor	non-renewable energy, includes upstream energy expenditures (transportation, transformation) beyond national boundary
Factor is multiplied by delivered energy based on the	net calorific value (H_i)
Reference	[TNM, 2006]
Natural gas	1
Heating oil	1
Hard coal	1
Electricity	2.5
Off peak electricity	1.8
District heating without CHP	1.26 / 1.12*
District heating with 67 % CHP	0.83
District heating biomass without CHP	0.76
District heating biomass with 67 % CHP	0.50

*) deviation of [BM, 2014] from [TNM, 2006], starting from January 2014.

Methodological points for discussion in Hungary

The most relevant discussion points are:

- Primary energy factors for district heating;
- Primary energy factor for biomass;
- Requirements based on surface-to-volume ratio;
- Requirements on calculation details: more details or more freedom.

3.11.2 Integration of National Requirements for New Buildings and NZEB Standards in the Hungarian Residential Building Typology

In parallel to the development of the present typology, similar work was being carried out as part of the development of the National Building Energy Strategy. The two typologies show some resemblance, but there are also important differences. The objective of the EPISCOPE typology is to contribute to a uniform European typology, and – based on available statistical data – estimations concerning the entire European building stock.

Hungary was not represented in the previous TABULA project, the complete typology was developed within EPISCOPE, and thus the NZEB buildings were introduced at the same time as the existing buildings.

Classification scheme for the Hungarian residential building stock ("Building Type Matrix")

During the IEE Project EPISCOPE the building type matrix was developed for Hungary, reflecting to the current building regulation. Figure hereunder shows the respective matrix.

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	national	… 1944	generic	 HU.N.SFH.01.Gen		 HU.N.MFH.01.Gen	
2	national	1945 … 1979	generic	 HU.N.SFH.02.Gen		 HU.N.MFH.02.Gen	
3	national	1980 … 1989	generic	 HU.N.SFH.03.Gen		 HU.N.MFH.03.Gen	
4	national	1990 … 2005	generic	 HU.N.SFH.04.Gen		 HU.N.MFH.04.Gen	
5	national	2006 …	generic	 HU.N.SFH.05.Gen		 HU.N.MFH.05.Gen	 HU.N.AB.05.Gen
6	national	1945 … 1979	industrialized technology				 HU.N.AB.02.Ind
7	national	1980 … 1989	industrialized technology				 HU.N.AB.03.Ind
8	national	… 1944	Flat area: below 80 m2	 HU.N.SFH.01.Bel80			
9	national	1945 … 1979	Flat area: below 80 m2	 HU.N.SFH.02.Bel80			

Figure 46: Classification scheme ("Building Type Matrix") of the Hungarian residential building typology including new buildings

Table 102: Exemplary new buildings representing the latest construction year classes (2006 …)

		SFH.05	TH	MFH.05	AB.05
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 HU.SFH.05.Gen	-	 HU.MFH.05.Gen	 HU.AB.05.Gen
Number of dwellings		1		5	30
Number of full storeys (conditioned)		2		3	5
Number of directly attached neighbour buildings		0		1	0
National reference area (conditioned floor area, internal dimensions)	m²	131		373	1702
TABULA reference area (conditioned floor area, internal dimensions)	m²	131		373	1702

Building example: variants meeting three energy performance levels for new buildings

In the following the exemplary multi-family house (MFH.05) will be demonstrated in more detail. Comparable information for the other buildings can be found in the updated national typology brochure [BME, 2014].

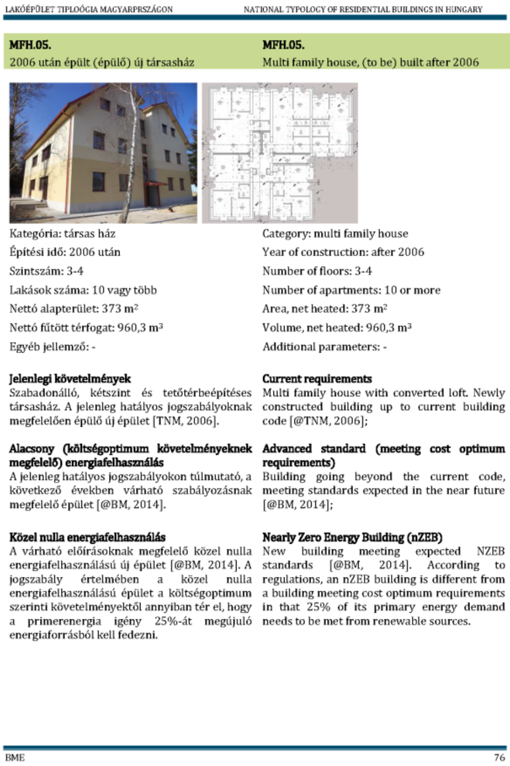
Table hereunder shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels for newly constructed buildings

1) **'Current requirements'**
   Newly constructed building up to current code [TNM, 2006];
2) **'Advanced standard (meeting cost optimum requirements)'**
   Building going beyond the current code, meeting standards expected in the near future (for applications from 2015 onwards, and as a general requirement from 2018) [BM, 2014];
3) **'Nearly Zero Energy Building (nZEB)'**
   New building meeting expected NZEB standards [BM, 2014]. According to regulations, an nZEB building is different from a building meeting cost optimum requirements in that 25 % of its primary energy demand needs to be met from renewable sources.

Table 103: Exemplary multi-family house (MFH) – definition of variants

		**MFH.05**		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
U-values				
Roof (Roof 2)	W/(m²K)	0.25 (0.22)	0.15 (0.17)	0.13 (0.12)
Wall	W/(m²K)	0.22	0.17	0.14
Window	W/(m²K)	1.50	1.30	1.00
Door	W/(m²K)	2.00	1.80	1.30
Floor	W/(m²K)	0.24	0.19	0.15
Thermal bridging supplement (whole envelope)	W/(m²K)	0.05	0.02	0.00
Heat Supply System				
Heat generator		non-condensing boiler	condensing boiler	condensing boiler
Thermal solar system		-	-	DHW



MFH.05. 2006 után épült (épülő) új társasház	**MFH.05.** Multi family house, (to be) built after 2006

Kategória: társas ház
Építési idő: 2006 után
Szintszám: 3-4
Lakások száma: 10 vagy több
Nettó alapterület: 373 m²
Nettó fűtött térfogat: 960,3 m³
Egyéb jellemző: -

Category: multi family house
Year of construction: after 2006
Number of floors: 3-4
Number of apartments: 10 or more
Area, net heated: 373 m²
Volume, net heated: 960,3 m³
Additional parameters: -

Jelenlegi követelmények
Szabadonálló, kétszint és tetőtérbeépítéses társasház. A jelenleg hatályos jogszabályoknak megfelelően épülő új épület [TNM, 2006].

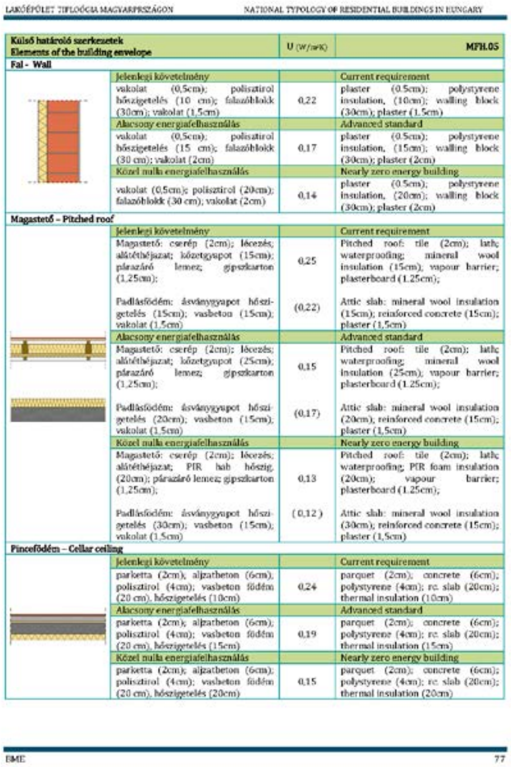
Alacsony (költségoptimum követelményeknek megfelelő) energiafelhasználás
A jelenleg hatályos jogszabályokon túlmutató, a következő években várható szabályozásnak megfelelő épület [@BM, 2014].

Közel nulla energiafelhasználás
A várható előírásoknak megfelelő közel nulla energiafelhasználású új épület [@BM, 2014]. A jogszabály értelmében a közel nulla energiafelhasználású épület a költségoptimum szerinti követelményektől annyiban tér el, hogy a primerenergia igény 25%-át megújuló energiaforrásból kell fedezni.

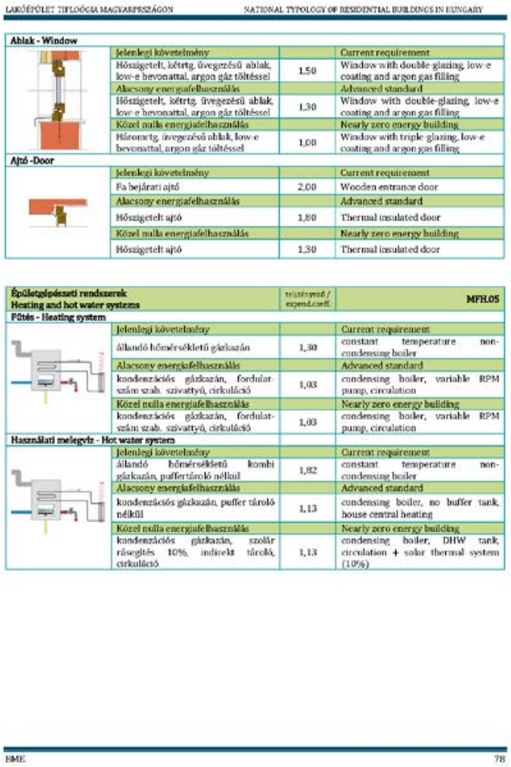
Current requirements
Multi family house with converted loft. Newly constructed building up to current building code [@TNM, 2006];

Advanced standard (meeting cost optimum requirements)
Building going beyond the current code, meeting standards expected in the near future [@BM, 2014];

Nearly Zero Energy Building (nZEB)
New building meeting expected NZEB standards [@BM, 2014]. According to regulations, an nZEB building is different from a building meeting cost optimum requirements in that 25% of its primary energy demand needs to be met from renewable sources.

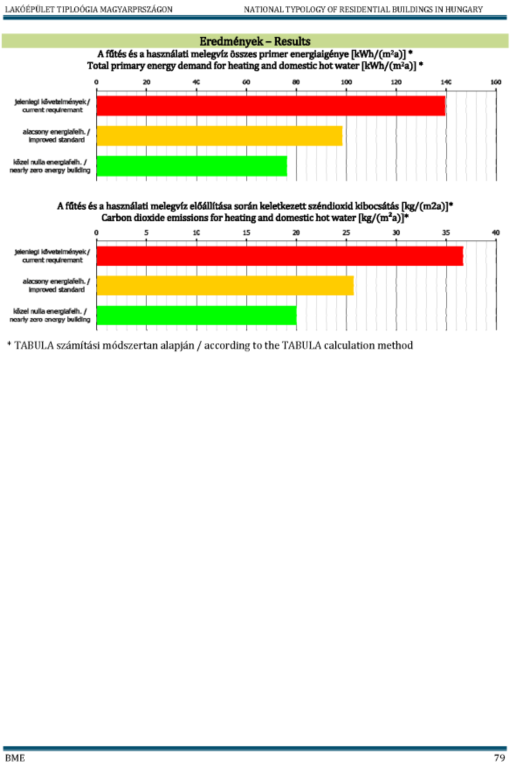


Külső határoló szerkezetek **Elements of the building envelope**	U (W/m²K)	**MFH.05**
Fal - Wall		
Jelenlegi követelmény		Current requirement
vakolat (0,5cm); polisztirol hőszigetelés (10 cm); falazóblokk (30cm); vakolat (1,5cm)	0,22	plaster (0.5cm); polystyrene insulation, (10cm); walling block (30cm); plaster (1.5cm)
Alacsony energiafelhasználás		Advanced standard
vakolat (0,5cm); polisztirol hőszigetelés (15 cm); falazóblokk (30 cm); vakolat (2cm)	0,17	plaster (0.5cm); polystyrene insulation, (15cm); walling block (30cm); plaster (2cm)
Közel nulla energiafelhasználás		Nearly zero energy building
vakolat (0,5cm); polisztirol (20cm); falazóblokk (30 cm); vakolat (2cm)	0,14	plaster (0.5cm); polystyrene insulation, (20cm); walling block (30cm); plaster (2cm)
Magastető – Pitched roof		
Jelenlegi követelmény		Current requirement
Magastető: cserép (2cm); lécezés; alátéthéjazat; kőzetgyapot (15cm); párazáró lemez; gipszkarton (1,25cm);	0,25	Pitched roof: tile (2cm); lath; waterproofing; mineral wool insulation (15cm); vapour barrier; plasterboard (1.25cm);
Padlásfödém: ásványgyapot hőszigetelés (15cm); vasbeton (15cm); vakolat (1,5cm)	(0,22)	Attic slab: mineral wool insulation (15cm); reinforced concrete (15cm); plaster (1,5cm)
Alacsony energiafelhasználás		Advanced standard
Magastető: cserép (2cm); lécezés; alátéthéjazat; kőzetgyapot (25cm); párazáró lemez; gipszkarton (1,25cm);	0,15	Pitched roof: tile (2cm); lath; waterproofing; mineral wool insulation (25cm); vapour barrier; plasterboard (1.25cm);
Padlásfödém: ásványgyapot hőszigetelés (20cm); vasbeton (15cm); vakolat (1,5cm)	(0,17)	Attic slab: mineral wool insulation (20cm); reinforced concrete (15cm); plaster (1,5cm)
Közel nulla energiafelhasználás		Nearly zero energy building
Magastető: cserép (2cm); lécezés; alátéthéjazat; PIR hab hőszig. (20cm); párazáró lemez; gipszkarton (1,25cm);	0,13	Pitched roof: tile (2cm); lath; waterproofing; PIR foam insulation (20cm); vapour barrier; plasterboard (1.25cm);
Padlásfödém: ásványgyapot hőszigetelés (30cm); vasbeton (15cm); vakolat (1,5cm)	(0,12)	Attic slab: mineral wool insulation (30cm); reinforced concrete (15cm); plaster (1,5cm)
Pincefödém – Cellar ceiling		
Jelenlegi követelmény		Current requirement
parketta (2cm); aljzatbeton (6cm); polisztirol (4cm); vasbeton födém (20 cm), hőszigetelés (10cm)	0,24	parquet (2cm); concrete (6cm); polystyrene (4cm); r.c. slab (20cm); thermal insulation (10cm)
Alacsony energiafelhasználás		Advanced standard
parketta (2cm); aljzatbeton (6cm); polisztirol (4cm); vasbeton födém (20 cm), hőszigetelés (15cm)	0,19	parquet (2cm); concrete (6cm); polystyrene (4cm); r.c. slab (20cm); thermal insulation (15cm)
Közel nulla energiafelhasználás		Nearly zero energy building
parketta (2cm); aljzatbeton (6cm); polisztirol (4cm); vasbeton födém (20 cm), hőszigetelés (20cm)	0,15	parquet (2cm); concrete (6cm); polystyrene (4cm); r.c. slab (20cm); thermal insulation (20cm)



Ablak - Window		
Jelenlegi követelmény		Current requirement
Hőszigetelt, kétrtg. üvegezésű ablak, low-e bevonattal, argon gáz töltéssel	1,50	Window with double-glazing, low-e coating and argon gas filling
Alacsony energiafelhasználás		Advanced standard
Hőszigetelt, kétrtg. üvegezésű ablak, low-e bevonattal, argon gáz töltéssel	1,30	Window with double-glazing, low-e coating and argon gas filling
Közel nulla energiafelhasználás		Nearly zero energy building
Háromrtg. üvegezésű ablak, low-e bevonattal, argon gáz töltéssel	1,00	Window with triple-glazing, low-e coating and argon gas filling
Ajtó -Door		
Jelenlegi követelmény		Current requirement
Fa bejárati ajtó	2,00	Wooden entrance door
Alacsony energiafelhasználás		Advanced standard
Hőszigetelt ajtó	1,80	Thermal insulated door
Közel nulla energiafelhasználás		Nearly zero energy building
Hőszigetelt ajtó	1,30	Thermal insulated door

Épületgépészeti rendszerek **Heating and hot water systems**	teljesítmény-tényező / expend.coeff.	**MFH.05**
Fűtés - Heating system		
Jelenlegi követelmény		Current requirement
állandó hőmérsékletű gázkazán	1,30	constant temperature non-condensing boiler
Alacsony energiafelhasználás		Advanced standard
kondenzációs gázkazán, fordulatszám szab. szivattyú, cirkuláció	1,03	condensing boiler, variable RPM pump, circulation
Közel nulla energiafelhasználás		Nearly zero energy building
kondenzációs gázkazán, fordulatszám szab. szivattyú, cirkuláció	1,03	condensing boiler, variable RPM pump, circulation
Használati melegvíz - Hot water system		
Jelenlegi követelmény		Current requirement
állandó hőmérsékletű kombi gázkazán, puffertároló nélkül	1,82	constant temperature non-condensing boiler
Alacsony energiafelhasználás		Advanced standard
kondenzációs gázkazán, puffer tároló nélkül	1,13	condensing boiler, no buffer tank, house central heating
Közel nulla energiafelhasználás		Nearly zero energy building
kondenzációs gázkazán, szolár rásegítés 10%, indirekt tároló, cirkuláció	1,13	condensing boiler, DHW tank, circulation + solar thermal system (10%)



Eredmények – Results

A fűtés és a használati melegvíz összes primer energiaigénye [kWh/(m²a)] *
Total primary energy demand for heating and domestic hot water [kWh/(m²a)] *

A fűtés és a használati melegvíz előállítása során keletkezett széndioxid kibocsátás [kg/(m2a)]*
Carbon dioxide emissions for heating and domestic hot water [kg/(m²a)]*

* TABULA számítási módszertan alapján / according to the TABULA calculation method

Figure 47: “Building Display Sheet” of the exemplary MFH <HU> [BME, 2014]

Table 104: Exemplary MFH – Results of the energy balance calculation; Procedure: national calculation method according to the current building code: [TNM, 2006] and [BM, 2014]

Variant N°		**001**	**002**	**003**
Label of the variant triplet		MFH.05		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Calculation method		TABULA		
National reference area (conditioned floor area, internal dimensions)	m²	373	373	373
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.64	0.48	0.38
Energy need for heating	kWh/(m²a)	34.7	24.9	17.8
Delivered energy				
Fossil fuels	kWh/(m²a)	92.5	63.3	69.1
Electricity	kWh/(m²a)	4.24	5.7	3.5
Primary energy demand	kWh/(m²a)	103.1	77.6	67.2

In addition, the national requirements are for NZEB are not specified in a detailed manner yet in the legislation, therefore the figures are indicative.

TABULA calculation results for all exemplary buildings

Table 105 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 105: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. Nº	Performance Level	h_Transmission W/(m^{2}K)	q_h_nd kWh/(m^{2}a)	q_ve_rec_h_usable kWh/(m^{2}a)	q_h_nd_net kWh/(m^{2}a)	q_g_h_out kWh/(m^{2}a)	q_w_nd kWh/(m^{2}a)	q_g_w_out kWh/(m^{2}a)	q_del_sum_gas kWh/(m^{2}a)	q_del_sum_oil kWh/(m^{2}a)	q_del_sum_coal kWh/(m^{2}a)	q_del_sum_bio kWh/(m^{2}a)	q_del_sum_el kWh/(m^{2}a)	q_del_sum_dh kWh/(m^{2}a)	q_del_sum_other kWh/(m^{2}a)	q_exp_sum_el kWh/(m^{2}a)
SFH  HU.SFH.05.Gen	01	Minimum Requirement	1.04	73	0	73	85	10	32	146	0	0	0	2	0	0	0
	02	Improved Standard	0.63	51	0	51	56	10	13	74	0	0	0	2	0	0	0
	03	Ambitious Standard / NZEB	0.47	41	0	41	46	10	19	58	0	0	0	3	0	0	0
MFH  HU.MFH.05.Gen	01	Minimum Requirement	0.71	58	0	58	71	15	18	125	0	0	0	3	0	0	0
	02	Improved Standard	0.54	45	0	45	57	15	19	80	0	0	0	6	0	0	0
	03	Ambitious Standard / NZEB	0.37	34	0	34	46	15	19	67	0	0	0	3	0	0	0
AB  HU.AB.05.Gen	01	Minimum Requirement	0.61	51	0	51	64	15	20	101	0	0	0	4	0	0	0
	02	Improved Standard	0.48	40	0	40	53	15	20	76	0	0	0	4	0	0	0
	03	Ambitious Standard / NZEB	0.35	32	0	32	37	15	20	58	0	0	0	1	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m^{2}K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m^{2}a)	energy need for heating
q_ve_rec_h_usable	kWh/(m^{2}a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m^{2}a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m^{2}a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m^{2}a)	net energy need domestic hot water
q_g_w_out	kWh/(m^{2}a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, … _el	kWh/(m^{2}a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m^{2}a)	sum produced electricity (negative value)

3.11.3 Sources / References Hungary

Table 106: Sources / References Hungary

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[BM, 2012]	40/2012. (VIII. 13.) BM rendelet az épületek energetikai jellemzőinek meghatározásáról szóló 7/2006. (V. 24.) TNM rendelet módosításáról	Hungarian Decree of the Minister of Interior 40/2012 (VIII. 13.) and the ammendment of the 7/2006. (V. 24)
[BM, 2014]	20/2014. (III. 7.) BM rendelet az épületek energetikai jellemzőinek meghatározásáról szóló 7/2006. (V. 24.) TNM rendelet módosításáról	Hungarian Decree of the Minister of Interior 20/2014 (III. 7.) on the ammendment of the 7/2006. (V. 24)
[BME, 2014]	Csoknyai Tamás PhD, Hrabovszky-Horváth Sára, Seprődi-Egeresi Márta, Szendrő Gábor: LAKÓÉPÜLET TIPOLÓGIA MAGYARORSZÁGON, Episcope project kiadvány, 2014	Csoknyai Tamás PhD, Hrabovszky-Horváth Sára, Seprődi-Egeresi Márta, Szendrő Gábor: NATIONAL TYPOLOGY OF RESIDENTAL BUILDINGS IN HUNGARY, Episcope project brochure, 2014
[TNM, 2006]	7/2006. (V.24.) TNM rendelet: Az épületek energetikai jellemzőinek meghatározásáról	Ministerial Order (the 7/2006. (V. 24) Decree of Minister without Portfolio, about Determination of Energy Efficiency of Buildings

3.12 <IE> Ireland

(by EPISCOPE partner Energy Action)

Draft Building Regulations were first introduced in Ireland in 1976 and were subsequently revised in 1981. Formal Building Regulations were officially introduced in Ireland in 1991 and there were subsequent revisions to the Regulations in 1997, 2002, 2005, 2008 and 2011.

Regarding the promotion of lower energy buildings, the House of Tomorrow Programme was launched in 2001 by Sustainable Energy Ireland, (since reconstituted as the Sustainable Energy Authority of Ireland – Ireland's national energy authority). The aim of the House of Tomorrow programme was to accelerate improvements in the quality of energy performance of Irish dwellings and to encourage the market uptake of cost-effective innovation. Central to this was the establishment of a nationwide network of living examples of houses incorporating superior energy features.

The heart of the programme was a demonstration scheme which part funded private and social housing developments that would deliver a saving of over 40 % in energy consumption and associated CO2 emissions relative to what would apply under the then current Building Regulations.

In total, over 124 housing developments were provided with funding support of €33m, involving over 5,300 units in every county in Ireland. These developments used a strong array of innovative technologies and practices, from insulation materials, advanced windows, and highly efficient boilers, to healthy ventilation control systems, energy efficient lighting and renewable energy systems including solar, heat pumps and biomass heating. The programme supported a further 23 projects in the form of installer training, technology guides, feasibility studies, research into housing performance and postgraduate studentships to help build awareness and capability among practitioners in the specification and implementation of innovative energy technology features in Irish houses. The House of Tomorrow Programme ceased in 2010.

3.12.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Ireland

The revised Building Regulations in 2008 and 2011 [TGD Part L 2011] represented a 40 % and 60 % respectively reduction in energy demand of a reference dwelling as defined in Appendix C of Technical Guidance Document Part L of the 2005 Building Regulations [TGD Part L 2005].

A 70 % improvement in energy demand (compared to the 2005 reference dwelling) is proposed for the 2016 revision of the Building Regulations by the Department of Environment, Community and Local Government [DECLG 2012]. This will set the Nearly Zero Energy Building standard for new dwellings in Ireland in accordance with the common general framework set out in Annex 1 of Directive 2010/31/EU on the Energy Performance of Buildings (Recast). For a typical dwelling, this will equate to an A2 rating with a primary energy value of 45 kWh/m2/annum and an energy performance co-efficient (EPC) and carbon performance co-efficient (CPC) not exceeding 0.302 and 0.305 respectively.

Minimum requirements for new residential buildings in Ireland

Technical Guidance Document (TGD) Part L (Conservation of Fuel and Energy - Dwellings) [TGD Part L 2011] sets out the building energy standards required for compliance with the 2011 Irish Building Regulations.

The revision to the minimum energy performance requirements in 2008 and 2011 from the 2005 baseline are shown in Table 107.

Table 107: Ireland – revisions to building energy performance levels

Overall Dwelling Performance	2005	2008	2011
Improvement	Baseline	40 %	60 %
Individual Backstop Values			
Renewable - Heat / Electrical (kWh/m^2/y)	-	10 (heat) 4 (electrical)	10 (heat) 4 (electrical)
Pitched Roof U-value - Ceiling/Slope	0.16/0.20	0.16/0.20	0.16/0.16
Flat Roofs U-value	0.22	0.22	0.2
Walls U-value	0.27	0.27	0.21
Floors U-value	0.25	0.25	0.21
Floors with under floor heating U-value	-	0.15	0.15
Windows etc. (25% of floor area)	2.2	2	1.6
Air Permeability (m^3/hr/m^2 @ 50 Pa)	-	10	7
Boiler Efficiency	-	86 %	90 %
SFP for balanced systems (W/litre/sec)	-	2	1.5

For new dwellings, the 2011 Building Regulations require a minimum renewable contribution of 10 kWh/m^2/ year from thermal sources or 4 kWh/m^2/year of electrical energy or a combination of both. Air Permeability shall not exceed 7m^3/hr/m^2 when tested in accordance with the defined procedure. Fabric U values shall not exceed the values listed in Table 107 though scope does exist for higher values in some locations once the overall average U value levels are achieved.

Ireland calculation method to comply with new building regulations for residential buildings

The Dwelling Energy Assessment Procedure (DEAP) [DEAP 3.2.1] is the Irish official procedure for calculating and assessing the energy required for space heating, ventilation, water heating and lighting, less savings from energy generation technologies. DEAP calculates the annual delivered energy consumption, primary energy consumption and carbon dioxide emission for standardised occupancy.

The DEAP software contains equations or algorithms representing the relationships between the factors contributing to the annual energy performance of the dwelling. The software is accompanied by a series of reference data tables.

DEAP is compliant with the methodology framework in the EU Energy Performance of Buildings Directive (EPBD). The DEAP calculation framework is based on IS EN 13790, and draws heavily on the calculation procedures and tabulated data of the Standard Assessment Procedure (SAP) for energy rating of dwellings in the UK.

DEAP is used to demonstrate compliance with the EPBD in Ireland including elements of the Irish Building Regulations Part L 2005, 2008 and 2011 for new dwellings. For Building Regulations 2005 TGD L, the DEAP software calculates the Carbon Dioxide Emission Rate (CDER) of the dwelling, and the corresponding Maximum Permitted Carbon Dioxide Emission Rate (MPCDER), expressed in units of kg CO2 per square metre per annum. This provision applies to new dwellings built between 1st July 2006 and 1st July 2008 subject to transitional arrangements cited in Building Regulations 2005 TGD L.

DEAP compares the dwelling's Energy Performance Coefficient (EPC) and Carbon Performance Coefficient (CPC) to the Maximum Permitted Energy Performance Coefficient (MPEPC) and Maximum Permitted Carbon Performance Coefficient (MPCPC) for Building Regulations 2008 and 2011 TGD L. DEAP also determines if the Building Regulations 2008 and 2011 TGD L renewables requirement is satisfied. Building Regulations 2008 TGD L applies to new dwellings from 1st July 2008 and Building Regulations 2011 TGD L applies to new dwellings from 1st December 2011.

DEAP confirms that the fabric heat loss is limited as defined in the 2005, 2008 and 2011 Building Regulations TGD L. DEAP checks that the building air permeability is limited as defined in the Building Regulations 2008 and 2011 TGD L documents. DEAP flags the lack of an air permeability test as a non-compliance where a test result is not specified. The permeability test result specified in DEAP should follow the guidance and sampling regimes outlined in the applicable TGD L documents.

The Building Regulations TGD L documents provide guidance on the applicability of each TGD L edition to dwellings based on dwelling age, date of planning permission and construction.

Status of NZEB definition for residential buildings in Ireland

The Irish Department of Environment, Community and Local Government set out the Irish NZEB definition for residential buildings in its policy document “Towards Nearly Zero Energy Buildings in Ireland – Planning for 2020 and beyond” [DECLG 2012].

By 2020 all new dwellings in Ireland will have an Energy Performance Coefficient (EPC) and Carbon Performance Coefficient (CPC) of 0.302 and 0.305 in accordance with the common general framework set out in Annex I of Directive 2010/31/EU on the energy performance of buildings (recast). This takes account of the energy load for space heating, water heating, fixed lighting and ventilation. For a typical dwelling this will equate to 45 kWh/m2/annum, a very significant proportion of which will be covered from renewable energy sources produced on-site or nearby.

In terms of BER certificates, this will have the effect that all new dwellings should be rated as A2 or higher.

The improvements in the energy and carbon factors and the EPC ratings since the 2005 Building Regulations up to the proposed NZEB standard in 2016 are detailed in Table 108.

Table 108: Ireland – energy and carbon performance limits for dwellings

Building Regulations: Part L (Average Dwelling)	2005	2008	2011	NZEB (2016)
% Improvement	Baseline	40 %	60 %	70 %
Primary Energy Consumption (kWh/m2/a)	150	90	60	45
CO2 Emission Rate (kgCO2/m2/a)	30	18	12	10
EPC rating	B3	B1	A3	A2
Maximum Permitted Energy Performance Co-efficient (MPEPC)	-	0.6	0.4	0.302
Maximum Permitted Carbon Performance Co-efficient (MPCPC)	-	0.69	0.46	0.305

The maximum elemental U values, air permeability levels and renewable contributions for the NZEB standard have yet to be published (as at July 2014).

Table 109: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the NZEB definition for residential buildings in Ireland

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 1)</th></tr>
<tr><td>Country</td><td>IE</td><td colspan="4">Ireland</td><td>Status
07/2014</td></tr>
<tr><td colspan="6">National Requirements for New Residential Buildings</td><td>Special Aspects with regard to the assumed National NZEB Definition</td></tr>
<tr><td colspan="6">Legislation / Standards
Technical Guidance Document (TGD) Part L (Conservation of Fuel and Energy - Dwellings) [TGD Part L 2011] sets out the building energy standards required for compliance with the 2011 Irish Building Regulations.
Explanation / Comments
TGD Part L 2011 represents a 60 % reduction in energy demand of a reference dwelling as defined in Appendix C of Technical Guidance Document Part L of the 2005 Building Regulations [TGD Part L 2005].</td><td>NZEB standard will achieve 70% reduction in energy demand compared to reference dwelling set out in 2005 Building Regulations.</td></tr>
<tr><td colspan="6">Energy Services</td><td rowspan="5">No deviations expected.</td></tr>
<tr><td>x</td><td>Heating</td><td>x</td><td>DHW</td><td></td><td>Appliances</td></tr>
<tr><td></td><td>Cooling</td><td>x</td><td>Auxiliary</td><td></td><td>Other:</td></tr>
<tr><td>x</td><td>Ventilation</td><td>x</td><td>Lighting</td><td></td><td></td></tr>
<tr><td colspan="6">Explanation / Comments</td></tr>
<tr><td colspan="4">Calculation Procedure</td><td colspan="2">Calculation period</td><td rowspan="4">No deviations expected.</td></tr>
<tr><td>x</td><td colspan="3">Calculation of energy need for heating (building)</td><td colspan="2">monthly</td></tr>
<tr><td>x</td><td colspan="3">Calculation of delivered energy (system)</td><td colspan="2">monthly</td></tr>
<tr><td colspan="6">Explanation / Comments</td></tr>
<tr><td colspan="6">Consideration of Special Technologies
Thermal Systems</td><td rowspan="11">No deviations expected.</td></tr>
<tr><td>x</td><td colspan="5">Ventilation system with heat recovery</td></tr>
<tr><td>x</td><td colspan="5">Thermal solar system</td></tr>
<tr><td></td><td colspan="5">Other special systems:</td></tr>
<tr><td colspan="2">On-Site Electricity Production</td><td>Feed-in</td><td>Self-use[1]</td><td>Balance period to determine self-use[1]</td><td>Self-use considered for H-C-W-HE[1]</td></tr>
<tr><td></td><td>On-site CHP</td><td>x</td><td>x</td><td>Year</td><td>H-C-W-HE</td></tr>
<tr><td></td><td>On-site PV</td><td>x</td><td>x</td><td>Year</td><td>HE</td></tr>
<tr><td></td><td colspan="5">Other energy generation systems:</td></tr>
<tr><td></td><td colspan="5"></td></tr>
<tr><td colspan="6">[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity</td></tr>
<tr><td colspan="6">Explanation / Comments
With PV, all kWhs generated are offset against the calculated annual energy demand.</td></tr>
<tr><td colspan="6">Type of Requirements (new buildings)</td><td rowspan="6">Energy Performance Coefficient (EPC) and Carbon Performance Coefficient (CPC) limits to be set at 0.302 and 0.305 respectively.</td></tr>
<tr><td>x</td><td colspan="2">U-values of building elements</td><td rowspan="2">x</td><td rowspan="2">Primary energy</td><td rowspan="2">total</td></tr>
<tr><td></td><td colspan="2">Heat transfer coefficient by transmission</td></tr>
<tr><td></td><td colspan="2">Energy need for heating</td><td>x</td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td colspan="2">Delivered energy</td><td>x</td><td>Other</td><td>Contribution from renewable technologies</td></tr>
<tr><td colspan="6">Explanation / Comments</td></tr>
</table>

Assessment of energy carriers in Ireland

The national primary energy factors are published by the Sustainable Energy Authority of Ireland and are also incorporated into Ireland's DEAP calculation method. The national primary energy factors used in DEAP are also used for Irish entries in TABULA.

Table 110: Ireland primary energy factors

Label / type of factor	Primary Energy Factor	CO_2 Equivalent Factors
Used for EPC rating	**x**	**x**
Used for building regulations requirements	**x**	**x**
Label (national language)	Primary Energy	CO_2 Emissions Indicator
Description / type of weighting factor	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation)	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation)
Factor is multiplied by delivered energy based on the	gross calorific value (H_s)	gross calorific value (H_s)
Reference	[SEAI s.a.], [SEAI 2013], [SEAI 2014]	[SEAI s.a.], [SEAI 2013], [SEAI 2014]
Unit		kg/kWh
Natural Gas	1.1	0.203
Heating Oil	1.1	0.203
Coal	1.1	0.203
Wood Pellets	1.1	0.203
Electricity	2.45	0.555
Electricity Production CHP	2.45	0.555
Electricity production PV system	2.45	0.555
District heating	1.28	0.237
District heating without CHP	1.28	0.237

Methodological points for discussion in Ireland

The 2011 Building Regulations in Ireland for dwellings require that the permitted technical limits for components set out in Table 108 are achieved. Even when the values are achieved, additional measures are often required in order to meet the EPC and CPC limits and thus achieve compliance with the Building Regulations. One of the most common additional measures is to install PV panels on the roof in order to generate electricity.

The DEAP calculation method offsets 100 % of the electricity generated against the calculated energy demand of the dwelling. While it is likely that the PV output will exceed the electrical demand in the building (especially during summer months) and hence excess electricity production will be exported to the network, this is not accounted for in the DEAP calculation. Also financially beneficial feed-in tariffs have not been available in Ireland (the electrical networks in Ireland will only pay approximately 50 % of the standard kWh price for exported production) and so meters allowing for both import and export are not commonly fitted.

As PV becomes increasingly used on new Irish Buildings, the issues above will need to be addressed.

3.12.2 Integration of National Requirements for New Buildings and NZEB Standards in the Irish Residential Building Typology

Prior to the TABULA project, no formal building typology has been compiled in Ireland on either a national or regional level.

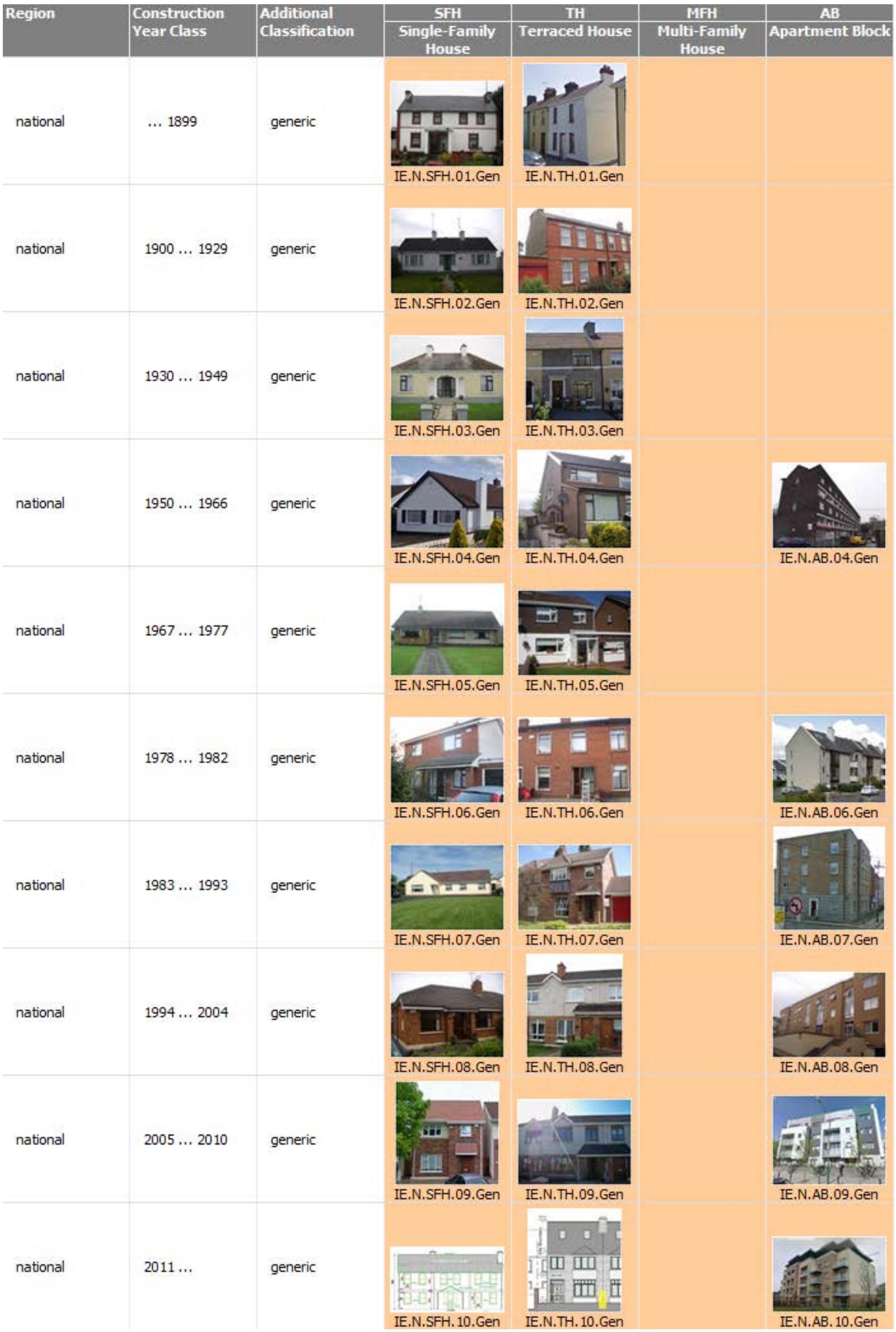
However, several reports such as ‘Homes for the 21st Century’ (UCD Energy Research Group/ Energy Action - 1999) [Energy Action 1999] and ‘The Irish National Survey of Housing Quality 2001-2002’ [Watson/James 2002] contained useful building typology data. The Irish Census also contains some building-related national statistics. The introduction of the Irish Building Energy Rating (BER) method known as Dwelling Energy Assessment Procedure [DEAP 3.2.1] by the Sustainable Energy Authority of Ireland (SEAI) in 2007 following implementation of the Energy Performance of Buildings Directive provided a natural reference point for the development of an Irish typology. In addition, the natural growth of BER data within SEAI’s central Irish database of BER certificates over the duration of the project from 2009 to 2012 proved a further source of reference data.

The Irish building typology was developed by combining data from both existing research sources and from new sources, many of which evolved since the legal requirement for the production of BER certificates for existing dwellings when sold or rented from 1 January 2009. The Irish TABULA typology brochure [Energy Action 2012] contains brochures on 30 Irish house types.

New buildings meeting the 2011 Buildings Regulations and the proposed NZEB standard have been added to the 2014 edition of the Irish TABULA brochure [Energy Action 2014].

Classification scheme for the Irish residential building stock (“Building Type Matrix”)

During the IEE Project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current and future legal requirements. Figure 48 shows the respective matrix. Three further examples buildings have been identified which are now used for showcase calculations reflecting possible practical implementations of new buildings according to the national minimum requirements and future NZEB standards (Table 111).



Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
national	… 1899	generic	IE.N.SFH.01.Gen	IE.N.TH.01.Gen		
national	1900 … 1929	generic	IE.N.SFH.02.Gen	IE.N.TH.02.Gen		
national	1930 … 1949	generic	IE.N.SFH.03.Gen	IE.N.TH.03.Gen		
national	1950 … 1966	generic	IE.N.SFH.04.Gen	IE.N.TH.04.Gen		IE.N.AB.04.Gen
national	1967 … 1977	generic	IE.N.SFH.05.Gen	IE.N.TH.05.Gen		
national	1978 … 1982	generic	IE.N.SFH.06.Gen	IE.N.TH.06.Gen		IE.N.AB.06.Gen
national	1983 … 1993	generic	IE.N.SFH.07.Gen	IE.N.TH.07.Gen		IE.N.AB.07.Gen
national	1994 … 2004	generic	IE.N.SFH.08.Gen	IE.N.TH.08.Gen		IE.N.AB.08.Gen
national	2005 … 2010	generic	IE.N.SFH.09.Gen	IE.N.TH.09.Gen		IE.N.AB.09.Gen
national	2011 …	generic	IE.N.SFH.10.Gen	IE.N.TH.10.Gen		IE.N.AB.10.Gen

Figure 48: Classification scheme ("Building Type Matrix") of the Irish residential building typology [Energy Action 2014], now extended towards new buildings

Table 111: Exemplary new buildings representing the latest construction year classes (2011 …)

		SFH	**TH**	**MFH**	**AB**
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
					
Number of dwellings		1	1		48
Number of full storeys (conditioned)		2	2		5
Number of directly attached neighbour buildings		0	1		0
National reference area (internal dimensioned area as defined in DEAP method)	m²	117	229		3078
TABULA reference area (conditioned floor area, internal dimensions)	m²	117	229		3804

Building example: variants meeting two energy performance levels for new buildings

In order to demonstrate the variants for new buildings in more detail, the technical summary of the exemplary single family house is now shown. Similar information for the other building types can be found in the updated national typology brochure [Energy Action 2014].

Two energy performance levels (2011 and NZEB) and three variants are specified as follows.

Energy Performance Levels

1. **Minimum Requirements.**
   Combination of building and supply system that complies with the current building regulations, [TGD Part L 2011]
2. **NZEB Standard**
   Ambitious NZEB standard with improved U-values, heating and ventilation systems and renewable energy contribution.

Three variants have been defined or the single family house. These are:

1. High renewable contribution with backstop or minimum building fabrics
2. Medium renewable contribution with mid level building fabrics
3. Low renewable contribution with advanced building fabrics

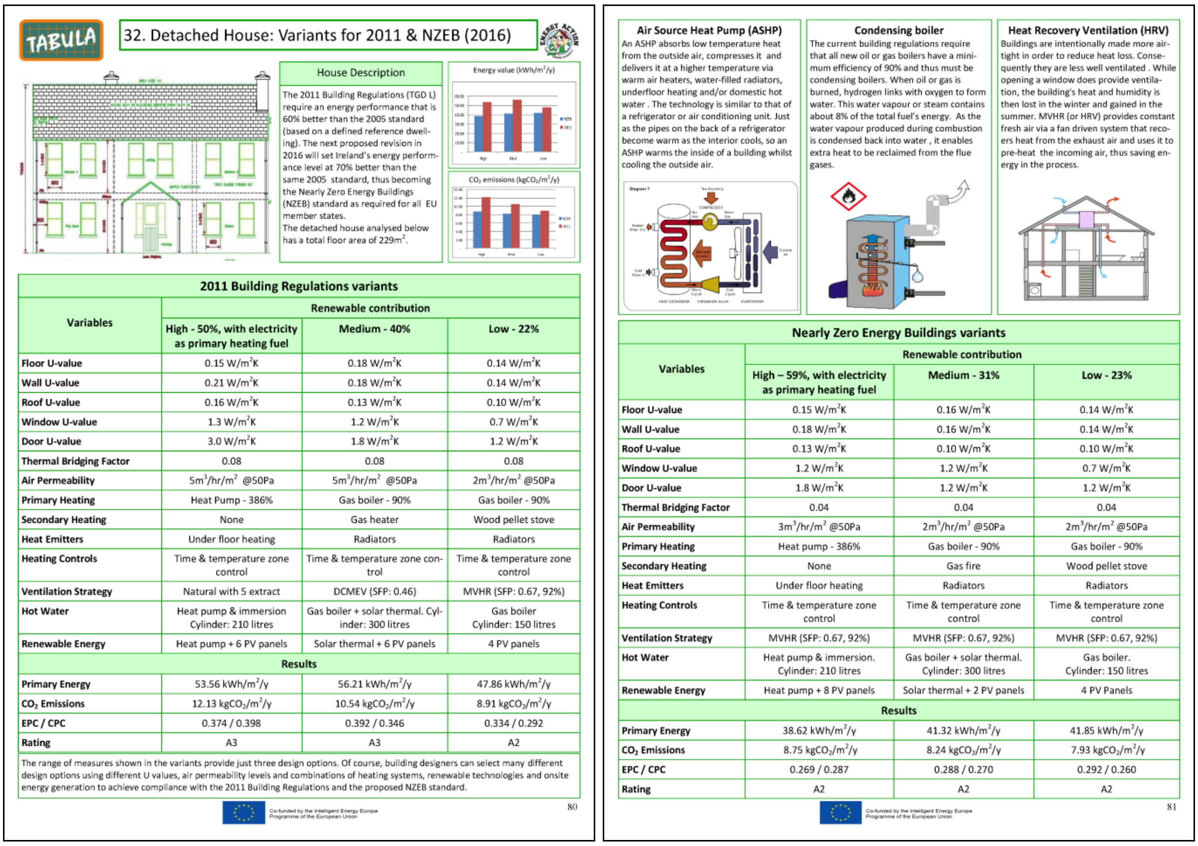
Table 112 shows the building features for the different performance level and variant cases for the single family house.

Table 112: Exemplary single-family house (SFH) – definition of variants

Label of the variant triplet		**High Renewables**		**Medium Renewables**		**Low Renewables**	
Variant N°		001	003	011	013	021	023
Energy Performance Level		Minimum Requirement	Ambitious Standard / NZEB	Minimum Requirement	Ambitious Standard / NZEB	Minimum Requirement	Ambitious Standard / NZEB
U-values							
Roof	W/(m²K)	0.16	0.13	0.13	0.10	0.10	0.10
Wall	W/(m²K)	0.21	0.18	0.18	0.16	0.14	0.14
Window	W/(m²K)	1.3	1.2	1.2	1.2	0.7	0.7
Door	W/(m²K)	3.0	1.8	1.8	1.2	1.2	1.2
Floor	W/(m²K)	0.15	0.15	0.18	0.16	0.14	0.14
Thermal bridging supplement (whole envelope)	W/(m²K)	0.08	0.04	0.08	0.04	0.08	0.04
Heat Supply System							
Heat generator		Heat Pump	Heat Pump	Gas Boiler	Gas Boiler	Gas Boiler	Gas Boiler
Specification / Supplemental system		-	-	Gas heater	Gas heater	Stove	Stove
Ventilation system		Natural	MVHR	DCMEV	MVHR	MVHR	MVHR
Thermal solar system		-	-	DHW	DHW	-	-
Further system		PV	PV	PV	PV	PV	PV

A two-page display sheet for the single family house (SFH) shown in Figure 49 is included in the new 2014 version of the Irish Building Typology brochure [Energy Action 2014].

The display sheets for new buildings are set out differently than those for existing buildings in that they indicate the technical features associated with the three variants meeting the 2011 and NZEB standards. The variants represent indicative design approaches on how to comply with the standards as, of course, many alternative design combinations and options can be also be adopted.



32. Detached House: Variants for 2011 & NZEB (2016)

House Description

The 2011 Building Regulations (TGD L) require an energy performance that is 60% better than the 2005 standard (based on a defined reference dwelling). The next proposed revision in 2016 will set Ireland's energy performance level at 70% better than the same 2005 standard, thus becoming the Nearly Zero Energy Buildings (NZEB) standard as required for all EU member states.
The detached house analysed below has a total floor area of 229m².

Energy value (kWh/m²/y)

CO₂ emissions (kgCO₂/m²/y)

2011 Building Regulations variants

Variables	Renewable contribution		
	High - 50%, with electricity as primary heating fuel	Medium - 40%	Low - 22%
Floor U-value	0.15 W/m²K	0.18 W/m²K	0.14 W/m²K
Wall U-value	0.21 W/m²K	0.18 W/m²K	0.14 W/m²K
Roof U-value	0.16 W/m²K	0.13 W/m²K	0.10 W/m²K
Window U-value	1.3 W/m²K	1.2 W/m²K	0.7 W/m²K
Door U-value	3.0 W/m²K	1.8 W/m²K	1.2 W/m²K
Thermal Bridging Factor	0.08	0.08	0.08
Air Permeability	5m³/hr/m² @50Pa	5m³/hr/m² @50Pa	2m³/hr/m² @50Pa
Primary Heating	Heat Pump - 386%	Gas boiler - 90%	Gas boiler - 90%
Secondary Heating	None	Gas heater	Wood pellet stove
Heat Emitters	Under floor heating	Radiators	Radiators
Heating Controls	Time & temperature zone control	Time & temperature zone control	Time & temperature zone control
Ventilation Strategy	Natural with 5 extract	DCMEV (SFP: 0.46)	MVHR (SFP: 0.67, 92%)
Hot Water	Heat pump & immersion Cylinder: 210 litres	Gas boiler + solar thermal. Cylinder: 300 litres	Gas boiler Cylinder: 150 litres
Renewable Energy	Heat pump + 6 PV panels	Solar thermal + 6 PV panels	4 PV panels
Results			
Primary Energy	53.56 kWh/m²/y	56.21 kWh/m²/y	47.86 kWh/m²/y
CO₂ Emissions	12.13 kgCO₂/m²/y	10.54 kgCO₂/m²/y	8.91 kgCO₂/m²/y
EPC / CPC	0.374 / 0.398	0.392 / 0.346	0.334 / 0.292
Rating	A3	A3	A2

The range of measures shown in the variants provide just three design options. Of course, building designers can select many different design options using different U values, air permeability levels and combinations of heating systems, renewable technologies and onsite energy generation to achieve compliance with the 2011 Building Regulations and the proposed NZEB standard.

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Air Source Heat Pump (ASHP)

An ASHP absorbs low temperature heat from the outside air, compresses it and delivers it at a higher temperature via warm air heaters, water-filled radiators, underfloor heating and/or domestic hot water . The technology is similar to that of a refrigerator or air conditioning unit. Just as the pipes on the back of a refrigerator become warm as the interior cools, so an ASHP warms the inside of a building whilst cooling the outside air.

Condensing boiler

The current building regulations require that all new oil or gas boilers have a minimum efficiency of 90% and thus must be condensing boilers. When oil or gas is burned, hydrogen links with oxygen to form water. This water vapour or steam contains about 8% of the total fuel's energy. As the water vapour produced during combustion is condensed back into water , it enables extra heat to be reclaimed from the flue gases.

Heat Recovery Ventilation (HRV)

Buildings are intentionally made more airtight in order to reduce heat loss. Consequently they are less well ventilated . While opening a window does provide ventilation, the building's heat and humidity is then lost in the winter and gained in the summer. MVHR (or HRV) provides constant fresh air via a fan driven system that recoers heat from the exhaust air and uses it to pre-heat the incoming air, thus saving energy in the process.

Nearly Zero Energy Buildings variants

Variables	Renewable contribution		
	High – 59%, with electricity as primary heating fuel	Medium - 31%	Low - 23%
Floor U-value	0.15 W/m²K	0.16 W/m²K	0.14 W/m²K
Wall U-value	0.18 W/m²K	0.16 W/m²K	0.14 W/m²K
Roof U-value	0.13 W/m²K	0.10 W/m²K	0.10 W/m²K
Window U-value	1.2 W/m²K	1.2 W/m²K	0.7 W/m²K
Door U-value	1.8 W/m²K	1.2 W/m²K	1.2 W/m²K
Thermal Bridging Factor	0.04	0.04	0.04
Air Permeability	3m³/hr/m² @50Pa	2m³/hr/m² @50Pa	2m³/hr/m² @50Pa
Primary Heating	Heat pump - 386%	Gas boiler - 90%	Gas boiler - 90%
Secondary Heating	None	Gas fire	Wood pellet stove
Heat Emitters	Under floor heating	Radiators	Radiators
Heating Controls	Time & temperature zone control	Time & temperature zone control	Time & temperature zone control
Ventilation Strategy	MVHR (SFP: 0.67, 92%)	MVHR (SFP: 0.67, 92%)	MVHR (SFP: 0.67, 92%)
Hot Water	Heat pump & immersion. Cylinder: 210 litres	Gas boiler + solar thermal. Cylinder: 300 litres	Gas boiler. Cylinder: 150 litres
Renewable Energy	Heat pump + 8 PV panels	Solar thermal + 2 PV panels	4 PV Panels
Results			
Primary Energy	38.62 kWh/m²/y	41.32 kWh/m²/y	41.85 kWh/m²/y
CO₂ Emissions	8.75 kgCO₂/m²/y	8.24 kgCO₂/m²/y	7.93 kgCO₂/m²/y
EPC / CPC	0.269 / 0.287	0.288 / 0.270	0.292 / 0.260
Rating	A2	A2	A2

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Figure 49: "Building Display Sheet" of the exemplary SFH <IE> [Energy Action 2014]

In Table 113, results of the national energy balance calculation using the DEAP method are displayed for the single family house.

Table 113: Exemplary SFH – Results of the energy balance calculation; Procedure: DEAP

Variant N°		**001**	**003**	**011**	**013**	**021**	**023**
Label of the variant triplet		High Renewables		Medium Renewables		Low Renewables	
Variation level		Minimum Requirement	Ambitious Standard / NZEB	Minimum Requirement	Ambitious Standard / NZEB	Minimum Requirement	Ambitious Standard / NZEB
Method		Dwelling Energy Assessment Procedure (DEAP v 3.2.1)					
National reference area**	m²	229	229	229	229	229	229
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.581	0.367	0.542	0.349	0.365	0.312
Relation to requirement		NA	NA	NA	NA	NA	NA
Energy need for heating	kWh/(m²a)	36	11.74	30.79	9.52	11.07	6.34
Delivered energy							
Fossil fuels	kWh/(m²a)	0	0	47.53	24.21	33.32	28.59
Renewable fuels	kWh/(m²a)	26.79	22.93	22.56	12.84	10.52	10.05
Electricity	kWh/(m²a)	27.46	23.24	7.20	7.51	7.52	7.52
Auxiliary energy	kWh/(m²a)	0.56	2.63	2.51	2.83	2.83	2.83
Primary energy demand	kWh/(m²a)	53.56	38.62	56.21	40.52	47.86	41.85
Relation to requirement		93 %	67 %	98 %	71 %	84 %	73 %

*) internal dimensioned area as defined in DEAP method

TABULA calculation results for all exemplary buildings

Table 114 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings. For the terraced house (TH), the variant numbers reflect the actual systems selected in TABULA.xlsm.

Table 114: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH 	01	Minimum Requirement	0.98	65	0	65	59	12	19	0	0	0	0	28	0	0	-6
	03	Ambitious Standard / NZEB	0.76	41	22	19	15	12	19	0	0	0	0	18	0	0	-7
	11	Minimum Requirement	0.91	61	0	61	56	12	18	73	0	0	0	2	0	0	-6
	13	Ambitious Standard / NZEB	0.71	38	22	16	13	12	18	24	0	0	0	3	0	0	-2
	21	Minimum Requirement	0.72	38	22	17	13	12	18	33	0	0	2	3	0	0	-4
	23	Ambitious Standard / NZEB	0.59	31	20	11	7	12	18	18	0	0	0	3	0	0	-2
TH 	31	Minimum Requirement	0.93	62	0	62	54	12	22	0	0	0	0	29	0	0	-7
	33	Ambitious Standard / NZEB	0.71	39	21	18	12	12	22	0	0	0	2	20	0	0	-11
	41	Minimum Requirement	0.85	58	29	29	23	12	22	50	0	0	0	4	0	0	-7
	43	Ambitious Standard / NZEB	0.67	36	0	36	28	12	22	55	0	0	0	3	0	0	-11
	51	Minimum Requirement	0.55	29	0	29	21	12	22	33	0	0	3	3	0	0	0
	53	Ambitious Standard / NZEB	0.55	29	18	11	6	12	22	18	0	0	0	4	0	0	0
MFH 	01	Minimum Requirement	0.38	22	0	22	11	12	26	0	0	0	0	22	0	0	-27
	03	Ambitious Standard / NZEB	0.22	9	6	3	0	12	26	0	0	0	0	21	0	0	-54
	11	Minimum Requirement	0.38	22	0	22	11	12	26	41	0	0	0	3	0	0	-27
	13	Ambitious Standard / NZEB	0.22	9	6	3	1	12	26	31	0	0	0	4	0	0	-54

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.12.3 Sources / References Ireland

Table 9: Sources / References Ireland

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[DEAP 3.2.1]	Dwelling Energy Assessment Procedure (DEAP) version 3.2.1; Sustainable Energy Authority of Ireland http://www.seai.ie/Your_Building/BER/BER_Assessors/Technical/DEAP/DEAP_2009/DEAP_Manual.pdf	Irish EPC calculation method
[DECLG 2012]	Department of Environment, Community and Local Government: Towards Nearly Zero Energy Buildings in Ireland, Planning for 2020 and Beyond, November 2012	Irish Government's Nearly Zero Energy Building Plan
[Energy Action 1999]	Energy Action, Energy Research Group & Environmental Institute, University College Dublin; Homes for the 21st Century – the Costs & Benefits of Comfortable Housing for Ireland: 1999 http://erg.ucd.ie/UCDERG/pdfs/H21stC_full.pdf	Financial, environmental and health benefits study from refurbishment of the Irish housing stock
[Energy Action 2012]	Hanratty, Michael; Sheldrick, Bill; Badurek, Marcin; Building Typology Ireland; Energy Action May 2012 http://episcope.eu/fileadmin/tabula/public/docs/brochure_until2012/IE_TABULA_TypologyBrochure_EnergyAction_2012.pdf	Irish TABULA brochure 2012
[Energy Action 2014]	Hanratty, Michael; Sheldrick, Bill; Badurek, Marcin; Building Typology Ireland; Energy Action May 2014 http://episcope.eu/fileadmin/tabula/public/docs/brochure/IE_TABULA_TypologyBrochure_EnergyAction.pdf	Irish TABULA brochure 2014
[SEAI s.a.]	SEAI Energy Policy Statistical Support Unit (EPSSU): Statistics Publications http://www.seai.ie/Publications/Statistics_Publications/	Publications on energy balance statistics
[SEAI 2013]	Sustainable Energy Authority of Ireland (SEAI): Derivation of Primary Energy and CO_2 Factors for Electricity in DEAP, 2013 http://www.seai.ie/Your_Building/BER/BER_FAQ/FAQ_DEAP/DEAP_elec_factors_FAQ_Q42013.pdf	Derivation of Primary Energy and CO_2 Factors for Electricity in DEAP
[SEAI 2014]	Sustainable Energy Authority of Ireland (SEAI): BER Assessors – Dwellings Technical Bulletin, February 2014 http://www.seai.ie/Your_Building/BER/Technical_Bulletins/Technical-Bulletin-February-2014.pdf	BER Assessors – Dwellings Technical Bulletin
[TGD Part L 2005]	Building Regulations 2005, Technical Guidance Document L, Conservation of Fuel and Energy – Dwellings; Department of Environment Community and Local Government http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,1652,en.pdf	Energy performance guidance document for Irish Building Regulations 2005
[TGD Part L 2011]	Building Regulations 2011, Technical Guidance Document L, Conservation of Fuel and Energy – Dwellings; Department of Environment Community and Local Government http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,27316,en.pdf	Energy performance guidance document for Irish Building Regulations 2011
[Watson/James 2002]	Watson, Dorothy; Williams, James; The Irish National Survey of Housing Quality 2001-2002; ESRI, Ireland 2002 http://www.environ.ie/en/Publications/DevelopmentandHousing/Housing/FileDownLoad,2447,en.pdf	Survey of Irish housing stock based on sample of 40,000 householders

3.13 <IT> Italy

(by EPISCOPE partner POLITO)

The Italian building typology is quite heterogeneous: the most frequent building type is a small size building; the single-family house and the small multi-storey buildings represent nearly 50 % of the entire national residential building stock. As regards the structural materials, 61.5 % of the residential buildings are made of load-bearing masonry walls, 24.7 % of reinforced concrete and 13.8 % of other materials such as wood, steel or mixed structure. More than 50 % of residential buildings are separate from other buildings, whereas the rest are adjacent to other structures on one or more sides [ISTAT 2001].

Approximately 20 % of the Italian residential built stock was constructed before 1919. The period between the two World Wars saw a decline in building activity and accounts for only 12 % of the current residential buildings. On the other hand, the period from the end of World War II to the early 1980s recorded a strong increase in building activity, producing around 50 % of the actual built stock. Lastly, from the early 1980s to the present time, building activity shrank again. As more than 70 % of the Italian residential buildings were built before the emanation of the first national law on building energy efficiency (1976) [ISTAT 2001], the potential of energy saving that can be reached by retrofitting the building thermal envelope and the technical systems can be very high.

The recent Italian National Energy Strategy (NES) from Ministry of Economic Development was published in March 2013 [NES 2013] and sets out four targets for the medium-long term (2020): (a) to align the cost of energy with the EU average, (b) to exceed the environmental carbon reduction targets established by the EU Climate-Energy package for 2020, (c) to increase the energy supply assurance and (d) to boost a sustainable economic growth through the development of the energy sector. The strategy for achieving these targets comprises seven priorities, each with specific supporting measures, either already launched or being finalised. The first priority identified by the NES is the energy efficiency. In particular, the NES has identified a high energy saving potential in the building sector: the final energy consumption reduction target for the residential and services sectors laid down in the NES is respectively 3.8 Mtoe and 2 Mtoe.

In Italy, the Legislative Decree No 192/2005 [D. Lgs. 192/2005] and its addictions and amendments [D. Lgs. 311/2006], which transposed the 2002/91/EC Directive [EPBD 2002], were recently amended by the Decree Law No 63/2013, in order to adopt the new provisions introduced by the 2010/31/EU Directive [EPBD recast 2010] at a national level. Decree Law No 63/2013, converted into the Law No 90/2013 [L. 90/2013], lays the groundwork and sets new criteria for updating and programming energy performance requirements of buildings (on thermal envelope, technical systems and technologies using renewable energy sources). As far as the new buildings are concerned, the recent Italian legislation is projected towards the achievement of the EU targets about the “nearly zero-energy buildings” (NZEBs).

In the forthcoming application decrees of the Law No 90/2013, the minimum energy performance requirements of buildings will take into account both, the heating and the cooling seasons, the different Italian climatic zones and the other performance standards established by the regulatory framework. This will require the development of calculation methods and the use of tools, such as the “comparative methodology” which will be applied to determine the optimal energy performance requirements that lead to the lowest cost during the estimated economic lifecycle of the building (according to the objectives of the 2010/31/EU Directive).

The “cost-optimal methodology” will be also applied for the definition of the “nearly zero-energy building”. Anyway at the present moment, the Italian NZEB has not been officially defined yet. Some Italian regions, for instance Piedmont Region [Reg. Piemonte 2011], are currently promoting initiatives targeting nearly zero-energy buildings, by means of dedicated regional calls and efficient building construction initiatives in the social housing and non-residential sectors.

3.13.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Italy

The Italian legislation on the building energy efficiency in force now is the Legislative Decree No 192/2005 (*D. Lgs. 192/2005*) and its subsequent amendments and application decrees. The *D. Lgs. 192/2005*, which transposes the 2002/91/EC Directive (EPBD), has been recently amended by the Law No 90/2013, which transposes the 2010/31/EU Directive (EPBD recast). The application decrees of *D. Lgs. 192/2005* will be soon replaced by the forthcoming decrees applying the Law No 90/2013. These decrees will update the current legal requirements of new residential buildings and will fix an official NZEB standard.

Minimum requirements for new residential buildings in Italy

The Italian *D. Lgs. 192/2005* and its application decree No 59/2009 [D.P.R. 59/2009] provide the minimum energy performance requirements for new buildings.

An allowable maximum value of annual primary energy need for space heating is fixed for different building uses, climatic zones and compactness ratios. In addition, an allowable maximum value of annual net energy need for space cooling is fixed for different building uses and climatic zones.

Moreover, values of the thermal transmittance of different building envelope components, values of the heat generator efficiency and of the global thermal system efficiency are provided by the same decrees[27].

As concerns renewable energy sources, Legislative Decree No 28/2011 [D. Lgs. 28/2011] requires their integration in new buildings, by establishing the coverage of a fixed percentage of energy need for space heating, space cooling and domestic hot water by means of a thermal solar plant, and the installation of a photovoltaic system whose electric power varies according to the building size.

Italian calculation method to comply with new building regulations for residential buildings

The Italian decree 26/06/2009 on “National guidelines for the building energy certification” [D.M. 26/06/2009], applying the Legislative Decree No 192/2005, specifies that the official national calculation method for the EPC is that provided by the technical specifications of the UNI/TS 11300 series. The same calculation method is applied to verify compliance with the new building energy performance requirements. The UNI/TS 11300 is made of four parts, as follows:

- UNI/TS 11300-1: Energy performance of buildings. Evaluation of energy need for space heating and cooling (2008, under revision) [UNI/TS 11300-1].
- UNI/TS 11300-2: Energy performance of buildings. Evaluation of primary energy need and of system efficiencies for space heating and domestic hot water production (2008, under revision) [UNI/TS 11300-2].
- UNI/TS 11300-3: Energy performance of buildings. Evaluation of primary energy and system efficiencies for space cooling (2010, under revision) [UNI/TS 11300-3].
- UNI/TS 11300-4: Energy performance of buildings. Renewable energy and other generation systems for space heating and domestic hot water production (2012) [UNI/TS 11300-4].

The part 1 of the technical specification UNI/TS 11300 is the national application of the European technical standard EN ISO 13790, which is based on the quasi steady-state calculation

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[27] The thermal transmittance values of the building envelope components can be verified instead of the primary energy values for space heating in case of buildings having the ratio between the transparent envelope surface and the conditioned floor area below 0.18.

method. This calculation method considers the monthly balance of the heat losses (transmission and ventilation) and the heat gains (solar and internal) evaluated in monthly average conditions. The dynamic effects on the net heating and cooling energy needs are taken into account by introducing a dynamic parameter named the “utilization factor”, which considers the mismatch between transmission plus ventilation heat losses and solar plus internal heat gains leading to heating/cooling loads.

The parts 2, 3 and 4 of the UNI/TS 11300 provide a calculation method based on national boundary conditions and input data, although they apply the general calculation framework presented in the European technical standard EN 15316 series.

The primary energy factors to be used for EPC issuing are provided by the technical document No 14/2013 from the Italian Thermotechnical Committee (CTI) [CTI 2013].

Status of NZEB definition for residential buildings in Italy

The forthcoming decrees, which will apply the national Law No 90/2013, will set up an official definition and will provide the energy performance requirements of the Italian NZEB. In the meantime, a national plan for increasing the number of nearly zero-energy buildings in Italy has been elaborated by ECOFYS in 2013 [ECOFYS 2013].

According to this plan, the current minimum energy parameter values and thermal characteristics will become more demanding from 2016 forward. They will be based on the benchmark values of certain parameters set for a reference building; the current limits and those soon to be set will be in line with the results of the “cost-optimal methodology”. It will be possible to establish primary energy consumption stated in kWh/m^2 per year, differentiated by building type, location and use. The transmittance values required for building elements will be lowered by 15 % compared to their current value from 1st January 2016 and by another 15 % from 1st January 2021. A similar improvement will be applied to the minimum energy performance requirements for space heating and conditioning systems. For public buildings, in line with current national legislation, the minimum requirements will be made 10 % more demanding. Moreover, verification of the requirements for nearly zero-energy buildings will be applied starting from 2018.

For all new buildings and buildings undergoing major refurbishments, the legislation currently being drafted provides for gradually increasing shares of energy from renewable sources (i.e. gradual reduction of the EP_{nren}/EP_{tot} ratio). The reduction shall be carried out in different stages (e.g. from 2015, from 2017, from 2019, from 2021) and the requirement will be differentiated according to climatic zone. The forthcoming legislation will also provide for verification of compliance with the following minimum parameters and indices:

- the H_T parameter, i.e. the average transmission heat transfer coefficient, according to climatic zone and building type;
- the $A_{sol,est}/A_{sup}$ parameter, i.e. the ratio of the buildings’ summer solar radiation surface to useful surface area in relation to the summer climate zone;
- the $EP_{H,nd}$ and the $EP_{C,nd}$ indices, i.e. the demand of useful thermal energy for space heating and cooling;
- EP_{tot} (total primary energy) for space heating, space cooling, domestic hot water, ventilation;
- EP_{nren} (non-renewable primary energy), i.e. progressively increasing shares of total energy which must be met using renewable sources.

At the present time there is no official definition of NZEB. However, according to the ECOFYS plan, it is believed that on the basis of the current share of 1.6 % of new buildings, 20 % of them can be ranked as NZEB, if the requirements described above are confirmed.

The definition of “nearly zero-energy building” will be applied to buildings meeting specific technical requirements and using a specific share of energy from renewable sources. Either of the following indices: energy performance for space heating (EP_H), energy performance for space cooling, including humidity control (EP_C), or global energy performance, expressed in non-renewable primary energy (EP_{nren}), or again global energy performance expressed in total primary energy (EP_{tot}), must be lower by a certain value than the values of the same indices calculated for a reference building (e.g. as an indication, the global energy performance index expressed in non-renewable primary energy must be 30-35 % lower than the value of the reference building in 2020). The reference building is a virtual building geometrically equivalent to the planned one, but meeting the minimum energy performance parameters (e.g. thermal transmittance of the envelope components) to be achieved by the year 2020. On the basis of this criterion and of the minimum energy performance requirements which, for the year 2020, will be validated on the basis of the results of the cost-optimal method, it will also be possible to establish a range for primary energy consumption expressed in kWh/m^2 per year, differing according to building type, location and use [ECOFYS 2013].

Some overview features of the current calculation method for new residential buildings (building regulation requirements/EPC) compared to the (assumed) NZEB definition for residential buildings in Italy are shown in Table 115.

Table 115: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition for residential buildings in Italy

Calculation Method New Building Regulations – (part 1)

Country	IT	Italy	Status	06/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the (assumed) National NZEB Definition

Legislation / Standards

Legislation: D. Lgs. 192/2005, D. Lgs. 311/2006, D.P.R. 59/2009

Technical standards: UNI/TS 11300-1/2/3/4

Explanation / Comments

The current energy performance requirements have been introduced in 2005, considering three different time steps of application level (from 2006, from 2008, from 2010). The requirements in force now are those referring to 2010 values.

Legislation: L. 90/2013.

No official Italian NZEB definition until now.

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

In case of EPC, the cooling energy performance is not included in the global classification, but it is evaluated through a particular index, which takes into account the net energy need for space cooling instead of the primary energy for the same use. The net energy need for space cooling is also a minimum energy performance requirement for new buildings.

The same energy services will be considered.

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Year / Month

Explanation / Comments

-

Italian technical standards will be aligned with the new CEN standards being set up according to Mandate 480-2010.

Consideration of Special Technologies

Thermal Systems

x	Ventilation system with heat recovery
x	Thermal solar system
	Other special systems:

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x		-	-
x	On-site PV		x	Month	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Photovoltaic is currently included in the balance as far as provisions are taken to use the produced electricity on-site and the calculated monthly electrical energy demand is directly covered – no bonus for exported energy foreseen.

Probably no changes will occur.

Table 115 (continuation)

Calculation Method New Building Regulations – (part 2)					
Country	**IT**	Italy		Status	06/2014
National Requirements for New Residential Buildings					**Special Aspects with regard to the (assumed) National NZEB Definition**
Type of Requirements (new buildings)					Probably in addition, the forthcoming legislation will provide for verification of compliance with the following parameters: - the average transmission heat transfer coefficient, H_T (W/K); - the ratio of the buildings' summer solar radiation surface to useful surface area ($A_{sol,est}/A_{sup}$); - the demand of useful thermal energy for space heating and cooling ($EP_{H,nd}$ and $EP_{C,nd}$); - the primary energy for space heating, space cooling, domestic hot water, ventilation (EP_{tot} and EP_{nren}).
x	U-values of building elements	x	Primary energy	Total and non-renewable	
	Heat transfer coefficient by transmission				
	Energy need for heating		Carbon dioxide emissions		
	Delivered energy	x	Other	Thermal system efficiency	
Explanation / Comments					

Assessment of energy carriers in Italy

The current national reference document for the assessment of the energy carrier is the technical report No 14/2013 from the Italian Thermotechnical Committee (CTI) [CTI 2013]. This document will be replaced by a new corresponding technical standard, aligned with the new CEN standards being set up according to Mandate 480-2010.

According to the Italian Thermotechnical Committee report, the building energy needs can be covered by means of:

- renewable energy produced “on site”,
- both non-renewable and renewable delivered energy from energy carries “off site”.

The delivered energy from energy carriers can be either non-renewable energy or renewable energy, according to the related conversion coefficients into primary energy of the different energy carriers.

In general, the monthly electrical energy needs can be covered by means of electrical energy produced by renewable sources “on site” or cogeneration using non-renewable or renewable energy carriers, up to lead to zero the electricity imported from the grid. On monthly basis, the gross delivered electricity is calculated as the difference between the electricity demand and the used electricity produced by renewable sources. If the production exceeds the demand:

- the surplus is calculated on annual basis,
- the annual re-imported electricity is the minimum value between the annual gross delivered electricity and the annual surplus,
- the annual exported electricity is calculated as the positive difference between the annual surplus and the annual re-imported electricity.

Waiting for a new legislative disposition, the CTI report No 14/2013 specifies that the annual re-imported electricity is equal to zero. As far as the exported electricity is concerned, the conversion coefficient is equal to zero if the electricity is produced by a photovoltaic system, while the conversion coefficient is equal to that of the electricity imported from the grid in case of cogeneration.

The Italian primary energy factors are listed in Table 116. The current national values for EPC do not take into account the heat losses due to extraction, processing, storage, transportation or transformation of the energy carrier.

Table 116: Italian primary energy factors

Label / type of factor	Total Primary Energy factor EPC standard Italy	Non-Renewable Primary Energy factor EPC standard Italy
used for EPC rating	x	x
used for building regulations requirements	x	x
Label (national language)	Fattori di energia primaria totale	Fattori di energia primaria non rinnovabile
Description / type of weighting factor	Non-renewable + renewable energy amounts (extraction, processing, storage, transportation or transformation excluded)	Non-renewable energy amounts (extraction, processing, storage, transportation or transformation excluded)
Factor is multiplied by delivered energy based on the	net calorific value (H_i)	net calorific value (H_i)
Reference	[CTI 2013]	[CTI 2013]
Natural gas	1	1
Heating oil	1	1
Hard coal	1	1
Lignite	1	1
Firewood	1	0.3
Wood pellets	1	0.3
Electricity	2.174	2.174
Electricity production CHP	2.174	2.174
Electricity production PV system	2.174 *	2.174 *
District heating	- **	- **
District heating without CHP	- **	- **
District heating with 100 % CHP	- **	- **

*) Only for self-use.

**) Provided by the district heating supplier.

Methodological points for discussion in Italy

As regards the assessment of energy carriers and the weight to be attributed to the energy produced by renewable energy sources, the following issues are being discussed:

a) the definition of the “boundary” of the building;
b) the distinction between “on site” renewable energy sources and “off site” renewable energy sources;
c) the balance of the electricity needs of the building through the electricity produced from renewable energy sources;
d) the value of the electricity produced by renewable energy sources and exported;
e) the primary energy conversion factors of different energy carriers.

These aspects will be clarified in the new legislative dispositions and national technical standards, respectively complying with the EPBD recast and the CEN Mandate 480-2010.

An overview of the related concepts is shown in Figure 50.

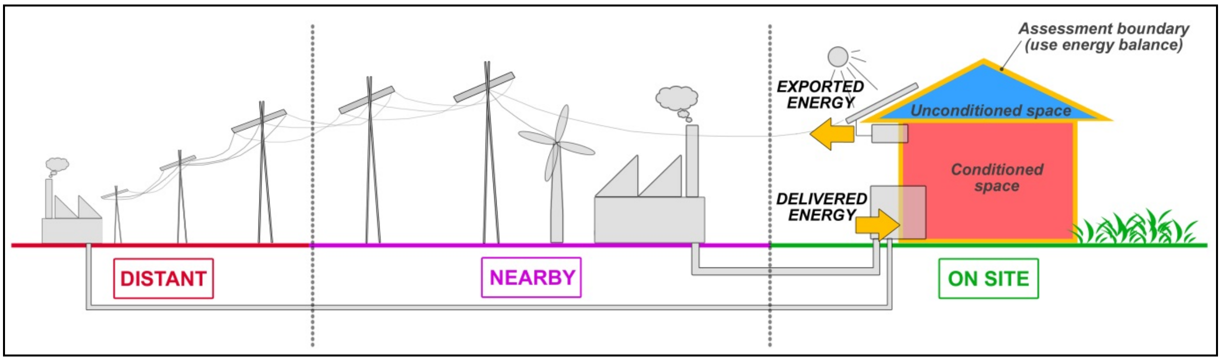

Figure 50: **Assessment boundary and geographical perimeters (http://arc.housing.salle.url.edu/semanco/kms/index.php/Energy_and_Related_Terms)**

3.13.2 Integration of National Requirements for New Buildings and NZEB Standards in the Italian Residential Building Typology

The “building typology” classification is a concept already used in Italy both at national and at regional level. However some problems exist, such as lack of a shared definition on building typology, unknown or not updated building typologies, difficulty in understanding the concept of “building typology” that makes this classification not used. These difficulties were overcome in the TABULA project, during which the Italian Residential Building Typology was defined and was developed with reference to the Italian “Middle Climatic Zone”, which includes more than 50 % of the Italian municipalities[28].

The Italian Residential Building Typology includes eight construction age classes, each representing a precise historical period that mirrors significant geometrical and construction typologies from the energy point of view. Each construction age class is then represented by four building size classes. According to the TABULA common principles, the building size classes include “single-family house”, “terraced house”, “multi-family house” and “apartment block” [POLITO 2012].

Classification scheme for the Italian residential building stock (“Building Type Matrix”)

The elements that allow to classify the building typology compose the axes of the so-called “Building Type Matrix”. Each climatic zone is characterized by a matrix and each matrix consists of rows, representing the building age classes, and columns, representing the building size classes. Each cell in the matrix is filled with a “building-type”, i.e. a building that is considered representative of that specific condition (climatic zone / construction age / building size).

The Italian “Building Type Matrix” has been developed for the “Middle Climatic Zone” and it is shown in Figure 51. The new buildings, reflecting the current legal requirements, are represented by the building types of the eighth building age class (after 2005). These buildings have been already identified in the TABULA project. Now in the EPISCOPE project, these example buildings (see Table 117) are used for showcase calculations reflecting possible practical implementations of new buildings from minimum energy performance requirements, to improved energy performance levels, to NZEB standards [POLITO 2014].

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[28] The Italian “Middle Climatic Zone” represents the Italian municipalities that have a number of heating degree days ranging from 2100 to 3000.

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	Middle Climatic Zone (Zona climatica media - ZONA E)	… 1900	generic	 IT.MidClim.SFH.01.Gen	 IT.MidClim.TH.01.Gen	 IT.MidClim.MFH.01.Gen	 IT.MidClim.AB.01.Gen
2	Middle Climatic Zone (Zona climatica media - ZONA E)	1901 … 1920	generic	 IT.MidClim.SFH.02.Gen	 IT.MidClim.TH.02.Gen	 IT.MidClim.MFH.02.Gen	 IT.MidClim.AB.02.Gen
3	Middle Climatic Zone (Zona climatica media - ZONA E)	1921 … 1945	generic	 IT.MidClim.SFH.03.Gen	 IT.MidClim.TH.03.Gen	 IT.MidClim.MFH.03.Gen	 IT.MidClim.AB.03.Gen
4	Middle Climatic Zone (Zona climatica media - ZONA E)	1946 … 1960	generic	 IT.MidClim.SFH.04.Gen	 IT.MidClim.TH.04.Gen	 IT.MidClim.MFH.04.Gen	 IT.MidClim.AB.04.Gen
5	Middle Climatic Zone (Zona climatica media - ZONA E)	1961 … 1975	generic	 IT.MidClim.SFH.05.Gen	 IT.MidClim.TH.05.Gen	 IT.MidClim.MFH.05.Gen	 IT.MidClim.AB.05.Gen
6	Middle Climatic Zone (Zona climatica media - ZONA E)	1976 … 1990	generic	 IT.MidClim.SFH.06.Gen	 IT.MidClim.TH.06.Gen	 IT.MidClim.MFH.06.Gen	 IT.MidClim.AB.06.Gen
7	Middle Climatic Zone (Zona climatica media - ZONA E)	1991 … 2005	generic	 IT.MidClim.SFH.07.Gen	 IT.MidClim.TH.07.Gen	 IT.MidClim.MFH.07.Gen	 IT.MidClim.AB.07.Gen
8	Middle Climatic Zone (Zona climatica media - ZONA E)	2006 …	generic	 IT.MidClim.SFH.08.Gen	 IT.MidClim.TH.08.Gen	 IT.MidClim.MFH.08.Gen	 IT.MidClim.AB.08.Gen

Figure 51: Classification scheme ("Building Type Matrix") of the Italian residential building typology [POLITO 2014], now extended towards new buildings

Table 117: Exemplary new buildings representing the latest construction year classes (2006 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 IT.MidClim.SFH.08.Gen	 IT.MidClim.TH.08.Gen	 IT.MidClim.MFH.08.Gen	 IT.MidClim.AB.08.Ge
Number of dwellings		1	1	13	31
Number of full storeys (conditioned)		2	2	3	7
Number of directly attached neighbour buildings		0	1	0	0
National reference area (Conditioned net floor area based on internal dimensions)	m²	174	127	829	2124
TABULA reference area (conditioned floor area, internal dimensions)*	m²	174	127	829	2124

*) Determined according to the convention established in [TABULA 2013].

Building example: variants meeting three energy performance levels for new buildings

Three different performance levels (“minimum requirement”, “improved standard”, “and advanced standard/NZEB”) have been considered for new buildings, reflecting in different values of the thermal transmittance of the building envelope components and in different efficiency levels of the thermal systems. Each performance level is characterised by a single construction technology and by some alternative types of systems/heat generators, as described below.

1. **“Minimum requirement”**
   The U-values of the building envelope components comply with the Legislative Decree No 192/2005. The efficiencies of the heat generators are the minimum allowable values established by the Decree No 59/2009 for standard low temperature gas boilers, biomass (wood pellets) boilers and electrical heat pumps. These three heat generator types have been considered as variants (001, 011, 021). A 50 % coverage of the energy need for DHW is guaranteed by the thermal solar system, according to Legislative Decree No 28/2011.
2. **“Improved standard”**
   The U-values of the building envelope components comply with the Decree 26/01/2010 [D.M. 26/01/2010]. Even if this decree is applicable for the energy refurbishment of existing buildings, the thermal transmittance values have been taken as reference values for the “improved standard” of new buildings because they are lower than the values of the “minimum requirement” standard. The reference values of the heat generator efficiencies are provided by Decree 19/02/2007 [D.M. 19/02/2007] for gas condensing boiler, by Legislative Decree No 28/2011 for biomass (wood pellets) boiler and by Decree 06/08/2009 [D.M. 06/08/2009] for electric heat pump. These three heat generator types have been considered as variants (002, 012, 022). The thermal solar plant covers 30 % of the energy need for space heating and 50 % of the energy need for domestic hot water, in compliance with Legislative Decree No 28/2011. According to the same decree, the photovoltaic system has been considered both for the *single-unit housings* (1.4 kW_p) and for the *multi-unit housings* (5 kW_p).

3. **"Advanced standard / NZEB"**
   As an official standard for NZEBs is still lacking, both the thermal transmittances and the thermal system efficiencies have been derived from projects of NZEBs from calls for funding in Piedmont Region [Reg. Piemonte 2011]. As the heat generators installed in these projects are only electrical heat pumps, two different variants have been considered, air source heat pump and ground source heat pump (003, 013). The thermal solar plant covers 45 % of the energy need for space heating and 75 % of the energy need for domestic hot water. In addition, the photovoltaic system has been considered both for the *single-unit housings* (3 kW$_p$) and for the *multi-unit housings* (10 kW$_p$). A ventilation system with heat recovery (80 % efficiency) has been applied to all the building types.

An example of variants considered for the new buildings is shown in Table 118 for the multi-family house. The related "Building display sheets", which are included in the "Building Typology Brochure" [POLITO 2014] are shown in Figure 52. The display sheets of all the new building types can be found in the same document [POLITO 2014].

Table 118: Exemplary multi-family house (MFH) – definition of variants

 IT.MidClim.MFH.08.Gen		**Minimum requirement** (Fixed U-values; three system variants)			**Improved standard** (Fixed U-values; three system variants)			**Ambitious Standard / NZEB** (Fixed U-values; two system variants)	
Variant N°		001	011	021	002	012	022	003	013
Energy Performance Level		Minimum Requirement			Improved Standard			Ambitious Standard / NZEB	
U-values									
roof/ceiling**	W/(m²K)	0.30			0.24			0.13	
wall	W/(m²K)	0.34			0.27			0.13	
window	W/(m²K)	2.20			1.80			1.10	
door	W/(m²K)	-			-			-	
floor	W/(m²K)	0.33			0.30			0.19	
thermal bridging supplement (whole envelope)	W/(m²K)	0.05			0.05			0.00*	
Heat Supply System									
heat generator		low temperature gas boiler	wood pellets boiler	electrical heat pump	gas condensing boiler	wood pellets boiler	electrical heat pump	electrical heat pump	
specification / supplemental system				air source			air source	air source	ground source
ventilation system		absent	absent	absent	absent	absent	absent	heat recovery	heat recovery
thermal solar system		DHW	DHW	DHW	H+DHW	H+DHW	H+DHW	H+DHW	H+DHW
Further system					PV	PV	PV	PV	PV

*) The thermal bridges are considered completely removed in the NZEB.

**) The reported values refer either to the roof if the attic space is conditioned or to the upper ceiling if the attic space is unconditioned (in this case the roof should have an U-value lower than 0.8 W/m^{2}K).

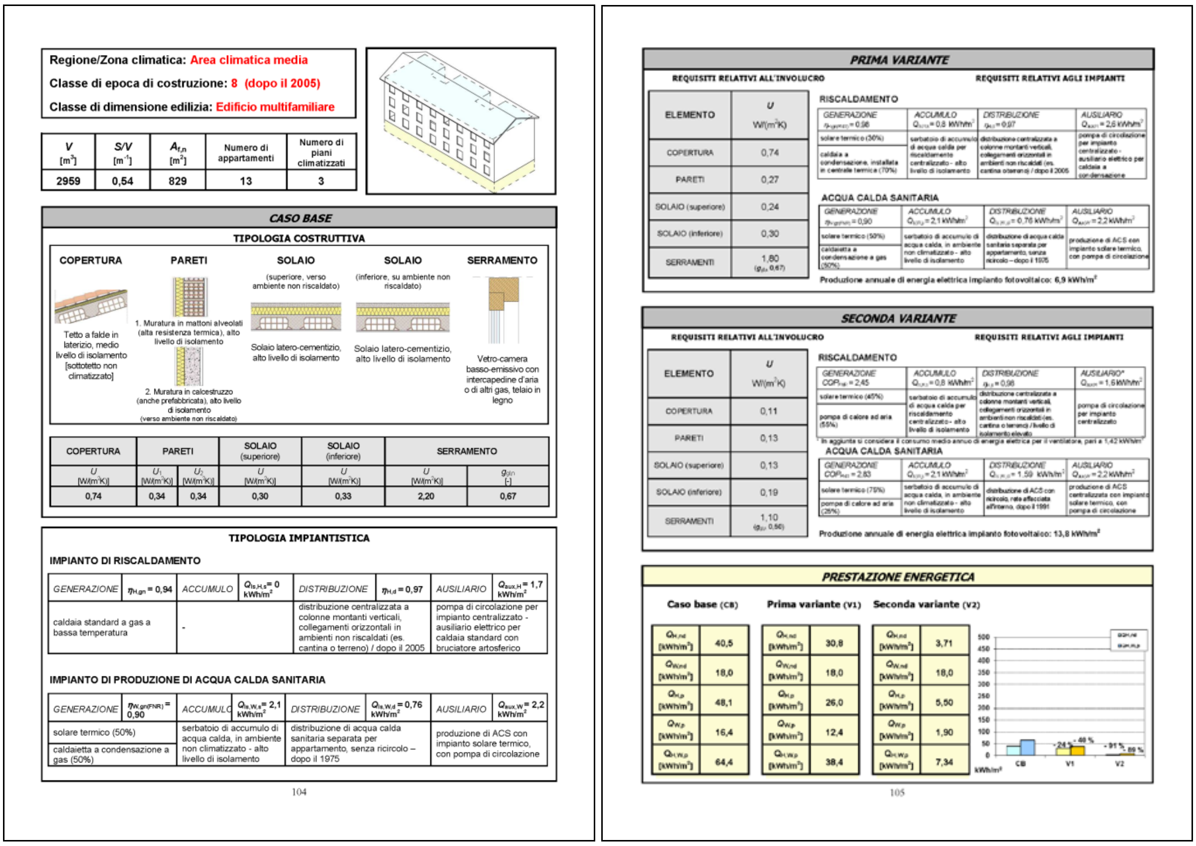


Figure 52: “Building Display Sheet” of the exemplary MFH <IT> (further examples in [POLITO 2014])

In Table 119, the results of the national energy balance calculation (procedure according to UNI/TS 11300 series) are displayed for the multi-family house of the Italian “Building Type Matrix”. The delivered and primary energy are referred to space heating. The delivered electricity and the auxiliary energy demand shown in Table 119 are calculated as the difference between the total electricity demand and the used electricity produced by the photovoltaic system, on monthly basis (according to the national method described above). The primary energy is referred to non-renewable energy sources.

Table 119: Exemplary MFH – Results of the energy balance calculation; Procedure: UNI/TS 11300/1-2-4

Variant N°		**001**	**011**	**021**	**002**	**012**	**022**	**003**	**013**
Label of the variant triplet		Minimum Requirement			Improved Standard			Ambitious Standard / NZEB	
Variation level		low temperature gas boiler	wood pellets boiler	air source electrical heat pump	gas condensing boiler	wood pellets boiler	air source electrical heat pump	air source electrical heat pump	ground source electrical heat pump
Energy standard		D.Lgs. 192/2005; D.P.R. 59/2009; D.Lgs. 28/2011			D.M. 26/01/2010; D.M. 06/08/2009; D.Lgs. 28/2011			Exemplary projects of NZEBs (calls for funding - Piedmont Region)	
Method		UNI/TS 11300/1-2-4							
National reference area*	m²	829	829	829	829	829	829	829	829
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.418	0.418	0.418	0.340	0.340	0.340	0.171	0.171
Energy need for heating	kWh/(m²a)	40.5	40.5	40.5	30.8	30.8	30.8	3.71	3.71
Delivered energy									
Fossil fuels	kWh/(m²a)	44.4	0.0	0.0	23.3	0.0	0.0	0.0	0.0
Renewable fuels	kWh/(m²a)	0.0	56.7	0.0	0.0	26.8	0.0	0.0	0.0
Electricity	kWh/(m²a)	0.0	0.0	19.5	0.0	0.0	9.2	0.64	0.43
Auxiliary energy	kWh/(m²a)	1.7	1.7	1.6	1.26	0.58	1.4	1.87	1.77
Primary energy demand	kWh/(m²a)	48.1	20.7	45.8	26.0	9.30	23.0	5.50	4.77

*) Conditioned net floor area based on internal dimensions.

**) The thermal transfer coefficient by transmission is not an energy performance requirement in the Italian legislation.

TABULA calculation results for all exemplary buildings

Table 120 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all the exemplary new buildings of the Italian “Building Type Matrix”.

Table 120: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level		h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  IT.MidClim.SFH.08.Gen	01	Minimum Requirement	low temp. gas boiler	1.23	69	0	69	69	10	15	92	0	0	0	9.3	0	0	0
	11		wood pellets boiler	1.23	69	0	69	70	10	15	0	0	0	131	7.8	0	0	0
	21		air source el. heat pump	1.23	69	0	69	69	10	15	0	0	0	0	44	0	0	0
	02	Improved Standard	gas condensing boiler	0.93	57	0	57	58	10	15	56	0	0	0	9.3	0	0	-20
	12		wood pellets boiler	0.93	57	0	57	58	10	15	0	0	0	68	7.8	0	0	-20
	22		air source el. heat pump	0.93	57	0	57	58	10	15	0	0	0	0	26	0	0	-20
	03	Ambitious Standard	air source el. heat pump	0.43	31	16	15	15	10	15	0	0	0	0	13	0	0	-20
	13		ground source el. heat pump	0.43	31	16	15	15	10	15	0	0	0	0	12	0	0	-20
TH  IT.MidClim.TH.08.Gen	01	Minimum Requirement	low temp. gas boiler	1.25	69	0	69	69	10	15	93	0	0	0	9.3	0	0	0
	11		wood pellets boiler	1.25	69	0	69	71	10	15	0	0	0	132	7.8	0	0	0
	21		air source el. heat pump	1.25	69	0	69	69	10	15	0	0	0	0	44	0	0	0
	02	Improved Standard	gas condensing boiler	0.95	57	0	57	58	10	15	56	0	0	0	9.3	0	0	-27
	12		wood pellets boiler	0.95	57	0	57	58	10	15	0	0	0	68	7.8	0	0	-27
	22		air source el. heat pump	0.95	57	0	57	58	10	15	0	0	0	0	26	0	0	-27
	03	Ambitious Standard	air source el. heat pump	0.44	31	16	15	15	10	15	0	0	0	0	13	0	0	-27
	13		ground source el. heat pump	0.44	31	16	15	15	10	15	0	0	0	0	12	0	0	-27
MFH  IT.MidClim.MFH.08.Gen	01	Minimum Requirement	low temp. gas boiler	0.98	60	0	60	61	15	18	84	0	0	0	4.8	0	0	0
	11		wood pellets boiler	0.98	60	0	60	62	15	18	11	0	0	103	3.9	0	0	0
	21		air source el. heat pump	0.98	60	0	60	61	15	20	0	0	0	0	36	0	0	0
	02	Improved Standard	gas condensing boiler	0.74	50	0	50	52	15	18	53	0	0	0	4.8	0	0	-16
	12		wood pellets boiler	0.74	50	0	50	52	15	18	11	0	0	54	3.9	0	0	-16
	22		air source el. heat pump	0.74	50	0	50	52	15	20	0	0	0	0	25	0	0	-16
	03	Ambitious Standard	air source el. heat pump	0.36	26	16	10	11	15	19	0	0	0	0	9.4	0	0	-17
	13		ground source el. heat pump	0.36	26	16	10	11	15	19	0	0	0	0	8.4	0	0	-17

Table 120 (continuation)

Building	Var. N°	Performance Level		h_Transmission W/(m^{2}K)	q_h_nd kWh/(m^{2}a)	q_ve_rec_h_usable kWh/(m^{2}a)	q_h_nd_net kWh/(m^{2}a)	q_g_h_out kWh/(m^{2}a)	q_w_nd kWh/(m^{2}a)	q_g_w_out kWh/(m^{2}a)	q_del_sum_gas kWh/(m^{2}a)	q_del_sum_oil kWh/(m^{2}a)	q_del_sum_coal kWh/(m^{2}a)	q_del_sum_bio kWh/(m^{2}a)	q_del_sum_el kWh/(m^{2}a)	q_del_sum_dh kWh/(m^{2}a)	q_del_sum_other kWh/(m^{2}a)	q_exp_sum_el kWh/(m^{2}a)
AB  IT.MidClim.MFH.08.Gen	01	Minimum Requirement	low temp. gas boiler	0.98	60	0	60	61	15	18	84	0	0	0	4.8	0	0	0
	11		wood pellets boiler	0.98	60	0	60	62	15	18	11	0	0	103	3.9	0	0	0
	21		air source el. heat pump	0.98	60	0	60	61	15	20	0	0	0	0	36	0	0	0
	02	Improved Standard	gas condensing boiler	0.74	50	0	50	52	15	18	53	0	0	0	4.8	0	0	-16
	12		wood pellets boiler	0.74	50	0	50	52	15	18	11	0	0	54	3.9	0	0	-16
	22		air source el. heat pump	0.74	50	0	50	52	15	20	0	0	0	0	25	0	0	-16
	03	Ambitious Standard	air source el. heat pump	0.36	26	16	10	11	15	19	0	0	0	0	9.4	0	0	-17
	13		ground source el. heat pump	0.36	26	16	10	11	15	19	0	0	0	0	8.4	0	0	-17

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m^{2}K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m^{2}a)	energy need for heating
q_ve_rec_h_usable	kWh/(m^{2}a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m^{2}a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m^{2}a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m^{2}a)	net energy need domestic hot water
q_g_w_out	kWh/(m^{2}a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m^{2}a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m^{2}a)	sum produced electricity (negative value)

3.13.3 Sources / References Italy

Table 121: Sources / References Italy

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[CTI 2013]	CTI Raccomandazione 14, Prestazioni energetiche degli edifici – Determinazione della prestazione energetica per la classificazione dell'edificio, Comitato Termotecnico Italiano. Febbraio 2013.	Technical Report No 14 from Italian Thermotechnical Committee (2013), concerning the assessment of the energy carriers.
[D. Lgs. 192/2005]	Decreto Legislativo 19 agosto 2005, n. 192 "Attuazione della direttiva 2002/91/CE relativa al rendimento energetico nell'edilizia", pubblicato sul Supplemento ordinario n. 158/L alla Gazzetta Ufficiale n. 222 del 23 settembre 2005.	Legislative Decree No 192/2005, transposing the 2002/91/EC Directive (EPBD).
[D. Lgs. 311/2006]	Decreto Legislativo 29 dicembre 2006, n. 311 "Disposizioni correttive ed integrative al decreto legislativo 19 agosto 2005, n. 192, recante attuazione della direttiva 2002/91/CE, relativa al rendimento energetico nell'edilizia", pubblicato sul Supplemento ordinario n. 26 alla Gazzetta Ufficiale n. 26 del 1° febbraio 2007.	Legislative Decree No 311/2006, including amendments and addictions to Legislative Decree No 192/2005.
[D. Lgs. 28/2011]	Decreto Legislativo 3 marzo 2011, n. 28 "Attuazione della direttiva 2009/28/CE sulla promozione dell'uso dell'energia da fonti rinnovabili, recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE", pubblicato sulla Gazzetta Ufficiale n. 71 del 28 marzo 2011.	Legislative Decree No 28/2011, concerning the promotion of the use of renewable energy sources.

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[D.M. 19/02/2007]	Decreto Ministeriale 19 febbraio 2007 “Disposizioni in materia di detrazioni per le spese di riqualificazione energetica del patrimonio edilizio esistente, ai sensi dell’articolo 1, comma 349, della legge 27 dicembre 2006, n. 296”, pubblicato sulla Gazzetta Ufficiale n. 47 del 26 febbraio 2007.	Decree 19/02/2007, concerning funding for energy refurbishment measures (efficiency values of heat generators).
[D.M. 26/06/2009]	Decreto Ministeriale 26/06/2009 "Linee guida nazionali per la certificazione energetica degli edifici“, pubblicato sulla Gazzetta Ufficiale n. 158 del 10 luglio 2009.	Decree 26/06/2009, concerning the energy performance certification of buildings.
[D.M. 06/08/2009]	Decreto Ministeriale 6 agosto 2009 “Disposizioni in materia di detrazioni per le spese di riqualificazione energetica del patrimonio edilizio esistente, ai sensi dell’articolo 1, comma 349, della legge 27 dicembre 2006, n. 296”, pubblicato sulla Gazzetta Ufficiale n. 224 del 26 settembre 2009.	Decree 06/08/2009, concerning funding for energy refurbishment measures (reference efficiency values of electrical heat pumps).
[D.M. 26/01/2010]	Decreto Ministeriale 26 gennaio 2010 “Aggiornamento del decreto 11 marzo 2008 in materia di riqualificazione energetica degli edifici”, pubblicato sulla Gazzetta Ufficiale n. 35 del 12 febbraio 2010.	Decree 26/01/2010, concerning funding for energy refurbishment measures (reference thermal transmittance values of the building envelope components).
[D.P.R. 59/2009]	D.P.R. 2 aprile 2009 n. 59 “Regolamento di attuazione dell’articolo 4, comma 1, lettere a) e b), del decreto legislativo 19 agosto 2005, n. 192, concernente attuazione della direttiva 2002/91/CE sul rendimento energetico in edilizia”, pubblicato sulla Gazzetta Ufficiale n. 132 del 10 giugno 2009.	Decree No 59/2009, concerning the application of Legislative Decree No 192/2005 about the minimum energy performance requirement of buildings.
[ECOFYS 2013]	ECOFYS, National plan for increasing the number of nearly zero-energy buildings in Italy, 2013.	Report by ECOFYS (2013) concerning the national plan for increasing the number of nearly zero-energy buildings in Italy.
[EPBD 2002]	Direttiva 2002/91/CE del Parlamento Europeo e del Consiglio del 16 dicembre 2002 sul rendimento energetico nell’edilizia, pubblicata sulla Gazzetta Ufficiale delle Comunità europee n. L1 del 4 gennaio 2003.	European Directive 2002/91/EC on the energy performance of buildings (EPBD).
[EPBD recast 2010]	Direttiva 2010/31/UE del Parlamento Europeo e del Consiglio del 19 maggio 2010 sulla prestazione energetica nell’edilizia, pubblicata sulla Gazzetta Ufficiale dell’Unione europea n. L153 del 18 giugno 2010.	European Directive 2010/31/EU on the energy performance of buildings (EPBD recast).
[ISTAT 2001]	ISTAT, Censimento della popolazione. Elaborazioni dell’Istituto Nazionale di Statistica, 2001.	Census data from the National Institute of Statistics (2001).
[L. 90/2013]	L. 3 agosto 2013 n. 90 “Conversione in legge, con modificazioni, del decreto-legge 4 giugno 2013, n. 63, recante disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell’edilizia per la definizione delle procedure d’infrazione avviate dalla Commissione europea, nonché altre disposizioni in materia di coesione sociale”, pubblicata sulla Gazzetta Ufficiale n. 181 del 3 agosto 2013.	Law No 90/2013, transposing the 2010/31/EU Directive (EPBD recast) and amending the Legislative Decree No 192/2005.
[NES 2013]	Ministero dello Sviluppo Economico, Strategia Energetica Nazionale: per un’energia più competitiva e sostenibile, marzo 2013.	Italian National Energy Strategy (2013) by the Ministry of Economic Development.
[POLITO 2012]	V. Corrado, I. Ballarini, S.P. Corgnati, National scientific report on the TABULA activities in Italy, Politecnico di Torino, Torino, 2012.	National scientific report on the TABULA activities in Italy (2012).
[POLITO 2014]	V. Corrado, I. Ballarini, S.P. Corgnati, Building Typology Brochure – Italy. Fascicolo sulla Tipologia Edilizia Italiana, EPISCOPE - D2.3, 2014.	Italian “Building Typology Brochure” – Deliverable 2.3 of the EPISCOPE project.

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Reg. Piemonte 2011]	Determinazione Dirigenziale 25 luglio 2011, n. 160 “Legge regionale 7 ottobre 2002, n. 23, art. 2, comma 2, lettera g) e 8, comma 5 e s.m.i. - Approvazione del “Bando regionale per la concessione di contributi per la realizzazione di edifici a energia quasi zero” e della modulistica relativa”, pubblicata sul Bollettino Ufficiale della Regione Piemonte n. 30 del 28 luglio 2011.	Calls for funding in Piedmont Region concerning NZEBs projects (2011).
[TABULA 2013]	T. Loga, N. Diefenbach et al., TABULA calculation method – Energy use for heating and domestic hot water, TABULA documentation, 2013.	TABULA document describing the common TABULA calculation method (2013).
[UNI/TS 11300-1]	UNI/TS 11300-1, Prestazioni energetiche degli edifici – Determinazione del fabbisogno di energia termica dell’edificio per la climatizzazione estiva ed invernale, Ente Nazionale Italiano di Unificazione. Maggio 2008.	National technical specification for the calculation of the energy performance of buildings. UNI/TS 11300-1: Energy performance of buildings. Evaluation of energy need for space heating and cooling (2008, under revision).
[UNI/TS 11300-2]	UNI/TS 11300-2, Prestazioni energetiche degli edifici – Determinazione del fabbisogno di energia primaria e dei rendimenti per la climatizzazione invernale e per la produzione di acqua calda sanitaria, Ente Nazionale Italiano di Unificazione. Maggio 2008.	National technical specification for the calculation of the energy performance of buildings. UNI/TS 11300-2: Energy performance of buildings. Evaluation of primary energy need and of system efficiencies for space heating and domestic hot water production (2008, under revision).
[UNI/TS 11300-3]	UNI/TS 11300-3, Prestazioni energetiche degli edifici - Determinazione del fabbisogno di energia primaria e dei rendimenti per la climatizzazione estiva, Ente Nazionale Italiano di Unificazione. Maggio 2010.	National technical specification for the calculation of the energy performance of buildings. UNI/TS 11300-3: Energy performance of buildings. Evaluation of primary energy and system efficiencies for space cooling (2010, under revision).
[UNI/TS 11300-4]	UNI/TS 11300-4, Prestazioni energetiche degli edifici – Utilizzo di energie rinnovabili e di altri metodi di generazione per la climatizzazione invernale e per la produzione di acqua calda sanitaria, Ente Nazionale Italiano di Unificazione. Maggio 2012.	National technical specification for the calculation of the energy performance of buildings. UNI/TS 11300-4: Energy performance of buildings. Renewable energy and other generation systems for space heating and domestic hot water production (2012).

3.14 <NL> The Netherlands

(by EPISCOPE partner DUT)

3.14.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in the Netherlands

In October 2012, the Netherlands sent its first version of the National Plan Nearly Zero-Energy Buildings (‘Nationaal Plan Bijna Energieneutrale Gebouwen’, in short ‘BENG’) to the European Commission and to its national parliament [AgentschapNL, 2013a]. The plan sketches a strategy on how to achieve nearly zero-energy buildings at the end of 2018 (public buildings) and 2020 (other new buildings) respectively.

In the Netherlands, a non-dimensional number is used as an indicator of the building’s energy performance, depending on how the building is used: the ‘energy performance coefficient’, (“energieprestatiecoëfficient” – epc). The epc is determined by dividing the calculated energy requirement of a building by a standardised energy performance, which is based on the heat-transfer surface and the total heated area of the dwelling [Guerra Santin & Itard, 2012]. The calculation of the epc should follow the norm NEN 7120: Energy Performance of buildings – Determination method (“Energieprestatie van gebouwen – Bepalingsmethode”, in short EPG), which also allows using the prenorm NVN 7125 Energy Performance Standard Measures at District Level (“Energieprestatienorm Maatregelen op Gebiedsniveau”, in short EMG). The determination method has the following characteristics:

- the energy use is determined for standard use and climate conditions;
- only the building related energy use is valued in the energy performance;
- if applicable, district related energy use can be valued with the EMG;
- the production of energy can take place inside or outside the building;
- renewable energy sources are valued;
- the net energy use is determined on a yearly basis.

The details of the Dutch calculation method for new buildings can be found in Table 122.

The epc was introduced in 1995 to set a minimal standard regarding the energy efficiency of new buildings (for existing buildings, a different coefficient is used). Over the years the epc standard has been tightened to improve the energetic quality of new buildings. The epc for a nearly zero-energy building is officially stated to be close to 0. In line with EU regulations, this norm will come into force at the end of 2018 for government buildings and at the end of 2020 for other buildings. This level is defined as ‘nearly energy neutral’ (“bijna-energieneutraal”), but the exact value is still unknown.

Regarding renewable energy sources, the principle is that builders are free to choose measures that reduce the demand for energy, use energy from renewable sources, and make effective use of fossil fuels, in order to achieve the required epc. As the requirements for the epc become stricter over time, the percentage of renewable energy will automatically become increasingly important in order to fulfil the requirement. Even so, it will still be compulsory to fulfil the requirements for thermal insulation of the building envelope of new buildings, as stipulated in the Building Decree (“Bouwbesluit”), which is part of the Housing Act (“Woningwet”). As for new and renovated dwellings, this decree prescribes an R_c of at least 3.5 m^2K/W for the building envelope and a U value of 1.65 W/m^2K for windows, doors, etc.

Since 2013, the epc for new and renovated homes should be not more than 0.6. In 2015, a further restriction to a maximum of 0.4 is planned. As stated above, the epc will be further reduced to 0 or nearly 0 to meet European nZEB standards.

Table 122: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition in the Netherlands

<table>
<tr><th colspan="2">Calculation Method New Building Regulations – (part 1)</th></tr>
<tr><td><table><tr><td>Country</td><td>NL</td><td>The Netherlands</td></tr></table></td><td><table><tr><td>Status</td><td>08/2014</td></tr></table></td></tr>
<tr><td>National Requirements for New Residential Buildings</td><td>Special Aspects with regard to the (assumed) National NZEB Definition</td></tr>
<tr><td>Legislation / Standards
NEN 7120: Energy performance of buildings - Determination method
Explanation / Comments</td><td>There is no specific calculation method for nZEBs. The regular calculation method is followed; the outcome of the calculation should meet a certain norm.</td></tr>
<tr><td>Energy Services
<table>
<tr><td>x</td><td>Heating</td><td>x</td><td>DHW</td><td></td><td>Appliances</td><td></td></tr>
<tr><td></td><td>Cooling</td><td>x</td><td>Auxiliary</td><td></td><td>Other:</td><td></td></tr>
<tr><td>x</td><td>Ventilation</td><td></td><td>Lighting</td><td></td><td></td><td></td></tr>
</table>
Explanation / Comments</td><td></td></tr>
<tr><td>
<table>
<tr><td colspan="2">Calculation Procedure</td><td>Calculation period</td></tr>
<tr><td>x</td><td>Calculation of energy need for heating (building)</td><td>Month</td></tr>
<tr><td>x</td><td>Calculation of delivered energy (system)</td><td>Month</td></tr>
</table>
Explanation / Comments</td><td></td></tr>
<tr><td>Consideration of Special Technologies
Thermal Systems
<table>
<tr><td>x</td><td>Ventilation system with heat recovery</td></tr>
<tr><td>x</td><td>Thermal solar system</td></tr>
<tr><td></td><td>Other special systems:</td></tr>
</table>
<table>
<tr><td colspan="2">On-Site Electricity Production</td><td>Feed-in</td><td>Self-use[1]</td><td>Balance period to determine self-use[1]</td><td>Self-use considered for H-C-W-HE[1]</td></tr>
<tr><td>x</td><td>On-site CHP</td><td>x</td><td>x</td><td>year</td><td>H-W</td></tr>
<tr><td>x</td><td>On-site PV</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="5">Other energy generation systems:</td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>
[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity
Explanation / Comments</td><td></td></tr>
<tr><td>Type of Requirements (new buildings)
<table>
<tr><td>x</td><td>U-values of building elements</td><td></td><td>Primary energy</td><td></td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>epc</td></tr>
</table>
Explanation / Comments</td><td>On the basis of NEN 7120, an energy performance coefficient (epc) can be calculated. For nZEBs this coefficient must be equal to or nearly zero. There are no specific nZEB requirements for building elements. The Building Code (based on the Housing Act) prescribes certain U values for all new and renovated buildings, which also apply to nZEBs.</td></tr>
</table>

Assessment of energy carriers in the Netherlands

In the Netherlands, almost exclusively gas is used for heating and domestic hot water. To these ends, the use of electricity is mostly auxiliary. The energy factors for each of the energy sources (primary energy value divided by the final energy value) are given in Table 123.

Table 123: Dutch primary energy factors

Label / type of factor	**Total Primary Energy Factors Netherlands**	**Non-Renewable Primary Energy Factor Netherlands**
Used for EPC rating	x	x
Used for building regulations requirements		
Label (national language)	Omrekenfactor naar primaire energie van de brandstof	Omrekenfactor naar primaire energie van de brandstof
Description / type of weighting factor	ratio between primary energy use and final energy use for both non-renewable and renewable energy sources, accounting for energy losses during generation and transport	ratio between primary energy use and final energy use for both non-renewable and renewable energy sources, accounting for energy losses during generation and transport
Factor is multiplied by delivered energy based on the	gross calorific value	gross calorific value
Reference	Gas: [TNO, 2008] Electricity: [NEN 2904]	Gas: [TNO, 2008] Electricity: [NEN 2904]
Natural gas	1	1
Heating oil	1	1
Electricity	2.56	2.3

*) Oil is mainly used in local heating, an energy factor of 1 is assumed

3.14.2 Integration of National Requirements for New Buildings and NZEB Standards in the Dutch Residential Building Typology

Classification scheme for the Dutch residential building stock (“Building Type Matrix”)

The Dutch building typology is largely based on earlier work carried out by the Netherlands Enterprise Agency (“Rijksdienst voor Ondernemend Nederland” – RVO.nl) and its predecessors AgentschapNL and SenterNovem, which developed a set of reference dwellings that each cover a segment of the housing stock [AgentschapNL, 2011]. As in TABULA, the segments are distinguished according to form (e.g. terraced houses, flats) and building year. The Dutch building typology has been expanded in the EPISCOPE project. Among others, 6 new classes developed later by AgentschapNL [AgentschapNL, 2013b] have been added. The result is presented below.

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	national (nationaal)	… 1964	generic (generiek)	 NL.N.SFH.01.Gen	 NL.N.TH.01.Gen	 NL.N.MFH.01.Gen	 NL.N.AB.01.Gen
2	national (nationaal)	1965 … 1974	generic (generiek)	 NL.N.SFH.02.Gen	 NL.N.TH.02.Gen	 NL.N.MFH.02.Gen	 NL.N.AB.02.Gen
3	national (nationaal)	1975 … 1991	generic (generiek)	 NL.N.SFH.03.Gen	 NL.N.TH.03.Gen	 NL.N.MFH.03.Gen	 NL.N.AB.03.Gen
4	national (nationaal)	1992 … 2005	generic (generiek)	 NL.N.SFH.04.Gen	 NL.N.TH.04.Gen	 NL.N.MFH.04.Gen	 NL.N.AB.04.Gen
5	national (nationaal)	2006 …	generic (generiek)	 NL.N.SFH.05.Gen	 NL.N.TH.05.Gen	 NL.N.MFH.05.Gen	 NL.N.AB.05.Gen

Figure 53: Classification scheme ("Building Type Matrix") of the Dutch residential building typology

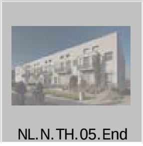
	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
6	national (nationaal)	1965 … 1974	detached (vrijstaand)	 NL.N.SFH.02.Deta			
7	national (nationaal)	1975 … 1991	detached (vrijstaand)	 NL.N.SFH.03.Deta			
8	national (nationaal)	… 1964	semi-detached (twee-onder-één-kap)	 NL.N.SFH.01.Semi			
9	national (nationaal)	1992 … 2005	semi-detached (twee-onder-één-kap)	 NL.N.SFH.04.Semi			
10	national (nationaal)	2006 …	semi-detached (twee-onder-één-kap)	 NL.N.SFH.05.Semi			
11	national (nationaal)	… 1964	terraced house, middle row, built in 1946-1964 (tussenwoning, gebouwd in 1946-1964)		 NL.N.TH.01.Mid1964		
12	national (nationaal)	… 1964	end house, built before 1946 (hoekwoning, gebouwd vóór 1946)		 NL.N.TH.01.End1945		
13	national (nationaal)	… 1964	end house, built in 1946-1964 (hoekwoning, gebouwd in 1946-1964)		 NL.N.TH.01.End1964		
14	national (nationaal)	1965 … 1974	end house (hoekwoning)		 NL.N.TH.02.End		
15	national (nationaal)	1975 … 1991	end house (hoekwoning)		 NL.N.TH.03.End		
16	national (nationaal)	1992 … 2005	end house (hoekwoning)		 NL.N.TH.04.End		
17	national (nationaal)	2006 …	end house (hoekwoning)		 NL.N.TH.05.End		

Figure 54: Classification scheme ("Building Type Matrix") of the Dutch residential building typology, further building types for single family and terraced houses

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
18	national (nationaal)	… 1964	common staircase and galleries (galerijflat)				 NL.N.AB.01.Gal
19	national (nationaal)	1975 … 1991	common staircase and galleries (galerijflat)				 NL.N.AB.03.Gal
20	national (nationaal)	… 1964	common staircase, no galleries, built before 1946 (portiekflat, gebouwd vóór 1946)				 NL.N.AB.01.Por1945
21	national (nationaal)	1965 … 1974	common staircase, no galleries (portiekflat)				 NL.N.AB.02.Por
22	national (nationaal)	1992 … 2005	common staircase, no galleries (portiekflat)				 NL.N.AB.04.Por
23	national (nationaal)	… 1964	maisonnettes (maisonnetteflat)				 NL.N.AB.01.Mai
24	national (nationaal)	1965 … 1974	maisonnettes (maisonnetteflat)				 NL.N.AB.02.Mai
25	national (nationaal)	1975 … 1991	maisonnettes (maisonnetteflat)				 NL.N.AB.03.Mai
26	national (nationaal)	1992 … 2005	maisonnettes (maisonnetteflat)				 NL.N.AB.04.Mai

Photos: courtesy of AgentschapNL (now RVO.nl)

Figure 55: Classification scheme ("Building Type Matrix") of the Dutch residential building typology, further building types for apartment buildings

The number in the name of the classes refers to the building period. The classes containing "05" in their names present the newest buildings, which have been built after 2005. Some data regarding these classes are presented in Table 124.

Table 124: Exemplary new buildings representing the latest construction year classes (2006 …)

TABULA category		**SFH**	**SFH**	**TH**	**TH**	**MFH**	**AB**
dwelling type		detached house	semi-detached house	terraced house, mid-row	terraced house, end-row	other multi-family buiilding	gallery flat
		 NL.N.SFH.05.Gen	 NL.N.SFH.05.Semi	 NL.N.TH.05.Gen	 NL.N.TH.05.End	 NL.N.MFH.05.Gen	 NL.N.AB.05.Gen
Number of dwellings		1	1	1	1	27	36
Number of full storeys (conditioned)		2	2	2	2	4	4
Number of directly attached neighbour buildings		0	1	2	1	0	0
Usable floor space	m²	170	148	124	124	2756	2941
TABULA reference area (conditioned floor area, internal dimensions)	m²	186	162	137	137	3032	3235
R_c value façade	m^{2}K/W	3.5	3.5	3.5	3.5	3.5	3.5
R_c value roof	m^{2}K/W	4.0	4.0	4.0	4.0	4.0	4.0
R_c value ground floor	m^{2}K/W	3.5	3.5	3.5	3.5	3.5	3.5
U value windows	W/m^{2}K	1.65	1.65	1.65	1.65	1.65	1.65
U value front door	W/m^{2}K	1.65	1.65	1.65	1.65	1.65	1.65

Source: [AgentschapNL, 2013b]

Building example: variants meeting three energy performance levels for new buildings

The Netherlands has no minimum requirements in terms of U values or R_c values for the existing stock. However, there are such minimum requirements for new buildings. Moreover, these resistance values have to be taken into account in order to attain the prescribed epc levels (0.8 since 2006, 0.6 since 2011).

In Table 125 three levels are presented, namely a minimum requirement, an improved standard and an ambitious or nZEB standard. For the minimum requirement, resistance values have been chosen that, under normal circumstances, would result in an epc of 0.6 or less. The presented U values are the same as in Table 124. These values indicate the existing state, without any refurbishment or other improvements.

The values in the column 'improved standard' denote some minor improvements to the respective homes. Most values are the same as those denoting the existing state, with the exception of the introduction of a low-temperature boiler and balanced ventilation with heat recovery.

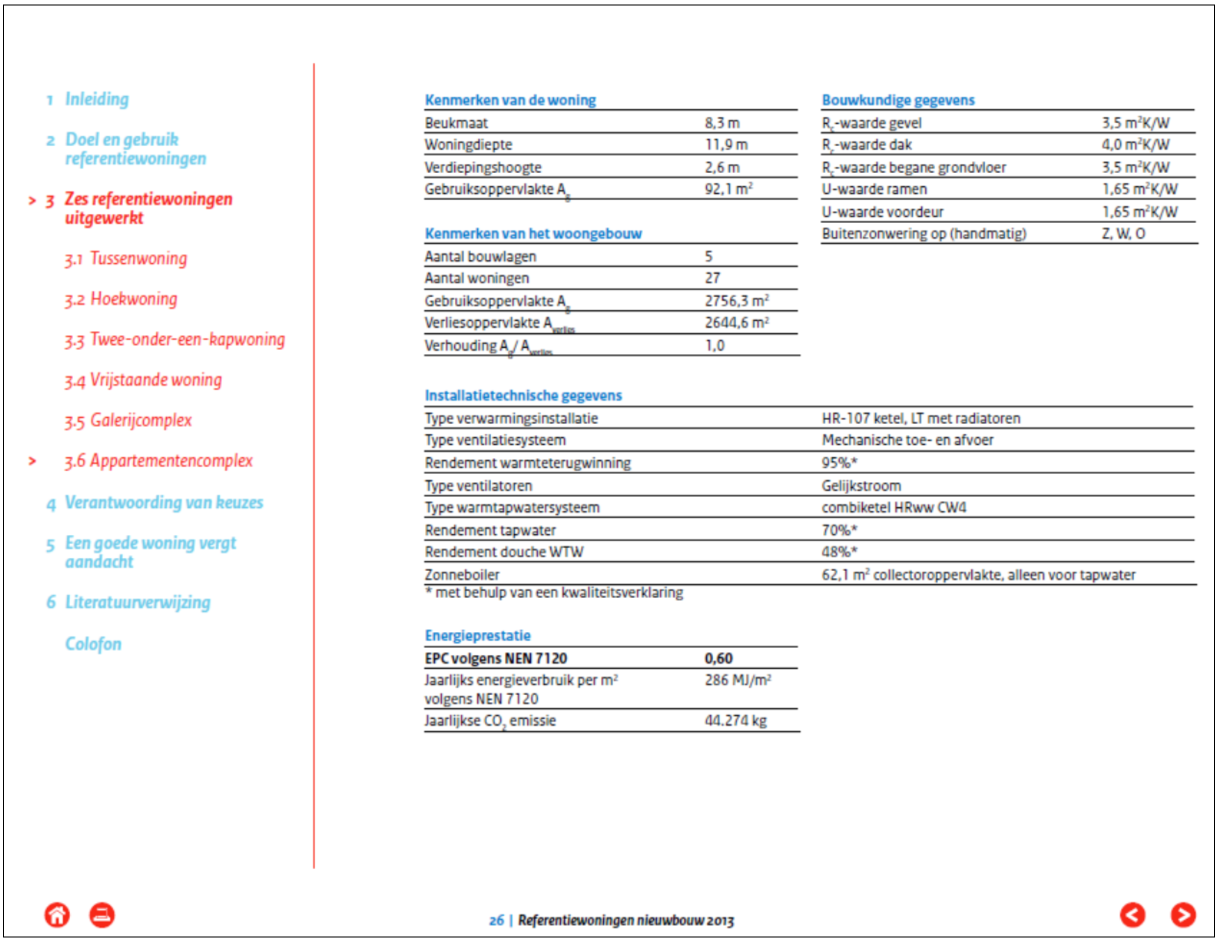
The ambitious or nZEB standard includes extra insulation, plus the introduction of an air to air/water heat pump and balanced ventilation with heat recovery. Regarding the insulation and the installations, we used the following nZEB norms given by [AgentschapNL, 2013b]:

- façade: $R_c > 5.0$ m^2K/W
- roof: $R_c > 6.0$ m^2K/W
- ground floor: $R_c > 5.0$ m^2K/W
- windows: U = 1.00 W/m^2K
- front door: U = 1.4 W/m^2K
- low-temperature (35-45ºC), high-efficiency boiler (HR107)
- balanced ventilation, 95% heat recovery
- solar boiler, including 5.5 m^2 of solar cells
- entire south-oriented roof used for PV panels

Table 125 presents the resulting insulation and system data for one of the six newest classes, namely a multi-family building not being a gallery flat. The corresponding page in the national brochure concerning the building typology is shown in Figure 56; the results of some calculations with the TABULA program for this building type are included in Table 126.

Table 125: Exemplary multi-family house (MFH) – definition of variants

Energy Performance Level		**Minimum Requirement**	**Improved Standard**	**Ambitious Standard / NZEB**
U values				
Roof	W/(m²K)	0.25	0.25	0.17
Wall	W/(m²K)	0.29	0.29	0.20
Window	W/(m²K)	1.65	1.65	1.00
Door	W/(m²K)	1.65	1.65	1.40
Floor	W/(m²K)	0.29	0.29	0.20
Heat Supply System				
Heat generator		high efficiency boiler, high temperature	High efficiency boiler, low temperature	Air to air/water heat pump
Ventilation system		exhaust, direct current	balanced, direct current	balanced, direct current
Thermal solar boiler		no	no	yes



1 Inleiding
2 Doel en gebruik referentiewoningen
> 3 Zes referentiewoningen uitgewerkt
3.1 Tussenwoning
3.2 Hoekwoning
3.3 Twee-onder-een-kapwoning
3.4 Vrijstaande woning
3.5 Galerijcomplex
> 3.6 Appartementencomplex
4 Verantwoording van keuzes
5 Een goede woning vergt aandacht
6 Literatuurverwijzing
Colofon

Kenmerken van de woning	
Beukmaat	8,3 m
Woningdiepte	11,9 m
Verdiepingshoogte	2,6 m
Gebruiksoppervlakte A_g	92,1 m²

Kenmerken van het woongebouw	
Aantal bouwlagen	5
Aantal woningen	27
Gebruiksoppervlakte A_g	2756,3 m²
Verliesoppervlakte $A_{verlies}$	2644,6 m²
Verhouding A_g / $A_{verlies}$	1,0

Bouwkundige gegevens	
R_c-waarde gevel	3,5 m²K/W
R_c-waarde dak	4,0 m²K/W
R_c-waarde begane grondvloer	3,5 m²K/W
U-waarde ramen	1,65 m²K/W
U-waarde voordeur	1,65 m²K/W
Buitenzonwering op (handmatig)	Z, W, O

Installatietechnische gegevens	
Type verwarmingsinstallatie	HR-107 ketel, LT met radiatoren
Type ventilatiesysteem	Mechanische toe- en afvoer
Rendement warmteterugwinning	95%*
Type ventilatoren	Gelijkstroom
Type warmtapwatersysteem	combiketel HRww CW4
Rendement tapwater	70%*
Rendement douche WTW	48%*
Zonneboiler	62,1 m² collectoroppervlakte, alleen voor tapwater

* met behulp van een kwaliteitsverklaring

Energieprestatie	
EPC volgens NEN 7120	**0,60**
Jaarlijks energieverbruik per m² volgens NEN 7120	286 MJ/m²
Jaarlijkse CO_2 emissie	44.274 kg

26 | Referentiewoningen nieuwbouw 2013

Source: [AgentschapNL, 2013b]

Figure 56: “Building Display Sheet” of the exemplary multi-family building

Table 126: Exemplary MFH – Results of the energy balance calculation; Procedure: TABULA method

Variant N°		**001**	**002**	**003**
Label of the variant triplet		NL.N.MFH.05.Gen.ReEx.001 (multifamily building other than gallery flat, built after 2005)		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
TABULA reference area	m²	3032	3032	3032
Energy need for heating	kWh/(m²a)	57	57	28
Delivered energy	kWh/(m²a)	66	31	13
Fossil fuels	kWh/(m²a)	66	31	0
Renewable fuels	kWh/(m²a)	0	0	0
Electricity	kWh/(m²a)	0	0	13
Auxiliary energy	kWh/(m²a)	5	7	7

TABULA calculation results for all exemplary buildings

Table 127 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all six exemplary buildings.

Table 127: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH (detached)  NL.N.SFH.05.Gen	01	Minimum Requirement	0.83	72	0	72	77	10	14	97	0	0	0	0	0	0	0
	02	Improved Standard	0.83	72	33	39	45	10	14	62	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.55	41	22	19	24	10	24	0	0	0	0	15	0	0	0
SFH (semi-detached)  NL.N.SFH.05.Semi	01	Minimum Requirement	0.62	66	0	66	71	10	14	91	0	0	0	0	0	0	0
	02	Improved Standard	0.62	66	34	32	38	10	14	55	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.42	37	22	15	20	10	24	0	0	0	0	13	0	0	0
TH (mid-row)  NL.N.TH.05.Gen	01	Minimum Requirement	0.56	61	0	61	66	10	14	86	0	0	0	0	0	0	0
	02	Improved Standard	0.56	61	33	27	33	10	14	50	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.36	33	22	11	16	10	24	0	0	0	0	12	0	0	0
TH (end-row)  NL.N.TH.05.End	01	Minimum Requirement	0.69	67	0	67	72	10	14	92	0	0	0	0	0	0	0
	02	Improved Standard	0.69	67	33	34	39	10	14	57	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.46	38	22	15	21	10	24	0	0	0	0	14	0	0	0
AB  NL.N.AB.05.Gen	01	Minimum Requirement	0.53	59	0	59	64	15	19	89	0	0	0	0	0	0	0
	02	Improved Standard	0.53	59	33	26	31	15	19	54	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.35	30	21	10	15	15	29	0	0	0	0	13	0	0	0
MFH  NL.N.MFH.05.Gen	01	Minimum Requirement	0.52	57	0	57	62	15	19	87	0	0	0	0	0	0	0
	02	Improved Standard	0.52	57	33	24	30	15	19	52	0	0	0	0	0	0	0
	03	Ambitious Standard / NZEB	0.33	28	20	8	13	15	29	0	0	0	0	13	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.14.3 Sources / References Netherlands

The references used in this subchapter are listed in Table 128.

Table 128: Sources / References for the Netherlands

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[AgentschapNL, 2011]	AgentschapNL (2011), Voorbeeldwoningen 2011, http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/woningbouw/particuliere-woningen/voorbeeldwoningen	presents a building typology, which is further developed in EPISCOPE
[AgentschapNL, 2013a]	AgentschapNL (2013), Infoblad energieneutraal bouwen – definitie en ambities, http://www.agentschapnl.nl/sites/default/files/Infoblad%20Energieneutraal%20bouwen%20Definitie%20en%20ambitie%20april%202013.pdf	brochure of the Dutch national government regarding the definition of nZEB
[AgentschapNL, 2013b]	AgentschapNL (2013), Referentiewoningen nieuwbouw 2013, http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/energieprestatie-nieuwbouw-epn/ontwerpen/referentiewoningen-nieuwbouw	presents 6 reference dwellings built after 2005, which form an extension of the Dutch building typology
[Guerra Santin & Itard, 2012]	Guerra Santin, O. / Itard, L. (2012), The effect of energy performance regulations on energy consumption, Energy Efficiency (2012) 5:269–282	article about the impact of the epc standard on the energy performance of dwellings
[NEN 2904]	NEN 2904:2004 - Energieprestatie van utiliteitsgebouwen - Bepalingsmethode	describes (among others) the calculation method of the epc for utility buildings. It contains the ratio of primary and final energy use for electricity, which is not only valid for utility buildings, but for all buildings.
[NEN 7120]	NEN 7120+C2:2012 nl - Energieprestatie van gebouwen - Bepalingsmethode	describes (among others) the calculation method of the epc for new buildings (and also the Energy Index for existing buildings)
[NVN 7125]	NVN 7125:2011 n - Energieprestatienorm voor maatregelen op gebiedsniveau (EMG) - Bepalingsmethode	describes a method for including the energy infrastructure at the district level in the calculation of the energy performance of a building. This can be seen as an addition on NEN 7120.
[TNO 2008]	TNO Built Environment and Geosciences (2008), Information on Standardization: Numerical indicator for the energy performance based on primary energy use and CO2 emissions - Procedures according to CEN standard EN 15603	contains the ratio of primary and final energy use for gas

3.15 <NO> Norway

(by EPISCOPE partner NTNU–SINTEF)

Minimum requirements on insulation levels were first introduced in Norway in the technical specifications of the building code from 1969 (TEK69). However, the use of mineral wool had already been common praxis since the mid '50s, also due to a requirement from Husbanken (The Norwegian housing bank) on a U-value of 0.4 W/m^{2}K for walls and roofs. In that period there was a high need for dwellings and Husbanken has financed 62 % of all new dwellings built in the period 1952-64 [Enova, 2012]. The technical requirements have been further tightened in 1987, 1997 and 2007, when for the first time it was included an overall energy performance requirement on energy demand. This was further sharpened in 2010 and it is today's building code's minimum performance requirement, known as TEK10 [Kommunal- og moderniseringsdepartementet, 2010]

3.15.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Norway

The current legal requirements are stated in the TEK10, which is foreseen to be revised in 2015 and in 2020. According to a White Paper on buildings energy efficiency by the Norwegian government [Kommunal- og regionaldepartementet, 2012], subsequently approved by the parliament, the TEK15 will implement the passive house standard, while TEK20 will set the requirements for nearly zero energy buildings. This is despite the fact that Norway – not being a member of the EU – is not forced to implement the EPBD recast from 2010, but shall rather approve case by case the European Directives. At the time of writing, indeed, the Norwegian parliament has not yet voted for its implementation.

Furthermore, a national voluntary standard exists that defines what a "passive house" is in Norwegian conditions. For the residential sector this is the standard NS 3700 [Standard Norge, 2013], while NS 3701 is the standard for non-residential buildings. However, it is not clear for the time being whether the TEK15 will be based on the NS 3700 or if modifications will be applied.

The TEK10 sets requirements on the energy needs but do not set requirements on the delivered energy demand, see chapter below. The EPC, on the other hand, is based on delivered energy demand, and so is the definition of the energy label, see below. The methodology for calculation of both energy needs (including heating, cooling, ventilation, hot water, auxiliaries, lighting and appliances) delivered energy, energy carriers distribution and primary energy and/or carbon emissions is described in the NS 3031 [Standard Norge, 2007]. The TEK10, as the building code in general, is under the responsibility of the Directorate for Buildings Quality (DiBK), while the EPC is under the responsibility of the Directorate for Water and Energy Resources (NVE).

A national definition of nearly zero energy buildings (nZEB) does not yet exists, such as defined in a standard. However, the research centre on Zero Emission Buildings (ZEB centre) has elaborated a definition that applies to its pilot buildings (for the time being: six single building – both residential and non, both new and refurbished – one new small development of about 20 dwellings and one new large development of about 700 dwellings, with some commercial activity included). For reference to nZEB definitions see [Sartori, Napolitano, & Voss, 2012] and [Buildings Performance Institute Europe, 2011].

Minimum requirements for new residential buildings in Norway

Minimum requirements are set in TEK10 in two ways: either prescriptive or performance compliance. With the prescriptive method a building shall comply with a list of requirements on the most relevant parameters influencing energy demand, such as U-values, air tightness, heat recovery efficiency. Following the prescriptive method, however, the result will normally be within the limit specified by the performance method. With the performance method a building shall comply with an overall energy performance indicator, expressed in total energy need (i.e. not in delivered energy, and hence, the efficiency of the system is not considered). The table below shows the energy performance requirement for the two types of buildings defined in the norm: small house (SFH and TH in TABULA) and apartment block (MFH and AB in TABULA). It shall be noticed that the requirement is on total energy need, including heating, ventilation, hot water, auxiliary, lighting and appliances, while cooling is normally not needed in residential buildings in Norway (anyway if there is cooling, the total limit remains the same).

Building type	Total energy need (kWh/m^{2}a)
Small house	120 + 1600/m^2 (heated floor area of the building)
Block of apartments	115

Energy needs for hot water, lighting and appliances are given as standardized values in NS 3031, and are the same for both residential types. These values are as follows:

- Hot water: 30 kWh/m^{2}a
- Lighting: 11 kWh/m^{2}a
- Appliances: 18 kWh/m^{2}a

The total of these three items is 58 kWh/m^{2}a, to which one should add the electric consumptions of ventilation fans (since balanced ventilation system with heat recovery is compulsory). In apartments this falls in the range of 5-7 kWh/m^{2}a, while it is somewhat lower in small house due to lower airflows required. Hence, energy need for space heating is limited to ca. 50 kWh/m^{2}a in apartments and to ca. 60 kWh/m^{2}a in small house, in order to comply with the overall limit. Furthermore, the NS 3031 requires that energy calculations are performed in reference to the Oslo climate.

Norwegian calculation method to comply with new building regulations for residential buildings

The EPC calculation method is based on the NS 3031, and it expresses two indicators: one energy performance indicator and one heating system indicator. The energy performance indicator is calculated in terms of delivered energy and expressed as a label with character from A (best) to G (worst), according to the EPBD. The heating system indicator is calculated as the share of heating needs (incl. hot water) covered by energy carriers other than electricity and fossils, and is expressed as a colour from green (best) to red (worst).

The EPC labelling is therefore shown in a two-dimensional grid as shown below. Since first established in 2010, the reference performance values have been trimmed and those shown below refer to the last adjustment, in force since 01/07/2013.

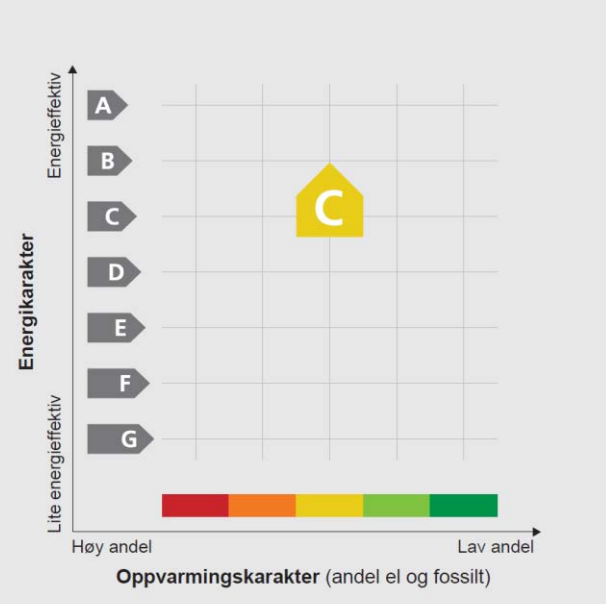


Figure 57: EPC label from Norway

The values for delivered energy that determine the energy class label are shown in the table below. It shall be noticed that the class C is meant to represent a new building built according to the TEK10, while class A is meant to represent a passive house built according to the NS 3700. Class F corresponds to the TEK69 + 7 %, so it represents buildings from that period, never refurbished and whose performance has, on the contrary, deteriorated.

Table 129: Delivered energy determining the energy class label

Building type	**Delivered energy per m^2 heated floor area (kWh/m^{2}a)**						
Energy class label	**A**	**B**	**C**	**D**	**E**	**F**	**G**
	< =	< =	< =	< =	< =	< =	< =
Small house	85+800/A	115+1600/A	145+2500/A	175+4100/A	205+5800/A	250+8000/A	> F
Apartment	75+600/A	95+1000/A	110+1500/A	135+2200/A	160+3000/A	200+4000/A	> F

The values for share of heating needs (hot water included) that determine the heating system performance colour are shown below.

Table 130: Values of heating needs determining the heating system performance colour

30.0 %	47.5 %	65.0 %	82.5 %	100.0 %

Status of NZEB definition for residential buildings in Norway

The two most important aspects of the ZEB definition developed by the ZEB centre are the level of ambition and the carbon (equivalent) emission factors, especially for electricity. It shall be pointed out that the aim of the Norwegian research centre on Zero Emission Buildings (ZEB) is to develop competitive products and solutions of buildings with zero emission of greenhouse gases related to their production, operation and demolition.

Four different levels of ambitions are defined as:

- ZEB-O÷EQ: Emissions related to all energy use in operation (O) except energy use for equipment/appliances (EQ) shall be compensated with on-site renewable energy generation.

- ZEB-O: Emissions related to all operational energy (O) shall be compensated for with on-site renewable energy generation as well as energy use for appliances.
- ZEB-OM: Emissions related to all operational energy (O) use plus embodied emissions from the materials (M) and technical installations shall be compensated for with on-site renewable energy generation.
- ZEB-COM: The same as ZEB-OM, but also taking into account emissions related to the construction (C) process of the building.

The following figure illustrates the four ambition levels for an "all electric" (all delivered and exported energy is electricity) office building used in a concept analysis. The emission on the y-axis has to be balanced (offset) by renewable electricity production (e.g. PV), which is either used for self-consumption (reducing delivered electricity) or exported electricity to the grid.

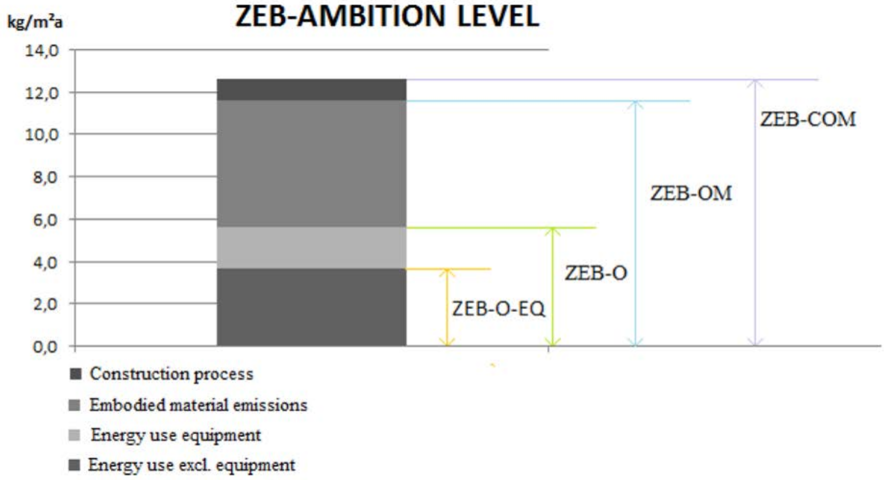


Figure 58: Four ZEB ambition levels for an all-electric office building

When considering (carbon equivalent) embodied emissions in materials one should bear in mind that materials used in buildings are produced in many different ways at many different geographic locations. In Norway, building materials are both locally produced and transported short and long distances. The electricity factor used for the different materials differs with changing production locations. Also, emission factors for electricity are calculated in different ways. Some emission calculations are detailed and based on the methodology of life cycle assessments, others consider only the emissions from the actual combustion processes.

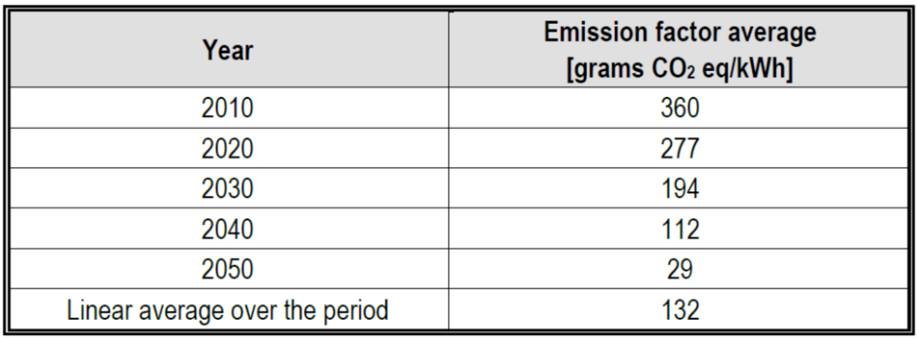
When considering (carbon equivalent) emissions from the use of energy carriers in the operating lifetime of a building, the most challenging factors to define are those for electricity and district heating, since they depend on a mix of sources. In the ZEB centre an extensive discussion has taken place on how electricity from the grid should be considered with regard to CO_{2_eq} emissions. With the renewable hydropower based electricity production system in Norway, one could argue that the CO_{2_eq} factor should be low. However, so far the approach in the ZEB centre is as follows:

- Norway is already a fully integrated part of the Nordic electricity system and over time will be a fully integrated part of the European system. Hence, the emission from electricity use, also in Norway, should be the average emission per kWh produced electricity in Europe.

- Simulations of the European electricity system towards 2050 done by SINTEF Energy [Graabak & Feilberg, 2011] indicate that it is technically and economical possible to reduce CO_{2_eq} emission by 90 % towards 2050.
- Approximately the same conclusion is given in "*A roadmap for moving to a competitive low carbon economy in 2050*", hence 85-95 % reduction towards 2050 is a realistic goal.

If a linear development is assumed, with an assumed lifetime of the building of 60 years (standard value used in the ZEB centre), the average emission factor is 132 grams of CO_{2eq}/kWh. The average factor per decade is provided in the following table.

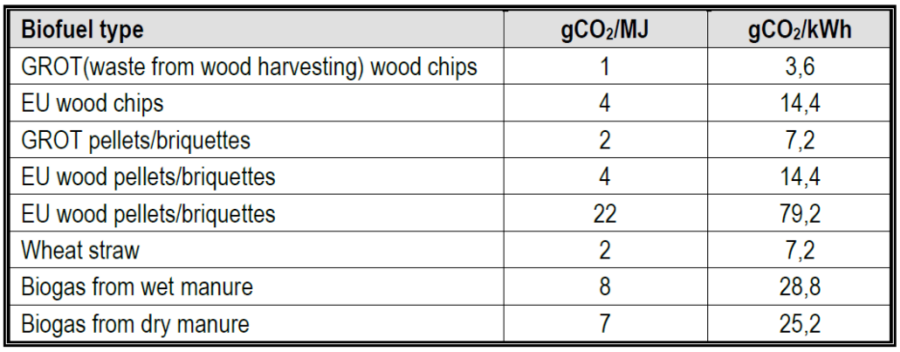
Table 131: Future assumed CO2 emission factors



Year	Emission factor average [grams CO_2 eq/kWh]
2010	360
2020	277
2030	194
2040	112
2050	29
Linear average over the period	132

The report from [Lien, 2013] on CO2 emissions from biofuels and district heating recommends the basic assumption of carbon neutrality for the direct combustion of biofuels, but accounting for the use of fossil fuels in the production chain of the biofuels. This is the current practice within the ZEB Centre. Emission factors for different types of biofuels are listed in the table below.

Table 132: CO2 emission factors for different biofuels



Biofuel type	gCO_2/MJ	gCO_2/kWh
GROT(waste from wood harvesting) wood chips	1	3,6
EU wood chips	4	14,4
GROT pellets/briquettes	2	7,2
EU wood pellets/briquettes	4	14,4
EU wood pellets/briquettes	22	79,2
Wheat straw	2	7,2
Biogas from wet manure	8	28,8
Biogas from dry manure	7	25,2

According to Lien (2013), district heating should not be viewed as emission-free waste heat utilization but should instead be analysed on the basis of the actual GHG emissions associated with its production. The present composition of incinerated waste in Norway is around 50 % fossil based. Specific GHG emissions from waste-incineration-based district heating are comparable to the combustion of natural gas. The specific CO2 emissions from waste incineration are given in Lien (2013) to be 211 grams of CO2 eq/kWh. However, here no consideration is made for the case of CHP (Combined Heat and Power) based district heating system and how to allocate the total emissions from the plant to the electricity and the heat generated. In practice, district heating values should be ideally available from case to case or retrieved from average national values available ion statistics.

Table 133: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the (assumed) NZEB definition in Norway

<table>
<tr><th colspan="2">Calculation Method New Building Regulations – (part 1)</th></tr>
<tr>
<td><table><tr><td>Country</td><td>NO</td><td>Norway</td></tr></table></td>
<td><table><tr><td>Status</td><td>06/2014</td></tr></table></td>
</tr>
<tr><td>National Requirements for New Residential Buildings</td><td>Special Aspects with regard to the (assumed) National NZEB Definition</td></tr>
<tr>
<td>Legislation / Standards
Requirements set in TEK10 (2010). Calculation methodology specified in NS 3031 (2014).
Explanation / Comments</td>
<td>TEK10 (2010) will become first TEK15 (2015) and then TEK20 (2020)</td>
</tr>
<tr>
<td>Energy Services
<table>
<tr><td>x</td><td>Heating</td><td>x</td><td>DHW</td><td>x</td><td>Appliances</td><td></td></tr>
<tr><td></td><td>Cooling</td><td>x</td><td>Auxiliary</td><td></td><td>Other:</td><td></td></tr>
<tr><td>x</td><td>Ventilation</td><td>x</td><td>Lighting</td><td></td><td></td><td></td></tr>
</table>
Explanation / Comments
Cooling is not considered in residential buildings.</td>
<td>Currently the ZEB centre defines several levels of ambition, going from balancing on the operational energy without consideration of Appliances, to the compensation of the full operational energy, to the consideration of embodied energy/emissions in the materials.</td>
</tr>
<tr>
<td><table>
<tr><th colspan="2">Calculation Procedure</th><th>Calculation period</th></tr>
<tr><td>x</td><td>Calculation of energy need for heating (building)</td><td>Hourly simplified dynamic calculations (software) is praxis</td></tr>
<tr><td>x</td><td>Calculation of delivered energy (system)</td><td>Idem</td></tr>
</table>
Explanation / Comments
Based on NS 3031 (2014)</td>
<td>Assessment of energy carriers will be introduced based on either primary energy or carbon emission equivalent conversion factors, or both. Such factors are not yet defined as national standard.</td>
</tr>
<tr>
<td>Consideration of Special Technologies
Thermal Systems
<table>
<tr><td>x</td><td colspan="5">Ventilation system with heat recovery</td></tr>
<tr><td>x</td><td colspan="5">Thermal solar system</td></tr>
<tr><td></td><td>Other special systems:</td><td colspan="4"></td></tr>
<tr><td colspan="2">On-Site Electricity Production</td><td>Feed-in</td><td>Self-use[1]</td><td>Balance period to determine self-use[1]</td><td>Self-use considered for H-C-W-HE[1]</td></tr>
<tr><td></td><td>On-site CHP</td><td></td><td></td><td></td><td></td></tr>
<tr><td>x</td><td>On-site PV</td><td></td><td>x</td><td>year</td><td>HE</td></tr>
<tr><td></td><td colspan="5">Other energy generation systems:</td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>
[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity
Explanation / Comments
Based on NS 3031 (2014)</td>
<td>In the NS 3031 PV is the sole form of electricity generation considered, and it is only possible to cover electric specific demand (auxiliary, ventilation, lighting and appliances). This will have to be changed in TEK20.</td>
</tr>
</table>

Table 133 (continuation)

<table>
<tr><th colspan="7">Calculation Method New Building Regulations – (part 2)</th></tr>
<tr><td>Country</td><td>NO</td><td colspan="3">Norway</td><td>Status</td><td>06/2014</td></tr>
<tr><td colspan="5">National Requirements for New Residential Buildings</td><td colspan="2">Special Aspects with regard to the (assumed) National NZEB Definition</td></tr>
<tr><td colspan="5">Type of Requirements (new buildings)</td><td colspan="2" rowspan="5">All options ticked are encompassed in the NS 3031, but no national values have been prepared. Reference is made to EN 15603.
The NS 3700 does not include a requirement for delivered energy or for primary energy or carbon emissions. Such requirements though are likely to be introduced in TEK20, and already in TEK15 for delivered energy only.</td></tr>
<tr><td>x</td><td>U-values of building elements</td><td rowspan="2"></td><td rowspan="2">Primary energy</td><td rowspan="2"></td></tr>
<tr><td></td><td>Heat transfer coefficient by transmission</td></tr>
<tr><td>x*</td><td>Energy need for heating</td><td></td><td colspan="2">Carbon dioxide emissions</td></tr>
<tr><td></td><td>Delivered energy</td><td>x</td><td>Other</td><td>Total electricity and fossil fuels delivered**</td></tr>
<tr><td colspan="5">Explanation / Comments
According to NS 3700 passive house standard for residential buildings
* compliance with an overall energy performance indicator/total energy need, as described above
* *There is a requirement that buildings shall have a heating system where at least 60 % of the heating need (40 % in buildings smaller than 500 m2) can be satisfied by energy carriers other than fossil fuels or direct use of electricity.</td><td colspan="2">Furthermore, other requirements apply to specific components, such as:
• U-value of windows and doors: <= 0.8 W/m^{2}K
• Normalized (over floor area) thermal bridge effect: <= 0.03 W/m^{2}K
• Air tightness n_{50} <= 0.6 ach
• Ventilation heat recovery efficiency: >= 80 %
• Specific Fan Power (SFP): <= 1.5 kW/(m^3/s)</td></tr>
</table>

Assessment of energy carriers in Norway

The norm NS 3031 describes how to make use of conversion factors to convert delivered energy quantities, per each energy carrier, into equivalent amounts of primary energy and carbon emissions. However, the norm does not provide reference national values for such conversion factors; but refer to the European norm EN 15603. In general, national standardized conversion factors do not exist yet, though the ZEB centre has adopted its own, as explained before.

Nevertheless, in practice the conversion factors are not used for the time being, since the EPC classification is based on delivered energy, as seen above.

Table 134: Primary energy factors Norway

Label / type of factor	Total Primary Energy Factor Norway	Non-Renewable Primary Energy Factor Norway
Used for EPC rating		
Used for building regulations requirements		
Label (national language)	Total primærenergi factor Norge	Ikkefornybar primærenergi factor Norge
Description / type of weighting factor	non-renewable + renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary
Factor is multiplied by delivered energy based on the	net calorific value	net calorific value
Reference	[Ecoinvent 2014]	[Ecoinvent 2014]
Heating oil	1.35	1.35
Firewood	1.09	0.09
Electricity	1.28	0.27
District heating	1.5	0.5

Methodological points for discussion in Norway

As discussed above the methodological points that have most relevance in the ZEB definition from the ZEB centre are the ambition level and the conversion factors for electricity, district heating, and the embodied emissions in materials.

One problem is that as the norm is per today allows subtracting PV generation only from the household electricity (lighting and appliances); while the TABULA methodology only looks at heating, ventilation and hot water. Therefore the effect of PV is invisible, if we apply the norm as it is; see example in Table 137.

Furthermore, ongoing discussion and research focus on the characterization of the temporal match between load and onsite generation, as well as the interaction with the grids. For the time being though no specific indicator is implemented. For these aspects see [Salom, Widen, Candanedo, Sartori, Voss, & Marszal, 2011], developed in the context of the joint IEA Solar Heating and Cooling (SHC) Task 40 and Energy in Buildings and Communities (EBC) Annex 52 "Net Zero Energy Solar Buildings"

3.15.2 Integration of National Requirements for New Buildings and NZEB Standards in the National Residential Building Typology

No formal residential building typology classification exists in Norway. The national residential buildings statistics is under the responsibility of Statistics Norway (SSB), and has been subject to major revisions during the recent year. SSB is about to launch their updated building statistics during 2014, and thereafter it will be possible to link the statistics with the building typology for Norway that is under development in EPISCOPE. This classification scheme is shown below, using 7 construction year classes for SFH, TH and AB, after having grouped different SSB building type subclasses to the SFH, TH and AB classes.

Classification scheme for the Norwegian residential building stock (“Building Type Matrix”)

The figure below shows the residential building stock classification scheme for Norway, based on the use of SFH, TH and AB building types and 7 construction year classes.

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	National (not region specific)	… 1955	generic	 NO.N.SFH.01.Gen	 NO.N.TH.01.Gen		 NO.N.AB.01.Gen
2	National (not region specific)	1956 … 1970	generic	 NO.N.SFH.02.Gen	 NO.N.TH.02.Gen		 NO.N.AB.02.Gen
3	National (not region specific)	1971 … 1980	generic	 NO.N.SFH.03.Gen	 NO.N.TH.03.Gen		 NO.N.AB.03.Gen
4	National (not region specific)	1981 … 1990	generic	 NO.N.SFH.04.Gen	 NO.N.TH.04.Gen		 NO.N.AB.04.Gen
5	National (not region specific)	1991 … 2000	generic	 NO.N.SFH.05.Gen	 NO.N.TH.05.Gen		 NO.N.AB.05.Gen
6	National (not region specific)	2001 … 2010	generic	 NO.N.SFH.06.Gen	 NO.N.TH.06.Gen		 NO.N.AB.06.Gen
7	National (not region specific)	2011 …	generic	 NO.N.SFH.07.Gen	 NO.N.TH.07.Gen		 NO.N.AB.07.Gen

Figure 59: Classification scheme ("Building Type Matrix") of the Norwegian residential building typology [Brattebø, O'Born, Sartori, Klinksi, & Nørstebø, 2014]

Table 135: Exemplary new buildings representing the latest construction year classes (2011 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
		 NO.N.SFH.07.Gen	 NO.N.TH.07.Gen	-	 NO.N.AB.07.Gen
Number of dwellings		1	2		24
Number of full storeys (conditioned)		2	2		4
Number of directly attached neighbour buildings		0	0		0
National reference area (conditioned floor area, internal dimensions, referring to BRA (bruksareal))	m²	184	198		1608
TABULA reference area (conditioned floor area, internal dimensions)	m²	184	198		1608

Building example: variants meeting three energy performance levels for new buildings

The following exemplary apartment block is shown in more detail. Information on other exemplary houses in Norway can be found in the national typology brochure for Norway [Brattebø, O'Born, Sartori, Klinksi, & Nørstebø, 2014]. Table 136 shows the energy performance levels by housing element for specific requirements for construction and improvement. There three energy performance requirements included in the TABULA model are as follows:

1. **"Minimum Requirements"** (Byggteknisk forskrift 2010/TEK10)

   A building and energy supply system that complies with the latest enacted requirements for new-built Norwegian housing (TEK10).

2. **"Improved Standard"** (Passivhus/NS3700)

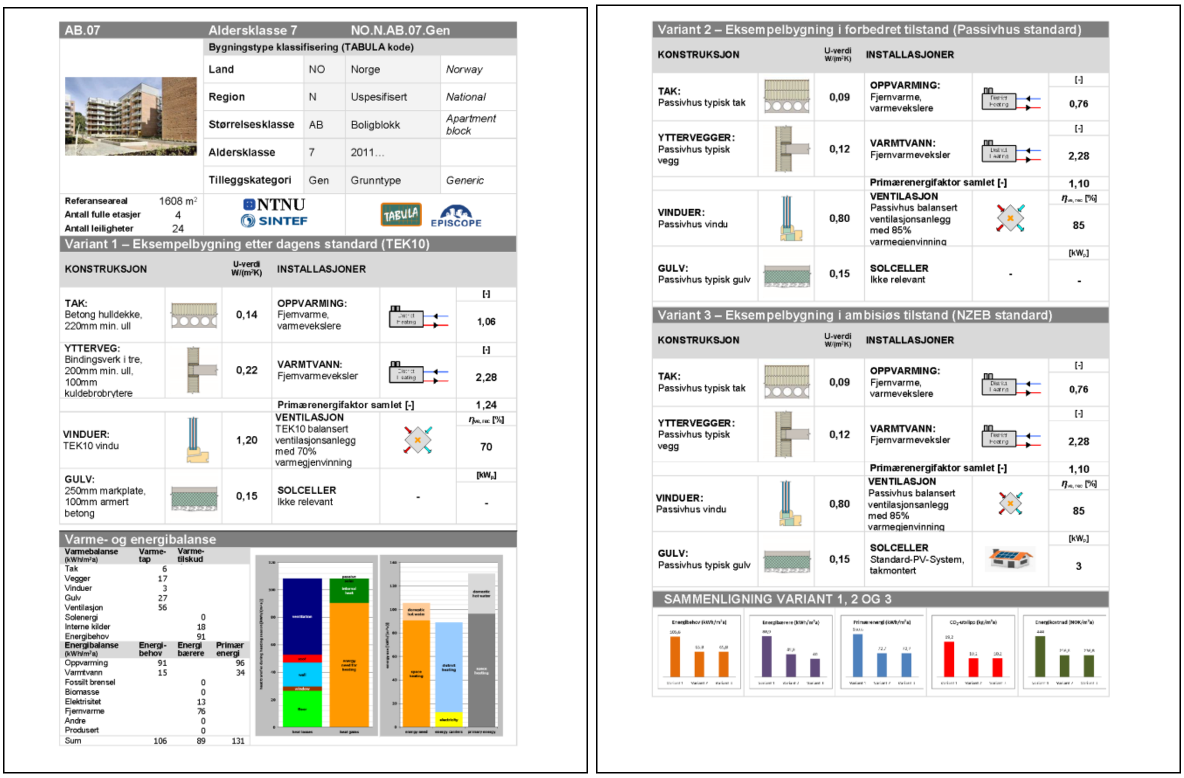
   A building and energy supply system that complies with Norwegian passive house standards (NS3700)

3. **"Ambitious Standard/NZEB"** (Passivhus + solceller)

   A building and energy supply system that meets passive house standards with additional on-site solar energy production (NS3700).

Table 136: Exemplary apartment block (AB) – definition of variants for Norwegian exemplary multi-family house

 NO.N.AB.07.Gen		NO.N.AB.07.Gen		
Variant N°		001	002	003
Energy Performance Level		Minimum Requirement / TEK10	Improved Standard / Passive house	Ambitious Standard / NZEB
SU-values				
Roof	W/(m²K)	0.14	0.09	0.09
Wall	W/(m²K)	0.22	0.12	0.12
Window	W/(m²K)	1.20	0.80	0.80
Door	W/(m²K)	-	-	-
Floor	W/(m²K)	0.15	0.08	0.08
Thermal bridging supplement (whole envelope)	W/(m²K)	0.03	0.03	0.03
Heat Supply System				
Heat generator		District heating		
Specification / Supplemental system		-	-	-
Ventilation system		TEK10 ventilation system with 70% heat recovery	Passive House ventilation system with 85% heat recovery	Passive House ventilation system with 85% heat recovery
Thermal solar system		-	-	-
Further system		-	-	Standard PV system, roof mounted



AB.07 Aldersklasse 7 NO.N.AB.07.Gen

Bygningstype klassifisering (TABULA kode)

Land	NO	Norge	*Norway*
Region	N	Uspesifisert	*National*
Størrelsesklasse	AB	Boligblokk	*Apartment block*
Aldersklasse	7	2011…	
Tilleggskategori	Gen	Grunntype	*Generic*

Referanseareal	1608 m²
Antall fulle etasjer	4
Antall leiligheter	24

Variant 1 – Eksempelbygning etter dagens standard (TEK10)

KONSTRUKSJON	U-verdi W/(m²K)	INSTALLASJONER	
TAK: Betong hulldekke, 220mm min. ull	0,14	**OPPVARMING:** Fjernvarme, varmevekslere	[-] 1,06
YTTERVEG: Bindingsverk i tre, 200mm min. ull, 100mm kuldebrobrytere	0,22	**VARMTVANN:** Fjernvarmeveksler	[-] 2,28
		Primærenergifaktor samlet [-]	1,24
VINDUER: TEK10 vindu	1,20	**VENTILASJON** TEK10 balansert ventilasjonsanlegg med 70% varmegjenvinning	$\eta_{ve,rec}$ [%] 70
GULV: 250mm markplate, 100mm armert betong	0,15	**SOLCELLER** Ikke relevant	[kW$_p$] -

Varme- og energibalanse

Varmebalanse (kWh/m²a)	Varme-tap	Varme-tilskud	
Tak	6		
Vegger	17		
Vinduer	3		
Gulv	27		
Ventilasjon	56		
Solenergi		0	
Interne kilder		18	
Energibehov		91	
Energibalanse (kWh/m²a)	**Energi-behov**	**Energi bærere**	**Primær energi**
Oppvarming	91		96
Varmtvann	15		34
Fossilt brensel		0	
Biomasse		0	
Elektrisitet		13	
Fjernvarme		76	
Andre		0	
Produsert		0	
Sum	106	89	131

Variant 2 – Eksempelbygning i forbedret tilstand (Passivhus standard)

KONSTRUKSJON	U-verdi W/(m²K)	INSTALLASJONER	
TAK: Passivhus typisk tak	0,09	**OPPVARMING:** Fjernvarme, varmevekslere	[-] 0,76
YTTERVEGGER: Passivhus typisk vegg	0,12	**VARMTVANN:** Fjernvarmeveksler	[-] 2,28
		Primærenergifaktor samlet [-]	1,10
VINDUER: Passivhus vindu	0,80	**VENTILASJON** Passivhus balansert ventilasjonsanlegg med 85% varmegjenvinning	$\eta_{ve,rec}$ [%] 85
GULV: Passivhus typisk gulv	0,15	**SOLCELLER** Ikke relevant	[kW$_p$] -

Variant 3 – Eksempelbygning i ambisiøs tilstand (NZEB standard)

KONSTRUKSJON	U-verdi W/(m²K)	INSTALLASJONER	
TAK: Passivhus typisk tak	0,09	**OPPVARMING:** Fjernvarme, varmevekslere	[-] 0,76
YTTERVEGGER: Passivhus typisk vegg	0,12	**VARMTVANN:** Fjernvarmeveksler	[-] 2,28
		Primærenergifaktor samlet [-]	1,10
VINDUER: Passivhus vindu	0,80	**VENTILASJON** Passivhus balansert ventilasjonsanlegg med 85% varmegjenvinning	$\eta_{ve,rec}$ [%] 85
GULV: Passivhus typisk gulv	0,15	**SOLCELLER** Standard-PV-System, takmontert	[kW$_p$] 3

SAMMENLIGNING VARIANT 1, 2 OG 3

Figure 60: "Building Display Sheet" of the exemplary NO.N.AB.07 from Norwegian residential building typology [Brattebø, O'Born, Sartori, Klinksi, & Nørstebø, 2014]

Table 137 shows the results of the national energy balance for the exemplary apartment building. The delivered and primary energy results do not include the PV system.

Table 137: Exemplary AB – Results of the energy balance calculation for “NO.N.AB.07.Gen”; Procedure: NS3031:2007

Variant N°		**001**	**002**	**003**
Label of the variant triplet		”District heating”		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		TEK10	Passive House	NZEB
Calculation method		NS3031:2007+A1:2011		
National reference area*	m²	1608	1608	1608
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.48	0.23	0.23
Energy need for heating	kWh/(m²a)	91	51	51
Delivered energy				
Fossil fuels	kWh/(m²a)	0	0	0
Renewable fuels	kWh/(m²a)	0	0	0
Electricity	kWh/(m²a)	112	9	9
District heating	kWh/(m²a)	76	40	40
Auxiliary energy	kWh/(m²a)	-	-	-
Primary energy demand	kWh/(m²a)	131	73	73

*) Referring to BRA (Bruksareal)

TABULA calculation results for all exemplary buildings

Table 138 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 138: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  NO.N.SFH.07.Gen ReEx.001	01	Minimum Requirement	1.07	97.6	34.3	63.2	58.0	10.0	19.2	0.0	0.0	0.0	7.5	71.8	0.0	0.0	0.0
	02	Improved Standard	0.71	62.0	31.7	30.3	25.3	10.0	19.2	0.0	0.0	0.0	3.3	33.0	0.0	0.0	0.0
	03	Ambitious Standard / NZEB	0.71	62.0	31.7	30.2	27.8	10.0	19.2	0.0	0.0	0.0	3.6	15.6	0.0	0.0	-19.7
TH  NO.N.TH.07.Gen ReEx.001	01	Minimum Requirement	1.10	99.6	34.2	65.4	60.2	10.0	19.2	0.0	0.0	0.0	7.8	73.7	0.0	0.0	0.0
	02	Improved Standard	0.72	63.2	31.7	31.5	26.4	10.0	19.2	0.0	0.0	0.0	3.4	33.6	0.0	0.0	0.0
	03	Ambitious Standard / NZEB	0.72	63.2	31.7	31.5	28.9	10.0	19.2	0.0	0.0	0.0	3.8	16.0	0.0	0.0	-19.7
AB  NO.N.AB.07.Gen ReEx.001	01	Minimum Requirement	0.99	90.6	34.9	55.7	52.5	15.0	22.4	0.0	0.0	0.0	0.0	0.0	76.4	0.0	0.0
	02	Improved Standard	0.61	50.8	30.6	20.2	17.2	15.0	22.4	0.0	0.0	0.0	0.0	0.0	40.4	0.0	0.0
	03	Ambitious Standard / NZEB	0.61	50.8	42.7	8.1	17.2	15.0	22.4	0.0	0.0	0.0	0.0	0.0	40.4	0.0	-9.9

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, …_el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.15.3 Sources / References Norway

Table 139: Sources / References Norway

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Brattebø, O'Born, Sartori, Klinksi, & Nørstebø, 2014]	Brattebø, H., O'Born, R., Sartori, I., Klinksi, M., & Nørstebø, B. (2014). Typologier for norske boligbygg. Trondheim: EPISCOPE.	Tabula typology brochures for Norway
[Buildings Performance Institute Europe, 2011]	Buildings Performance Institute Europe. (2011). Principles for nearly zero-energy buildings. Brussels: Buildings Performance Institute Europe.	Nearly Zero Energy Building guidelines for Europe
[Enova, 2012]	Enova. (2012). Potential and barriers study: Energy efficiency improvement in Norwegian buildings (in Norwegian). Oslo: Enova.	Potentials and barrier study of Norwegian housing
[Graabak & Feilberg, 2011]	Graabak, I., & Feilberg, N. (2011). CO2 emissions in a different scenarios of electricity generation in Europe. Trondheim: SINTEF Energy Research.	Report on CO2 from future European energy scenarios
[Kommunal- og moderniseringsdepartementet, 2010]	Kommunal- og moderniseringsdepartementet. (2010). Forskrift om tekniske krav til byggverk (Byggteknisk forskrift). Oslo: Norwegian Government and Modernisation Department. Retrieved from http://lovdata.no/dokument/SF/forskrift/2010-03-26-489	TEK10 Standard for new buildings
[Kommunal- og regionaldepartementet, 2012]	Kommunal- og regionaldepartementet. (2012). Gode bygg for eit betre samfunn. Oslo: Norwegian Parliament. Retrieved from http://www.regjeringen.no/nn/dep/kmd/Dokument/proposisjonar-og-meldingar/stortingsmeldingar/2011-2012/meld-st-28-20112012.html?id=685179	Laws and recommendations regarding future building politics in Norway
[Lien, 2013]	Lien, K. (2013). CO2 emissions from Biofuels and District Heating. Oslo: SINTEF Academic Press.	Report of CO2 from biofuels and district heating in Norway
[Salom, Widen, Candanedo, Sartori, Voss, & Marszal, 2011]	Salom, J., Widen, J., Candanedo, J., Sartori, I., Voss, K., & Marszal, A. (2011). Understanding Net Zero Energy Buildings: Evaluation of load matching and grid interaction indicators. Proceedings of Building Simulation 2011 (pp. 2514-2521). Sydney: 12th Conference of International Building Performance Simulation Association.	Assessment of NZEB building indicators known as LMGI – Load
[Sartori, Napolitano, & Voss, 2012]	Sartori, I., Napolitano, A. and Voss K., (2012). Net zero energy buildings: A consistent definition frame-work. Energy and Buildings, Vol 48, pp 220-232.	A definition framework on nZEB
[Standard Norge, 2007]	Standard Norge. (2007). Calculation of energy performance of buildings - Method and data. Oslo: Standard Norge.	Calculation methods standard for energy use in buildings
[Standard Norge, 2013]	Standard Norge. (2013). Criteria for passive houses and low energy buildings - Residential buildings. Oslo: Standard Norge.	Passive house standard for Norway

3.16 <RS> Serbia

(by associated EPISCOPE partner University of Belgrade)

Several professional and scientific researches have been conducted over the years addressing the built heritage in Serbia but they were more design or social based investigations focused on housing development, achieved standards, design phenomena and architectural qualities.

First attempt to formulate the methodology of structuring the building fund was in 2003, when, at the Faculty of Architecture University of Belgrade, through the national scientific project “Energy optimization of buildings in the context of sustainable architecture”, [Jovanović Popović 2003] basic principles and key points for investigation were defined. Developed methodology has been tested on the multifamily housing stock of the city of Belgrade. In this research characteristic periods and typical building types were defined with identification of representative buildings but no calculations of energy performance were done.

Research “Energy characteristics of residential building envelopes in Belgrade” [Ignjatović 2012] continued on the same track and broadened the methodology by including the assessment of energy performance both by calculating and on site investigation, including infrared inspection.

By joining the IEE TABULA project work on the typology assessment has continued and resulted in formulation of national residential building typology that has been developed in 2013 [Jovanović Popović 2013]. Typology has been formulated on two tracks: following the common TABULA recommendations and calculation procedures but at the same time respecting the local characteristics and national regulations for calculation of energy performance certificates (EPC).

Nearly zero-energy buildings (NZEB) have not been defined yet in Serbian legislation, nor has the influence of such regulation been anticipated or analyzed.

3.16.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Serbia

Development of legal requirements for the thermal insulation in Serbia has started more than 40 years ago by introduction of first regulations in 1967. In years to follow laws were regularly updated expanding the methodology for calculation. The requirements were followed by the appropriate national standards and calculation procedures [Jovanović Popović 2011].

Table 140: Comparative review of the development of the calculation requirements for buildings

Implementation field		**Regulation Adoption Year**					
		1967	1970	1980	1987	1990	1997/ 98
Thermal insulation (k_{max})		■	■	■	■	■	■
Vapour diffusion				■	■	■	■
Summer regime	Damping factor of the temperature oscillation amplitude			■	■	■	■
	Temperature oscillation delays				■		■
Specific heat losses	Building				■	■	■
	Specific facilities						■

Serbia has started the process of harmonization with EU regulations which have resulted in passing of the Law on Planning and Building in 2009. During the process of defining the regulations, it was estimated that the requirements set in EPBD recast are too demanding and taking into account the situation in Serbia, post war period and economy crisis, the new regulations were based on EPBD Directive from 2002. New Law has presented the need for improving the energy efficiency of building stock and for the first time the term energy performance of building was defined with the obligation of producing the EPC for buildings. For this reason two sub law rulebooks were produced: Rulebook on energy efficiency in buildings (explaining the general procedures and principles for calculation with the list of applicable standards) [Rulebook 2011] and Rulebook on conditions, content and method of issuing energy performance certificates (defining the types of EPCs and procedures for issuance) [Rulebook 2012]. These regulations were adopted starting from 2011 (obligatory from 2012) and are currently under the process of revision and improvement.

In 2013 also the Law on rational use of energy has been passed but without sub-law documents so, for now, it has no direct influence on energy performance of buildings.

NZEB standards are now being considered as the new, logical, step forward in fostering the principles of energy efficiency of buildings and harmonization of legislation with EU. The planned timetable anticipates that by Jan. 2015 national NZEB principles are to be defined (methodology, levels of consumption, economical aspects, implementation principles) and by the Jan. 2016 new sub-law regulations to be produced enabling the implementation.

Minimum requirements for new residential buildings in Serbia

Since the adoption in 2011 all new buildings and those that are in the process of major reconstruction are to be constructed according to the new regulations. The procedure has introduced the “energy efficiency elaborate” as the part of the general design documentation and issuance of EPC as the part of the technical approval. This has made calculation of performance: energy needed for heating as obligatory and energy needed for preparation of hot water, cooling, electrical system and ventilation to be obligatory once the national software for the calculation is adopted. Although calculation of building physics was obligatory according to the previous regulations no calculation of overall consumption has been done. At the same time more stringent values for the performance of elements of thermal envelope have been set. On the other hand calculation of influences of linear and punctual thermal loses which were to be individually calculated and are now simplified and estimated at the rate of 10 % of increase of thermal envelope.

Also influence of local climate has been taken into consideration in much more precise way through introduction of local design temperatures and HDD (heating degree days) values instead of three mayor climatic zones.

Buildings are to meet the designed $Q_{H,nd}$ (energy needed for heating) according to the building type. For the residential buildings values are set: individual housing new 65 kWh/m^{2}a and old 75 kWh/m^{2}a and for multifamily new 60kWh/m^{2}a and old 70 kWh/m^{2}a.

Allowed U values (W/m^{2}K) for some building elements are shown in the table with comparison to the previous standards for the second climatic zone – moderate continental climate:

Table 141: Allowed U values (W/m2K) for some building elements with comparison to the previous standards (second climatic zone – moderate continental climate)

Construction element	U value (W/m2K)		
	Old regulation Jus.U.J5.600 (1998)	New regulation	
		New construction	Existing buildings
External wall	0.90	0.30	0.40
Wall to unheated	0.80	0.40	0.55
Roof	0.45	0.15	0.20
Flat roof	0.45	0.15	0.20
Ground floor	0.90	0.30	0.40
Windows	3.10	1.50	1.50
Doors	3.10	1.50	1.50

Serbian calculation method to comply with new building regulations for residential buildings

Serbian EPC have been issued since the October 2012 based on the calculation principles stated in the EN 13790/2008 and described in the Rulebook on energy efficiency in buildings [Rulebook 2011] and Rulebook on conditions, content and method of issuing energy performance certificates [Rulebook 2012]. Calculation is done for the energy demand for heating and ranking (labelling) is stated according to the ratio comparing to the prescribed value set in the regulations. At the same time all elements of thermal envelope must meet the maximal set values for the U values. National database of EPCs is in the process of establishment and will be governed by the Ministry for construction, transport and infrastructure.

Although rulebook states that other types of used energy are to be calculated in total balance (hot water preparation, electricity, cooling, ventilation) their values are not, for now, influencing the energy grade and calculation is not obligatory before national software is introduced. Date for introducing the national software has not been set and procedure for establishment is unclear.

EPC form also includes data on CO_2 emission and primary energy values (conversion factors are given in the rulebook).

Status of NZEB definition for residential buildings in Serbia

In Serbia there is no national definition of nearly zero energy buildings (NZEBs). Following the current trends of harmonization of national legislative with EU standards EPBD recast directive is considered as the mandatory although levels and impacts were not disused yet. Several research and professional works have tackled the topic trying to define the desirable goals [Jovanović Popović 2014]. Following Serbia’s path towards EU by the planned 2020 it actually means that local regulations need to be at the European level and harmonized with present and future directives. If we are to discuss such scenario we can assume that reduction of consumption has to take place every year by the rate of 25 % in order to reach defined levels.

Table 142: Possible initiative towards “nearly zero energy buildings” for Serbia for new buildings (residential buildings)

2011-2012	2015-16	2017	2018	2019	2020
Regulations on EE of buildings Regulations on EPC	25 % reduction compared to 2011 48 kWh/m2a	25 % reduction compared to 2015 36 kWh/m2a	25 % reduction compared to 2017 27 kWh/m2a	25 % reduction compared to 2018 20 kWh/m2a	25 % reduction compared to 2019 15 kWh/m2a

From the presented table it is obvious that planned improvements are almost unreachable therefore more adequate national strategy needs to be defined. For this reason, it is planned that by the end of 2014, official working group from respected ministries, scientific and professional bodies will be formed and that it will formulate the starting points and methodological frame for national NZEB definition.

Variations of improvement of thermal envelopes and mechanical installations done for the EPISCOPE project can serve as the starting point that will give sufficient data on real potential levels that are achievable and as such can serve as the references for future activities.

Table 143: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the assumed NZEB definition in Serbia

Calculation Method New Building Regulations – (part 1)

Country	SR	Serbia	Status	08/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the assumed National NZEB Definition

Legislation / Standards

Rulebook on energy efficiency in buildings (2011)

Rulebook on conditions, content and method of issuing energy performance certificates (2012)

Explanation / Comments

Since 2012, new buildings in Serbia are constructed in accordance to the regulation on the energy efficiency in buildings [Rulebook 2011], [Rulebook 2012] in compliance with EPBD. All new buildings should achieve a mandatory rating of at least C category of EPC, and refurbished buildings should improve their current EPC level for at least one level [Rulebook 2012].

Energy Services

x	Heating	x	DHW		Appliances	
	Cooling		Auxiliary		Other:	
	Ventilation		Lighting			

Explanation / Comments

Domestic hot water is calculated but does not influence the rating level of EPC

Calculation Procedure

		Calculation period
x	Calculation of energy need for heating (building)	Year / Month
x	Calculation of delivered energy (system)	Year

Explanation / Comments

Consideration of Special Technologies

Thermal Systems

	Ventilation system with heat recovery	
	Thermal solar system	
	Other special systems:	

On-Site Electricity Production		Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
	On-site CHP				
	On-site PV				
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Additional systems are not influencing the energy grade of analyzed building

Type of Requirements (new buildings)

x	U-values of building elements		Primary energy	
x	Heat transfer coefficient by transmission			
x	Energy need for heating		Carbon dioxide emissions	
	Delivered energy		Other	

Explanation / Comments

Values for the primary energy demand and carbon dioxide emissions are calculated and illustrated in EPC but are not affecting energy grade of the building

Assessment of energy carriers in Serbia

Structure of energy carriers in Serbia is rather diverse with trend of periodical changes of carriers according to the market situation. Historically it can be said that wood fuels have always been in high percentage of use for heating. There is a tendency of reduction of use of oil and derivates for heating and change towards use of natural gas and lately electricity.

If not stated otherwise the figures and data in the following section derive from [SB 658 2013].

Electricity

Total electricity consumption in Serbia was 27 167 GWh, of which 14 517 GWh was used in households. The majority of electricity was produced in thermal power plants (26 885 GWh) and the rest using hydro energy (9914 GWh).

Coal

In households in Serbia, use of sub-bituminuos coal, brown coal and lignite was 486 157 t (total use: 1 265 775 t), and briquettes of brown coal and dry lignite 209 132 t (total use: 399 450 t).

Wood fuels

Firewood is still widespread energy source in households in Serbia (459 608 t of 641 588 t total used in Serbia). Total use of wood briquettes was 25 260 t, and wood pellets 28 365 t.

Oil and oil derivates

Total use of liquid petroleum gas was 361 173 t (for households 262 007 t), unleaded gasoline 415 551 t, diesel 261 078 t, heating oil 261 078 t and fuel oil 216 770 t.

Natural gas

Total use of natural gas was 1 153 920 000 Stm^3 (for households 244 243 000 Stm^3).

Renewable energy sources

Production of energy from renewable energy sources in Serbia in 2009 was 2.19 Mtoe, and estimated technically feasible unused potential of RES was estimated at 3.83 Mtoe [Bozic et al. 2014].

Energy balance

Based on official statistical data for year 2012, total energy consumption in Serbia was 329.648 TJ (of which for households 102 329 TJ). Breakdown of users is shown in Figure 61.

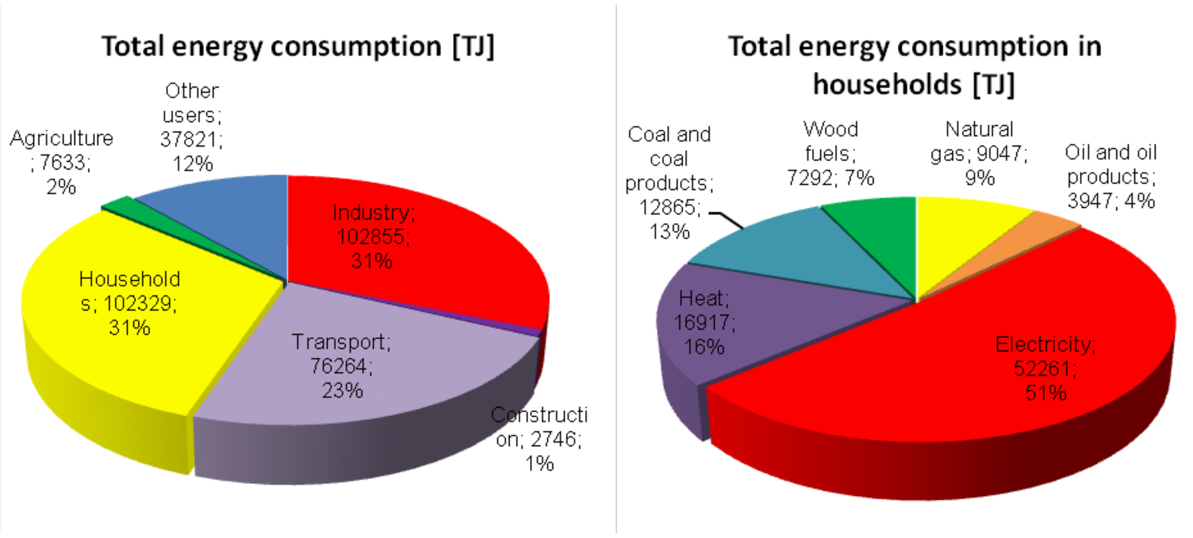


Figure 61: Breakdown of energy carriers for households in Serbia for 2012

Feed-in tariffs for electricity production from renewable energy sources, applied from 1st of January 2014 and valid till 31st of December 2015, are shown in Table 144 [Decree 2013]. The incentive period lasts 12 years. Feed-in tariff depends on the power plant capacity (the smaller incentive capacity, the higher feed-in tariff for each kWh of produced electricity.

Table 144: Feed-in tariff in Serbia (summarized outline)

Item No.	Type of power plant	Installed power P (MW)	Feed-in tariff (c€/kWh)
1.	Hydro power plant	up to 30	12.40 – 5.9
2.	Biomass power plant		13.26 – 8.22
3.	Biogas power plant		15.66 – 12.31
4.	Landfill and sewage gas power plant		6.91
5.	Wind power plants		9.20
6.	Solar power plant	up to 0.5	20.66 – 16.25
7.	Geothermal power plants		9.67 – 6.92
8.	Waste fired power plant		8.57
9.	Coal fired co-generation power plant	up to 10	8.04
10.	Gas fired co-generation power plant	up to 10	8.89

Rulebook on Energy efficiency in buildings defines conversion factors for calculating primary energy demands and carbon-dioxide emission factors [Rulebook 2011]. It should be noted that these values are not mandatory used yet, as the national computer program has not been adopted yet, so only energy demands for space are calculated and compared to the prescribed ones.

In the Initial National Communication of the Republic of Serbia, for assessment of CO_2 emission IPCC (Intergovernmental Panel on Climate Change) Tear 1 methodology was used [In. Nat. Com. 2010]. IPCC methodology is much more comprehensive, detailed and accurate [IPCC 1996].

Table 145: Serbian weighting factors / primary energy and CO2 emission factors

Label / type of factor	Weighting Factor / Primary Energy Factor	CO2 emission factor
Used for EPC rating	*	*
Used for building regulations requirements	*	*
Label (national language)	Faktor preracunavanja primarne energije (prema: Pravilnik o energetskoj efikasnosti zgrada, 2011)	Faktor emisije CO_2 (prema: Pravilnik o energetskoj efikasnosti zgrada, 2011)
Description / type of weighting factor	Not specified	Not specified
Factor is multiplied by delivered energy based on	Not specified but probably net calorific value	Not specified but probably net calorific value
Reference	[Rulebook 2011]	[Rulebook 2011]
Unit	[-]	[g/kWh]
Natural Gas E	1.1	200
Heating Oil	1.2	Fuel oil EL 265 Fuel oil L 280
Firewood	0.1	
Electricity	2.5	530
District heating	1.8	330
District heating with 100 % CHP	1.0	

*) not used for EPC rating, nor for building regulations requirements; only provided as illustrative data, does not affect rating of the building

Methodological points for discussion in Serbia

Definition of NZEB in Serbia has to consider economical as well as technical aspects and different scenarios are to be discussed. Implementation possibilities have to be one of the key starting points when establishing the desired levels of consumption and performance of buildings in order to have achievable goals. Methodology also has to take into account specific position in which current construction process is in, and urgent need for improvement of existing building fund which is, in Serbia, renewed by the rate of less than 1 % yearly.

Structure of energy carriers in Serbia is directly influenced by market conditions, where some of the carriers (electricity) is subsidised making it convenient for inappropriate use or not controlled in sustainable manner (wood) therefore it is very hard to establish viable methodology for future NZEB applications.

As district heating system has been vastly developed in Serbia (55 towns with district heating system with total installed capacity of 7000 MW), business association “Heating Serbia” as well as many DH public utilities have an opinion that feed-in tariff, besides electricity production by RES, should be also applied to heat produced by RES in district heating system. The consequence would be significant reduction of GHG emission.

Building engineers have an opinion that intensive building of ZEB (even NZEB) is practically impossible without state subsidies or other credit lines currently unavailable in Serbia.

3.16.2 Integration of National Requirements for New Buildings and NZEB Standards in the Serbian Residential Building Typology

First building typology on national level was developed within the TABULA project in 2013 with concern towards local characteristics and parallel set of calculation done according to the national regulations. These results are now being integrated in new draft that is currently in the process of preparation for the formulation of Strategy of energy development of Serbia by 2015 with projection by 2030.

Classification scheme for the Serbian residential building stock (“Building Type Matrix”)

Following the definition of National Building Typology during the IEE project TABULA, according to the methodology defined during the project EPISCOPE, the building matrix was extended towards new buildings, reflecting the current legal requirements [Rulebook 2011].

	Region	Construction Year Class	Additional Classification	SFH	TH	MFH	AB
				Single-Family House	Terraced House	Multi-Family House	Apartment Block
1	National	... 1918	generic	 RS.N.SFH.01.Gen	 RS.N.TH.01.Gen	 RS.N.MFH.01.Gen	 RS.N.AB.01.Gen
2	National	1919 ... 1945	generic	 RS.N.SFH.02.Gen	 RS.N.TH.02.Gen	 RS.N.MFH.02.Gen	 RS.N.AB.02.Gen
3	National	1946 ... 1960	generic	 RS.N.SFH.03.Gen	 RS.N.TH.03.Gen	 RS.N.MFH.03.Gen	 RS.N.AB.03.Gen
4	National	1961 ... 1970	generic	 RS.N.SFH.04.Gen	 RS.N.TH.04.Gen	 RS.N.MFH.04.Gen	 RS.N.AB.04.Gen
5	National	1971 ... 1980	generic	 RS.N.SFH.05.Gen	 RS.N.TH.05.Gen	 RS.N.MFH.05.Gen	 RS.N.AB.05.Gen
6	National	1981 ... 1990	generic	 RS.N.SFH.06.Gen	 RS.N.TH.06.Gen	 RS.N.MFH.06.Gen	 RS.N.AB.06.Gen
7	National	1991 ... 2011	generic	 RS.N.SFH.07.Gen	 RS.N.TH.07.Gen	 RS.N.MFH.07.Gen	 RS.N.AB.07.Gen
8	National	2012 ...	generic	 RS.N.SFH.08.Gen		 RS.N.MFH.08.Gen	 RS.N.AB.08.Gen

Figure 62: Classification scheme ("Building Type Matrix") of the Serbian residential building typology, now extended towards new buildings

Table 146: Exemplary new buildings representing the latest construction year classes (2012 …)

Building Size Class		**SFH**	**TH**	**MFH**	**AB**
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
Picture		 RS.N.SFH.08.Gen		 RS.N.MFH.08.Gen	 RS.N.AB.08.Gen
Number of dwellings		2		27	40
Number of full storeys (conditioned)		3		5	8
Number of directly attached neighbour buildings		0		0	2
National reference area*	m²	342		1124	2345
TABULA reference area (conditioned floor area, internal dimensions)	m²	311		1022	2132

*) National reference area is the net conditioned living area enlarged for 10 % to include partition walls, ventilation shafts etc.

Building example: variants meeting three energy performance levels for new buildings

Table 147 shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels

1. **“Minimum Requirements”** (compliant with current minimum EPC level for new buildings based on [Rulebook 2011] and [Rulebook 2012];
2. **“Improved Standard”** (all elements of thermal envelope are improved by adding insulation, windows and doors are improved to the nearly passivhouse standard level);
3. **“Ambitious Standard / NZEB”** (selected elements of thermal envelope are further improved and windows and doors are improved to the passivhouse standard level).

Three basic types of heat supply systems have been defined, while U-values of thermal envelope remain constant for each level of building thermal insulation (Minimum requirements, Improved standard and NZEB):

- **“Biomass “ (Variants 01, 02, 03):**

  Variant 01 heating system is defined as central hydronic system with wood pellet boiler as heat generator, radiator thermostatic valves and variable speed pump. DHW is prepared by heat from pellet fired boiler and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  Variant 02 heating system is defined as central hydronic system with wood pellet boiler as heat generator, radiator thermostatic valves and variable speed pump. DHW is prepared by heat from pellet fired boiler in winter time, solar thermal system in summer time and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  For **Variant 03** heating system is defined as 100 % CHP district heating system (wood chips as fuel), radiator thermostatic valves and variable speed pump. DHW is distributed from district heating system. Supplement electrical heater is installed, too. Ventilation system is balanced, with heat recovery device. PV panels system is defined on the roof.

- **“Natural Gas “ (Variants 11, 12, 13):**

  Variant 11 heating system is defined as central hydronic system with low temperature gas boiler in cellar. DHW is prepared by heat from gas fired boiler and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  Variant 12 heating system is defined as low temperature central hydronic system with condensing gas fired boiler in cellar as heat generator. DHW is prepared by heat from gas fired boiler in winter time, solar thermal system in summer time and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  For **Variant 13** heating system is defined as low temperature central hydronic system with condensing gas fired boiler in cellar and as heat generator. DHW is prepared by heat from gas fired boiler and supplemental electrical heater. Ventilation system is balanced, with heat recovery. PV panels system is defined on the roof.

- **“Electricity“(Variants 21, 22, 23):**

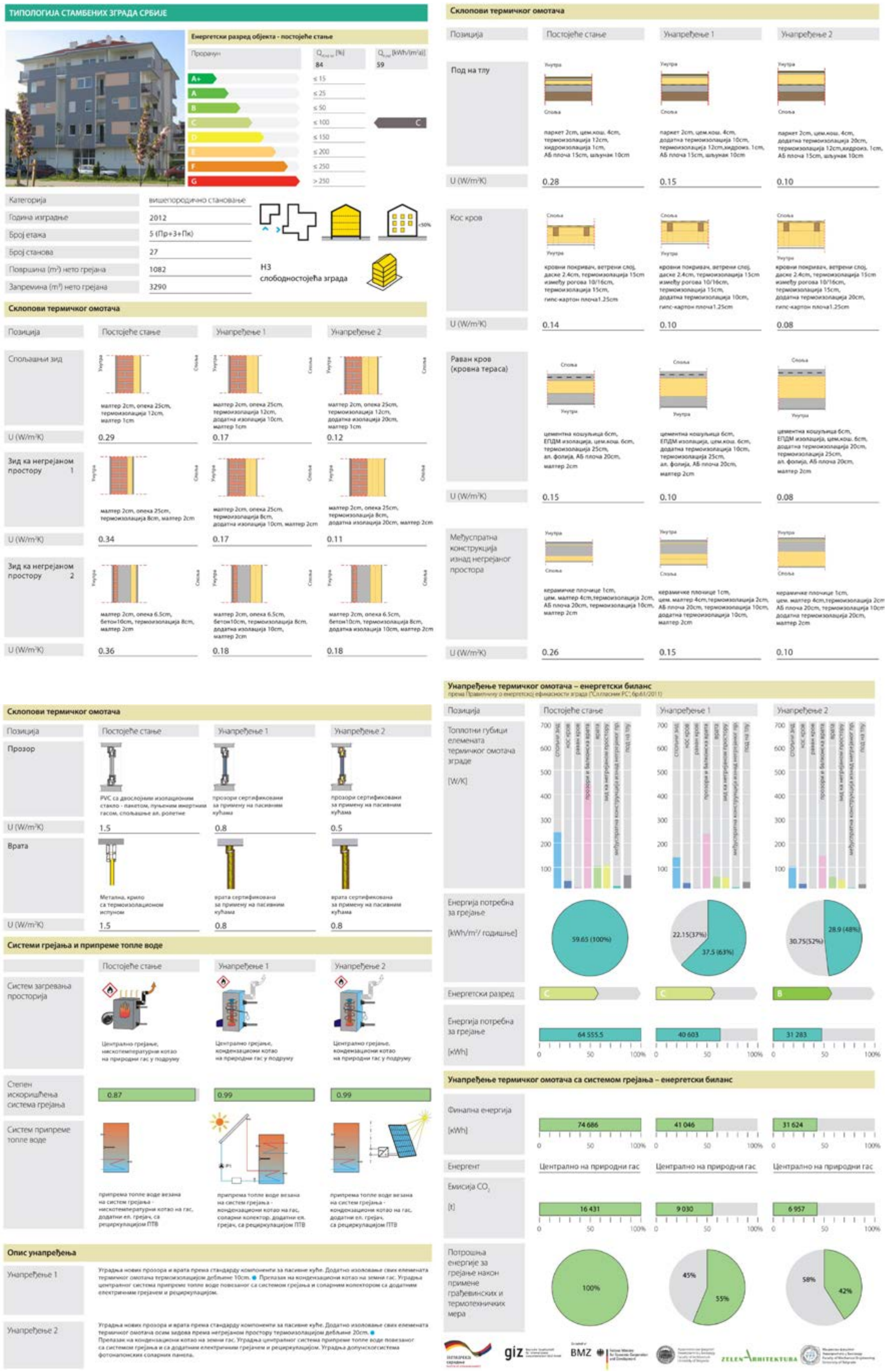
  Variant 21 heating system is defined as air/water heat pump as heat generator. DHW is prepared by heat from heat pump and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  Variant 22 heating system is defined as ground/water heat pump as heat generator. DHW is prepared by heat from heat pump, solar thermal system and supplemental electrical heater. Ventilation system is natural, with exhaust air extraction through ventilation shafts.

  For **Variant 23** heating system is defined as central hydronic system, with ground source heat pump as heat generator. DHW is prepared by heat from heat pump, solar thermal system and supplemental electrical heater. Ventilation system is balanced, with heat recovery. PV panels system is defined on the roof.

Table 147: Exemplary multi-family house (MFH) – definition of variants

 **RS.N.MFH.08.Gen**		**“Biomass”**			**“Natural Gas”**			**“Electricity”**		
Variant N°		001	002	003	011	012	013	021	022	023
Energy Performance Level		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
U-values										
Roof	W/(m^{2}K)	0.14	0.1	0.08	0.14	0.1	0.08	0.14	0.1	0.08
Wall	W/(m^{2}K)	0.29	0.16	0.11	0.29	0.16	0.11	0.29	0.16	0.11
Window	W/(m^{2}K)	1.3	0.8	0.5	1.3	0.8	0.5	1.3	0.8	0.5
Door	W/(m^{2}K)	1.5	0.8	0.8	1.5	0.8	0.8	1.5	0.8	0.8
Floor	W/(m^{2}K)	0.28	0.16	0.11	0.28	0.16	0.11	0.28	0.16	0.11
Thermal bridging supplement (whole envelope)	W/(m^{2}K)	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00
Heat Supply System										
Heat generator		wood pellet boiler		CHP DH (wood chips)	LT boiler	condensing boiler	condensing boiler	electrical heat pump		
Specification / Supplemental system		+electrical heater	+electrical heater	+electrical heater	+electrical heater	+electrical heater	+electrical heater	ext.air +electrical heater	soil +electrical heater	soil +electrical heater
Ventilation system		exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery
Thermal solar system			DHW			DHW			DHW	DHW
Further system				PV			PV			PV



ТИПОЛОГИЈА СТАМБЕНИХ ЗГРАДА СРБИЈЕ

Енергетски разред објекта - постојеће стање

Прорачун	$Q_{H,nd,rel}$ [%]	$Q_{H,nd}$ [kWh/(m²a)]
	84	59
A+	≤ 15	
A	≤ 25	
B	≤ 50	
C	≤ 100	C
D	≤ 150	
E	≤ 200	
F	≤ 250	
G	> 250	

Категорија	вишепородично становање
Година изградње	2012
Број етажа	5 (Пр+3+Пк)
Број станова	27
Површина (m²) нето грејана	1082
Запремина (m³) нето грејана	3290

Н3
слободностојећа зграда

Склопови термичког омотача

Позиција	Постојеће стање	Унапређење 1	Унапређење 2
Спољашњи зид	малтер 2cm, опека 25cm, термоизолација 12cm, малтер 1cm	малтер 2cm, опека 25cm, термоизолација 12cm, додатна изолација 10cm, малтер 1cm	малтер 2cm, опека 25cm, термоизолација 12cm, додатна изолација 20cm, малтер 1cm
U (W/m²K)	0.29	0.17	0.12
Зид ка негрејаном простору 1	малтер 2cm, опека 25cm, термоизолација 8cm, малтер 2cm	малтер 2cm, опека 25cm, термоизолација 8cm, додатна изолација 10cm, малтер 2cm	малтер 2cm, опека 25cm, термоизолација 8cm, додатна изолација 20cm, малтер 2cm
U (W/m²K)	0.34	0.17	0.11
Зид ка негрејаном простору 2	малтер 2cm, опека 6.5cm, бетон10cm, термоизолација 8cm, малтер 2cm	малтер 2cm, опека 6.5cm, бетон10cm, термоизолација 8cm, додатна изолација 10cm, малтер 2cm	малтер 2cm, опека 6.5cm, бетон10cm, термоизолација 8cm, додатна изолација 10cm, малтер 2cm
U (W/m²K)	0.36	0.18	0.18

Склопови термичког омотача

Позиција	Постојеће стање	Унапређење 1	Унапређење 2
Под на тлу	паркет 2cm, цем.кош. 4cm, термоизолација 12cm, хидроизолација 1cm, АБ плоча 15cm, шљунак 10cm	паркет 2cm, цем.кош. 4cm, додатна термоизолација 10cm, термоизолација 12cm,хидроиз. 1cm, АБ плоча 15cm, шљунак 10cm	паркет 2cm, цем.кош. 4cm, додатна термоизолација 20cm, термоизолација 12cm,хидроиз. 1cm, АБ плоча 15cm, шљунак 10cm
U (W/m²K)	0.28	0.15	0.10
Кос кров	кровни покривач, ветрени слој, даске 2.4cm, термоизолација 15cm између рогова 10/16cm, термоизолација 15cm, гипс-картон плоча1.25cm	кровни покривач, ветрени слој, даске 2.4cm, термоизолација 15cm између рогова 10/16cm, термоизолација 15cm, додатна термоизолација 10cm, гипс-картон плоча1.25cm	кровни покривач, ветрени слој, даске 2.4cm, термоизолација 15cm између рогова 10/16cm, термоизолација 15cm, додатна термоизолација 20cm, гипс-картон плоча1.25cm
U (W/m²K)	0.14	0.10	0.08
Раван кров (кровна тераса)	цементна кошуљица 6cm, ЕПДМ изолација, цем.кош. 6cm, термоизолација 25cm, ал. фолија, АБ плоча 20cm, малтер 2cm	цементна кошуљица 6cm, ЕПДМ изолација, цем.кош. 6cm, додатна термоизолација 10cm, термоизолација 25cm, ал. фолија, АБ плоча 20cm, малтер 2cm	цементна кошуљица 6cm, ЕПДМ изолација, цем.кош. 6cm, додатна термоизолација 20cm, термоизолација 25cm, ал. фолија, АБ плоча 20cm, малтер 2cm
U (W/m²K)	0.15	0.10	0.08
Међуспратна конструкција изнад негрејаног простора	керамичке плочице 1cm, цем. малтер 4cm,термоизолација 2cm, АБ плоча 20cm, термоизолација 10cm, малтер 2cm	керамичке плочице 1cm, цем. малтер 4cm,термоизолација 2cm, АБ плоча 20cm, термоизолација 10cm, додатна термоизолација 10cm, малтер 2cm	керамичке плочице 1cm, цем. малтер 4cm,термоизолација 2cm АБ плоча 20cm, термоизолација 10cm додатна термоизолација 20cm, малтер 2cm
U (W/m²K)	0.26	0.15	0.10

Склопови термичког омотача

Позиција	Постојеће стање	Унапређење 1	Унапређење 2
Прозор	PVC са двослојним изолационим стакло - пакетом, пуњеним инертним гасом, спољашње ал. ролетне	прозори сертификовани за примену на пасивним кућама	прозори сертификовани за примену на пасивним кућама
U (W/m²K)	1.5	0.8	0.5
Врата	Метална, крило са термоизолационом испуном	врата сертификована за примену на пасивним кућама	врата сертификована за примену на пасивним кућама
U (W/m²K)	1.5	0.8	0.8

Системи грејања и припреме топле воде

	Постојеће стање	Унапређење 1	Унапређење 2
Систем загревања просторија	Централно грејање, нискотемпературни котао на природни гас у подруму	Централно грејање, кондензациони котао на природни гас у подруму	Централно грејање, кондензациони котао на природни гас у подруму
Степен искоришћења система грејања	0.87	0.99	0.99
Систем припреме топле воде	припрема топле воде везана на систем грејања - нискотемпературни котао на гас, додатни ел. грејач, са рециркулацијом ПТВ	припрема топле воде везана на систем грејања - кондензациони котао на гас, соларни колектор, додатни ел. грејач, са рециркулацијом ПТВ	припрема топле воде везана на систем грејања - кондензациони котао на гас, додатни ел. грејач, са рециркулацијом ПТВ

Опис унапређења

Унапређење 1	Уградња нових прозора и врата према стандарду компоненти за пасивне куће. Додатно изоловање свих елемената термичког омотача термоизолацијом дебљине 10cm. ● Прелазак на кондензациони котао на земни гас. Уградња централног система припреме топле воде повезаног са системом грејања и соларним колектором са додатним електричним грејачем и рециркулацијом.
Унапређење 2	Уградња нових прозора и врата према стандарду компоненти за пасивне куће. Додатно изоловање свих елемената термичког омотача осим зидова према негрејаном простору термоизолацијом дебљине 20cm. ● Прелазак на кондензациони котао на земни гас. Уградња централног система припреме топле воде повезаног са системом грејања и са додатним електричним грејачем и рециркулацијом. Уградња допунскогсистема фотонапонских соларних панела.

Унапређење термичког омотача – енергетски биланс
према Правилнику о енергетској ефикасности зграда ("Сл.гласник РС", бр.61/2011)

Позиција	Постојеће стање	Унапређење 1	Унапређење 2
Топлотни губици елемената термичког омотача зграде [W/K]			
Енергија потребна за грејање [kWh/m²/ годишње]	59.65 (100%)	22.15(37%) 37.5 (63%)	30.75(52%) 28.9 (48%)
Енергетски разред	C	C	B
Енергија потребна за грејање [kWh]	64 555.5	40 603	31 283

Унапређење термичког омотача са системом грејања – енергетски биланс

	Постојеће стање	Унапређење 1	Унапређење 2
Финална енергија [kWh]	74 686	41 046	31 624
Енергент	Централно на природни гас	Централно на природни гас	Централно на природни гас
Емисија CO_2 [t]	16 431	9 030	6 957
Потрошња енергије за грејање након примене грађевинских и термотехничких мера	100%	45% 55%	58% 42%

Figure 63: “Building Display Sheet” of the exemplary MFH

Table 148: Exemplary MFH – Results of the energy balance calculation; Procedure: Serbian EPC calculation procedure [Rulebook 2011]

Variant N°		**011**	**012**	**013**
Label of the variant triplet		"Natural Gas"		
Variation level		Minimum Requirement	Improved Standard	Ambitious Standard / NZEB
Energy standard		Rulebook (2011)		
Calculation method		Serbian EPC calculation procedure [Rulebook 2011]		
Heated area (net conditioned area)	m²	1082		
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.535	0.342	0.273
Relation to requirement		100%	65%	52%
EPC rating		C	C	B
Energy need for heating	kWh/(m²a)	59.65	37.53	28.91
Delivered energy	kWh/(m²a)	69	38	30
Primary energy demand	kWh/(m²a)	76	41.7	32.15
CO_2 Emissions	kg/(m²a)	15.2	8.6	6.6

TABULA calculation results for all exemplary buildings

Table 149 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 149: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
SFH  RS.N.SFH.08.Gen ReEx.001	01	Minimum Requirement	0.74	56	0	56	55	10	19	0	0	0	77	15	0	0	0
	02	Improved Standard	0.46	39	0	39	38	10	19	0	0	0	56	8	0	0	0
	03	Ambitious Standard / NZEB	0.31	31	20	11	13	10	20	0	0	0	0	7	38	0	-32
	11	Minimum Requirement	0.74	56	0	56	55	10	19	79	0	0	0	14	0	0	0
	12	Improved Standard	0.46	39	0	39	38	10	19	51	0	0	0	7	0	0	0
	13	Ambitious Standard / NZEB	0.31	31	0	31	30	10	19	42	0	0	0	14	0	0	-27
	21	Minimum Requirement	0.74	56	0	56	55	10	19	0	0	0	0	37	0	0	0
	22	Improved Standard	0.46	39	0	39	38	10	19	0	0	0	0	21	0	0	0
	23	Ambitious Standard / NZEB	0.31	31	20	11	11	10	19	0	0	0	0	15	0	0	-27
MFH  RS.N.MFH.08.Gen ReEx.001	01	Minimum Requirement	0.95	67	0	67	66	15	24	0	0	0	93	18	0	0	0
	02	Improved Standard	0.50	43	0	43	42	15	24	0	0	0	64	9	0	0	0
	03	Ambitious Standard / NZEB	0.35	32	20	12	14	15	25	0	0	0	0	8	45	0	-23
	11	Minimum Requirement	0.95	67	0	67	66	15	24	96	0	0	0	17	0	0	0
	12	Improved Standard	0.50	43	0	43	42	15	24	58	0	0	0	7	0	0	0
	13	Ambitious Standard / NZEB	0.35	32	0	32	31	15	24	45	0	0	0	17	0	0	-18
	21	Minimum Requirement	0.95	67	0	67	66	15	24	0	0	0	0	44	0	0	0
	22	Improved Standard	0.50	43	0	43	42	15	24	0	0	0	0	23	0	0	0
	23	Ambitious Standard / NZEB	0.35	32	19	12	12	15	24	0	0	0	0	16	0	0	-18
AB  RS.N.AB.08.Gen ReEx.001	01	Minimum Requirement	0.74	55	0	55	54	15	24	0	0	0	78	18	0	0	0
	02	Improved Standard	0.39	36	0	36	35	15	24	0	0	0	56	9	0	0	0
	03	Ambitious Standard / NZEB	0.27	29	19	9	12	15	25	0	0	0	0	8	42	0	-22
	11	Minimum Requirement	0.74	55	0	55	54	15	24	80	0	0	0	17	0	0	0
	12	Improved Standard	0.39	36	0	36	35	15	24	50	0	0	0	7	0	0	0
	13	Ambitious Standard / NZEB	0.27	29	0	29	28	15	24	43	0	0	0	17	0	0	-17
	21	Minimum Requirement	0.74	55	0	55	54	15	24	0	0	0	0	40	0	0	0
	22	Improved Standard	0.39	36	0	36	35	15	24	0	0	0	0	21	0	0	0
	23	Ambitious Standard / NZEB	0.27	29	19	10	10	15	24	0	0	0	0	16	0	0	-17

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, ..._oil, ..._coal, ... _bio, ..., _el, ... _dh, ... _other, ..._el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.16.3 Sources / References Serbia

Table 150: Sources / References Serbia

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Bozic 2014]	Bozic V., Cvetkovic S., Zivkovic B., 2014: Influence of renewable energy sources on climate change mitigation in the Republic of Serbia, Thermal Science Journal doi: 10.2298/TSCI 130221047B	
[Decree A 2013]	Uredba o načinu obračuna I načinu raspodele prikupljenih sredstava po osnovu naknade za podsticaj povlašćenih proizvođača električne energije, The Official Gazette of Republic of Serbia No. 8/2013	Decree on incentive measures for privileged power producers, 2013
[Decree B 2013]	Uredba o merama podsticaja za povlašćene proizvođače električne energije , RS Official Gazette No. 8/2013	Decree on incentive measures for privileged power producers, 2013
[Ignjatović 2012]	Ignjatović D., Ćuković Ignjatović N., Stanković B., Mraović A., 2012: Atlas energetskih karakteristika omotača građevinskih objekata u Beogradu, Belgrade Faculy of Architecture University of Belgrade	Scientific project, Investigation of Belgrade building stock. Energy performance assessment and on site investigation
[In. Nat. Com. 2010]	Initial National Communication of the Republic of Serbia under the United Nations Framework Convention on Climate Change (UNFCCC), The Ministry of Environment and Spatial Planning, November 2010	
[IPCC 1996]	IPCC Guidelines for national GHG inventories, 1966, Geneva, Switzerland	
[Jovanović Popović 2003]	Jovanović Popović, M., Ignjatović, D., Ristivojević Mihajlović M., Krstić A., Ćosić G., Dimić, S., Slavković, S., Radivojević, A., Đokić, L. , 2003: Energetska optimizacija zgrada u kontekstu održive arhitekture: Analiza strukture građevinskog fonda Belgrade: Faculty of Architecture University of Belgrade,	Scientific project: Energy optimization of buildings in context of sustainable architecture“, part 1: Analysis of structure of building stock
[Jovanović Popović 2011]	Jovanović Popović, M., Ignjatović, D., Radivojević, A., Rajčić, A., Đukanović, Lj., Ćuković Ignjatović, N., Nedić, M., 2011: Assessment of Energy Performances of the Serbian Building Stock, Belgrade, Faculty of Architecture Univesity of Belgrade	Scientific study
[Jovanović Popović A 2013]	Jovanović Popović, M., Ignjatović, D., Radivojević, A., Rajčić, A., Đukanović, Lj., Ćuković Ignjatović, N., Nedić, M. 2013: Nacionalna tipologija stambenih zgrada Srbije. Belgrade: Faculty of Architecture University of Belgrade, GIZ.	National typology of residential buildings in Serbia
[Jovanović Popović 2014]	Jovanović Popović, M., Stanković, B., Kavran, J. 2014: Strategy for national definition of Nearly Zero Energy Buildings. Proceedings of First International Academic Conference on Places and Technologies,Faculty of Architecture University of Belgrade, pp. 621-628.	Strategy for national definition of Nearly Zero Energy Buildings
[Rulebook 2011]	Pravilnik o energetskoj efikasnosti zgrada, The Official Gazette of Republic of Serbia No. 61/2011	Rulebook on energy efficiency in buildings
[Rulebook 2012]	Pravilnik o uslovima, sadržini i načinu izdavanja sertifikata o energetskim svojstvima zgrada, The Official Gazette of Republic of Serbia No. 69/2012	Rulebook on conditions, content and method of issuing energy performance certificates
[SB 568 2013]	Energy Balance 2012, Bulletin 568, Statistical Office of the Republic of Serbia, Belgrade, 2013	

3.17 <SI> Slovenia

(by EPISCOPE partner ZRMK)

Several attempts of assembling building typologies have been conducted in the past. The first professional study was carried out in the mid-90 [Bostjancic et al. 1993]. Study was concentrated on energy restoration of buildings. Afterwards, two more were made - building typology that is used for statistical purposes and one more that is used for CO2 scenarios. The latter is composed by only 2 types of construction (single family houses and apartment building) and multiple years of construction classes which correspond to energy efficiency levels. Not one of these tree typologies involves building systems. Building typologies in the Slovenian residential buildings have been made in the past, but were all adapted to certain purpose (renovations, emission scenarios, etc.). Until IEE TABULA, Slovenia did not have a typology that comprehensively structured the residential building stock.

The definition of nearly zero-energy buildings (nZEB) has not yet been defined, but draft criteria have already been reported in the national plan for the increase of nZE buildings.

3.17.1 Current Legal Requirements and Status of National NZEB Definition for Residential Buildings in Slovenia

Since the first thermal regulation became law in 1970, several tightenings and changes of the new legal requirements for new buildings took place. The latest regulation PURES 2010 came into force in 2010. As a next step towards nearly zero-energy buildings, it includes a tightening of the requirements for new buildings already in 2015.

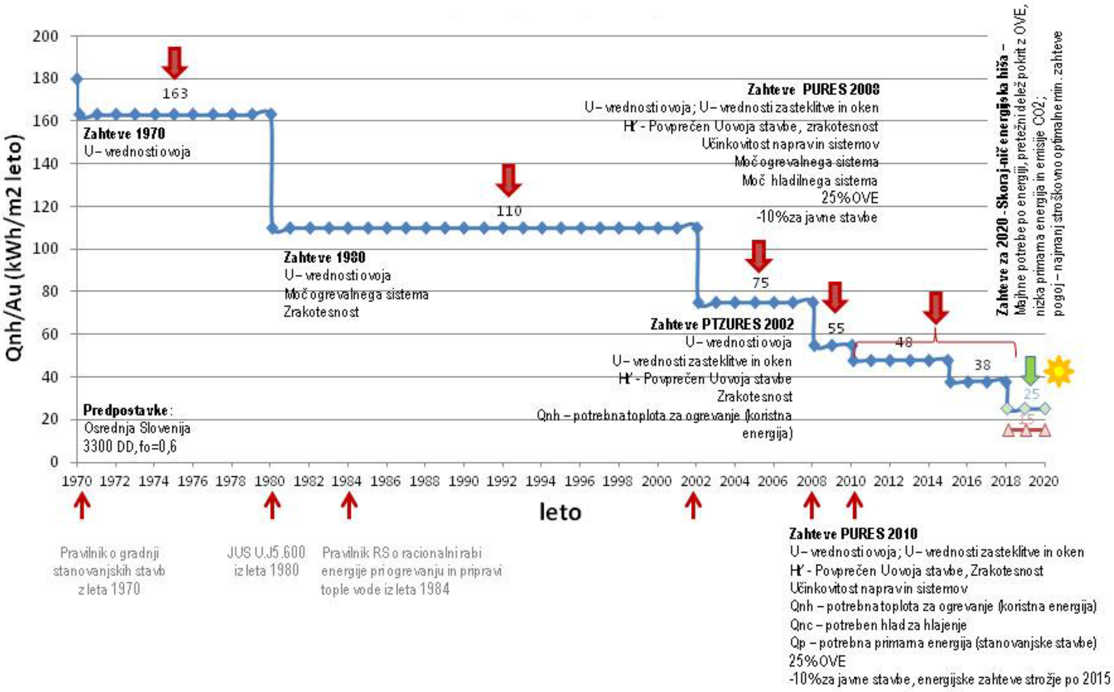


Figure 64: Overview of the tightening prescribed minimum requirements for the energy performance of buildings in Slovenia and increasing complexity of minimum requirements

Minimum requirements for new residential buildings in Slovenia

Based on the EPBD Recast Slovenia adopted the Regulations on Energy Efficiency in Buildings (PURES 2010) June 2010, which introduces a methodology for the calculation of indicators of the energy performance of the building in accordance with the EPBD CEN standards or SIST EN ISO 13790. It provides minimum requirements for the energy performance of new buildings and major renovation of existing buildings, lays down minimum requirements in the event of maintenance and technical improvements (before the end of the life of each individual element of the system and subsystem building). Regulation PURES 2010 prescribed up to 10 % more stringent requirements for all public buildings.

An important novelty is the requirement of at least 25 % share of renewable sources in total final energy consumption for the operation of (all) systems in the building, which is regarded as fulfilled in the following cases:

- if the share of final energy consumption for heating and cooling buildings and hot water in-obtained one of the following ways:
    - at least 25 percent of solar radiation,
    - at least 30 percent of the gaseous biomass,
    - at least 50 percent of solid biomass,
    - at least 70 percent from geothermal energy,
    - at least 50 percent of ambient heat,
    - at least 50 percent of CHP plants with high efficiency in accordance with the regulations, which regulates the supporting electricity produced by cogeneration of heat and electricity with high efficiency,
    - the building is at least 50 percent supplied from the energy-efficient district heating and cooling.
- or if it is necessary energy need for heating at least 30 percent lower than the minimum requirements allow
- building or dwelling if it is installed at least 6 m2 (bright areas) hair-tion of solar energy with an annual yield of 500 kWh / (m2a).

PURES 2010 sets strict minimum requirements for thermal protection of the building envelope and for the maximum heat for the heating of the buildings. Together with the prescribed 25 % share of renewable sources in total final energy consumption for the operation of the systems in the building and technical requirements for systems (condensing gas boilers required for the COP of the heat pump required efficiency systems for the recovery ventilation, mandatory in-law hot water systems for renewables) is a key part of the minimum requirements for energy-efficient buildings. The primary energy for heating and cooling is quite limited and its tightening is foreseen in the next PURES 2015 Regulation.

Slovenian calculation method to comply with new building regulations for residential buildings

Depending on the type of building and the purpose of its use, there are two types of energy performance certificates:

(1) Calculating energy performance certificate, which shall be determined on the basis of the calculated energy indicators of energy use of the building. Calculating energy performance certificate is issued for newly constructed buildings and existing residential buildings;

(2) Measured energy performance certificate, which shall be determined on the basis of measurement of energy. Measured energy performance certificate is issued to existing non-residential buildings.

Notwithstanding the preceding paragraph, instead of the measured energy performance certificate issued by calculating the energy performance certificate, if an independent expert determines that the data on the actual energy consumption are not reliable.

National**:**	**Metodologija za izračun energijskih lastnosti stavbe + TSG-1-004:2010**
English:	Methodology for calculating energy performance of buildings + Technical guideline for construction: TSG-1-004:2010 efficient use of energy

Energy efficiency indicators for the construction of the building energy performance certificate shall be determined on the basis of the calculation methodology that is based on the standard EN ISO 13790, with appropriate adjustments and is included in “Methodology for calculating energy performance of buildings”. This methodology consists of a complete scheme for the calculation of residential buildings and includes calculation modules for heating, cooling, air-conditioning and a ventilation system. The calculation procedure and the conversion factors for the calculation of primary energy are described in Technical guideline for construction: TSG-1-004:2010 efficient use of energy.

Energy efficiency indicators for the measured energy performance certificate shall be determined on the basis of the measured values of energy consumption during the last three completed calendar years preceding the year of manufacture energy performance certificate, in accordance with the SIST prEN 15603 section 7.1. If the data on the energy consumed for the last three years are not available, use data for the last two or the last complete calendar year preceding the year of manufacture cards. Data on energy consumption shall be determined on the basis of energy consumption bills or other appropriate records for each fuel source. These data should provide contracting energy performance certificate.

Status of NZEB definition for residential buildings in Slovenia

In the draft of technical minimum requirements for nearly zero-energy building tightening of minimum requirements regarding the maximum allowable needs for heating, cooling or air conditioning, hot water and lighting in the building are foreseen. As well as an increase in headline share of renewable energy in total energy consumption for the operation of the building.

If the maximum permitted heat required to heat the building in the event of a family house with a shape factor (envelope / volume) of 0.6 according to the requirements PURES 2010 (**Fehler! Verweisquelle konnte nicht gefunden werden.**) by the end of 2014 is limited to 48 kWh/m2a and this restriction starting in 2015 reduced to 38 kWh/m2a with the introduction of minimum requirements for nearly zero-energy building provides an additional reduction of the maximum required heat for the building:

- 25 kWh/m2a, with the limitation of primary energy can be met only with a significantly higher actual share of renewable energy (expected to increase from 25 % to 50 %) in the total final energy consumption for the operation of the systems in the building;
- On 15 kWh/m2 per year, if the use of renewable energy sources at the site of the building there is insufficient technical possibilities.

The above values are, as already prescribed in the applicable regulations PURES 2010 makes sense to adapt, taking into account climatic characteristics at the site of the building and the form factor of the building.

The nearly zero energy buildings are starting from the study of cost-optimal minimum requirements provided (draft submitted to the Scientific Council of the Ministry) [NR COL 2014] the following maximum allowable values for primary energy:

Table 151: Maximum value of primary energy per type of building (draft)

Type of building	Maximum allowed value of primary energy (kWh/m2a)	
	New Build	Major renovations
Single-family building	50	90
Multi-family building	45	70
Non-residential building*	70	100

* based on analysis of cost-optimal level of office buildings, as most targeted group of non-residential buildings

The value of primary energy will be nearly zero-energy buildings can be achieved by increasing the share of local renewable energy sources with the following techniques described below.

District heating systems with biomass as fuel, the systems for the conversion of energy in controlled emissions mainly in urban and geographically unfavourable densely populated areas effectively reduce primary energy use while raising the level of local energy self-sufficiency in comparison with other energy products. Systems or cogeneration, polygeneration are best suited for transformation of biomass (potentially waste) into thermal energy with high efficiency of local energy resources while increasing the share of renewables in the national electricity system without burdening the environment with emissions of particulate matter and other emissions, and the more local influences such as nitrogen and sulfur oxides. Exceptionally, in the suburban and less populated areas may also be individual biomass boilers represent a significant contribution to the reduction of primary energy consumption.

Irrespective of the location are in reducing primary energy consumption for heating nearly zero-energy buildings suitable heat pumps that use a high share of RES in its operations. Thus, coefficient of performance (COP), as the share of renewables in electricity production in the national electricity sector have a significant impact on the share of renewable energy sources used by the heat pump in its operations. In 2012, the share of RES in Slovenia for electricity production was 31.4 %, which means that the heat pump with a COP of 3.5 exploits 80.4 % renewables and 19.6 % of non-renewable sources of energy for their operation. This represents approximately 35 % less primary energy for the same volume of heat than comparable systems on oil or gas. Achieving the objective in 2020 with 39.3 % share of RES in the national electricity system will mean that the same heat pump used 82.7 % of its energy from renewable sources for its operation.

Some other systems that are more dependent on natural variations in weather conditions (solar panels, solar power) are in the case of own use in nearly zero-energy buildings also suitable for improving the balance of primary energy, their value lies mainly in the economic and technical accessibility of individuals to technologies that can contribute to nature-friendly lifestyle.

Upon final approval of the minimum requirements for nearly zero-energy building is essential to ensure the consistency of standard profiles use buildings with the emerging new generation of CEN EPBD standards, re-examine the areas of energy involved in determining energy indicators (in Slovenia in residential buildings also consider the use of energy for lighting), to examine how the computation renewable sources produced on the building / with her / near the building. In approving the technical definition of nearly zero energy buildings is also important to revise the conversion factors for the calculation of primary energy.

Table 152: Current calculation method for new residential buildings referring to the building regulations requirements and special aspects of the assumed NZEB definition in Slovenia

Calculation Method New Building Regulations – (part 1)

Country	SI	Slovenia	Status	07/2014

National Requirements for New Residential Buildings	Special Aspects with regard to the assumed Slovenian NZEB Definition
Legislation / Standards Regulation on efficient use of energy in buildings (Ur.l.Št. 52/2010, 30.06.2010) Regulation on the methodology for producing and issuing energy performance certification of buildings (Ur.l.Št. 77/2009, 02.10.2009; 2) Calculation standard: Methodology for calculating energy performance of buildings Technical guideline for construction: TSG-1-004:2010 efficient use of energy **Explanation / Comments** The current level of requirements has been introduced in 2010. Next tightening of the regulation is scheduled in 2015 and for residential dwellings will result in more stringent requirements for heat transfer coefficient by transmission, energy need for heating and cooling and primary energy.	No official Slovenian NZEB definition until now. The NZEB standard will presumably be determined on the basis of primary energy and heat transfer coefficient by transmission.

Energy Services

x	Heating	x	DHW		Appliances	
x	Cooling	x	Auxiliary		Other:	
x	Ventilation		Lighting			

Explanation / Comments

Cooling systems are usually not installed in Slovenian residential buildings.

Appliances and lighting are included as a part of internal gains.

	Calculation Procedure	Calculation period
x	Calculation of energy need for heating (building)	Month
x	Calculation of delivered energy (system)	Year / Month

Explanation / Comments

Consideration of Special Technologies

	Thermal Systems	
x	Ventilation system with heat recovery	
x	Thermal solar system	
	Other special systems:	

	On-Site Electricity Production	Feed-in	Self-use[1]	Balance period to determine self-use[1]	Self-use considered for H-C-W-HE[1]
x	On-site CHP	x			
x	On-site PV		x	Month	H-C-W
	Other energy generation systems:				

[1] "self use" = parts of the electricity demand of the building is directly covered by the produced electricity; self use considered for "H-C-W-HE": Heating - Cooling - DHW - Household Electricity

Explanation / Comments

Type of Requirements (new buildings)

x	U-values of building elements	x	Primary energy	non-renewable
x	Heat transfer coefficient by transmission			
x	Energy need for heating		Carbon dioxide emissions	
	Delivered energy	x	Other	energy need for cooling

Explanation / Comments

Assessment of energy carriers in Slovenia

Tabled values of total primary energy factors are published in Technical guideline of energy efficient use [TSG-1-004:2010]. As it stands, at the moment the non-renewable primary energy factor are not yet specified in any regulation. They can be obtained from the energy supplier only for informational purposes only.

For electricity production Slovenia uses all forms of primary energy and resources. Dominant share of electricity is produced in conventional power plants (thermal, hydro and nuclear power); share of production, connected to the distribution network in 2011 amounted to more than six percent of total production (Table 153).

Table 153: Shares of different types of electricity production in Slovenia 2011
[Javna agencija RS za energijo 2012]

Type of production	Production GWh	Share %
Nuclear power plant	5,902	39.00
Thermal power plant	4,916	32.50
Hydro power plant	3,420	22.60
Other small producers (transmission network)	497	0.60
Other small producers (in the distribution network)	803	5.30
Total	15,137	100.00

On-site photovoltaics systems are considered in the primary energy demand of the EPC in the extent that the calculated monthly electrical energy demand for heating, DHW and auxiliary energy is directly covered.

Table 154: Slovenian primary energy factors

Label / type of factor	Primary Energy Factors Slovenia
Used for EPC rating	x
Used for building regulations requirements	x
Label (national language)	Tehnična smernica za graditev TSG-1-004:2010 Učinkovita raba energije
Description / type of weighting factor	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary
Factor is multiplied by delivered energy based on the	net calorific value
Reference	[TSG-01-004:2010]
Natural gas	1.1
Heating oil	1.1
Firewood	0.1
Wood pellets	0.1
Electricity	2.5
Electricity production CHP	0
Electricity production PV system	0
District heating	1.2
District heating without CHP	0.1
District heating with 100 % CHP	1

Methodological points for discussion in Slovenia

The most relevant discussion points are:

- Total primary energy factors (renewable energy):
  There has been no assessment so far on this matter. In the future an extensive research is expected on the matter of defining and calculating total (renewable + non-renewable) primary energy.
- Biomass:
  A new expert evaluation of biomass total primary energy factor is needed.
- PV:
  The general use of PV is yet to be discussed. Since the start of economical crisis there has been no financial support scheme for PVs and since then the number of new installed systems strongly decreased. Besides this, a fire safety of such systems is a big issue on this matter.

3.17.2 Integration of National Requirements for New Buildings and NZEB Standards in the Slovenian Residential Building Typology

Modern design trends typology of buildings includes a wide range of building’s indicators, such as geometrical, structural and energy. In the past, several attempts of building typologies have already emerged, which were used for different purposes - checking energy refurbishment, statistical categorization of buildings and verifying emissions of carbon dioxide. Among the most important was the middle of the 90's a study, which is concentrated on energy refurbishment of buildings [Boštjančič, J., Brezar, V., Zupancic, D. 1993].

During the TABULA project the differentiated national version of the classification scheme (“building type matrix”) was transformed into the common TABULA concept [ZRMK 2011]. The datasets of existing buildings were adjusted and transferred to the TABULA data structure. The existing set of construction pictures was improved and supplemented by a large number of further construction and measure types [ZRMK 2012].

Classification scheme for the Slovenian residential building stock (“Building Type Matrix”)

During the IEE project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current legal requirements [PURES 2010]. Figure 65 shows the respective matrix. Three further example buildings have been identified which are now used for showcase calculations reflecting possible practical implementations of new buildings according to the national minimum requirements and future NZEB standards.

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Slovenija)	… 1945	generic (Tipična)	 SI.N.SFH.01.Gen	 SI.N.TH.01.Gen	 SI.N.MFH.01.Gen	 SI.N.AB.01.Gen
2	national (Slovenija)	1946 … 1970	generic (Tipična)	 SI.N.SFH.02.Gen	 SI.N.TH.02.Gen	 SI.N.MFH.02.Gen	 SI.N.AB.02.Gen
3	national (Slovenija)	1971 … 1980	generic (Tipična)	 SI.N.SFH.03.Gen	 SI.N.TH.03.Gen	 SI.N.MFH.03.Gen	 SI.N.AB.03.Gen
4	national (Slovenija)	1981 … 2001	generic (Tipična)	 SI.N.SFH.04.Gen	 SI.N.TH.04.Gen	 SI.N.MFH.04.Gen	 SI.N.AB.04.Gen
5	national (Slovenija)	2002 … 2008	generic (Tipična)	 SI.N.SFH.05.Gen	 SI.N.TH.05.Gen	 SI.N.MFH.05.Gen	 SI.N.AB.05.Gen
6	national (Slovenija)	2009 …	generic (Tipična)	 SI.N.SFH.06.Gen	 SI.N.TH.06.Gen	 SI.N.MFH.06.Gen	 SI.N.AB.06.Gen

Figure 65: Classification scheme ("Building Type Matrix") of the Slovenian residential building typology [ZRMK 2014], now extended towards new buildings

Table 155: Exemplary new buildings representing the latest construction year classes (2009 …)

		SFH	TH	MFH	AB
		Single-Family House	Terraced House	Multi-Family House	Apartment Block
					
Number of dwellings		1	1	5	75
Number of full storeys (conditioned)		2	2	4	13
Number of directly attached neighbour buildings		0	2	0	0
National reference area*	m²	287	188	1851	6066
TABULA reference area (conditioned floor area, internal dimensions)	m²	287	188	1851	6066

*) "Conditioned floor area" is the floor area of the spaces with controlled conditions excluding non-habitable basement or other non-residential spaces, includes a floor area of all floors, if there is more than one [TSG-1-004:2010]

Building example: variants meeting three energy performance levels for new buildings

In the following the exemplary single-family house is demonstrated in more detail. Comparable information for the other buildings can be found in the updated national typology brochure [ZRMK 2014] and the underlying work report [ZRMK 2012].

Table 156 shows the building features for different model cases. The three energy performance levels predetermined by the TABULA concept are specified as follows:

Energy Performance levels

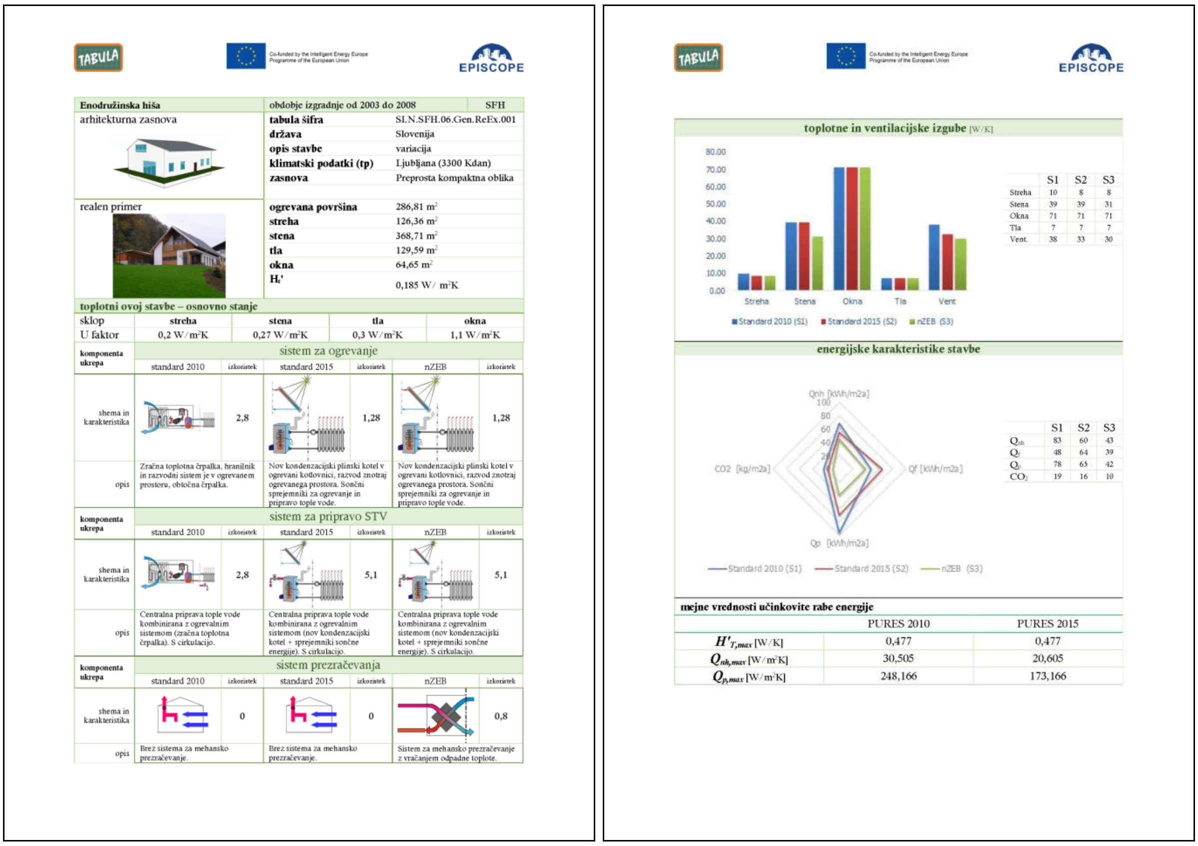
1. **"Minimum Requirements" ("PURES 2010")**
   Combination of building and supply system that exactly complies with the current minimum requirements [PURES 2010].
2. **"Improved Standard" ("PURES 2015")**
   Level of "PURES 2015" that tightens the requirements of the current Regulation.
3. **"Ambitious Standard / NZEB" ("National reports on calculation of cost-optimal levels of minimum energy performance requirements")**
   Level of "NZEB", the most ambitious of the three standards funded by the national grant programme, which was set by "National plan for nearly zero-energy buildings for Slovenia" [NP NZEB 2014]. This is attained by U-values of typical passive houses and a heat supply system with an utmost fraction of renewables.

Three basic types of heat supply systems have been defined:

- **"Combination1"(Variants 01, 02, 03):**
  The U-values of variants 01, 02 and 03 are set according to the energy performance level, where the values of NZEB levels are typical for passive houses. Heating systems are considered as low-cost investments and a ventilation system is used only where obligatory - for achieving the NZEB standards.
- **"Combination2"(Variants 11, 12, 13):**
  The U-values of variants 11, 12 and 13 are set according to the energy performance level, where the values of NZEB levels are typical for passive houses. For minimum requirements the heat supply is provided by a heat pump, the next two levels (improved and ambitious) explore the possibility of implementing a condensing gas boiler.
- **"Electricity"(Variants 21, 22, 23):**
  The U-values of variants 11, 12 and 13 are set according to the energy performance level, where the values of NZEB levels are typical for passive houses. The supply system consists in all variants of an electrical heat pump, in case of Variants 21 and 22 with external air as heat source and as ground source in Variant 23. The latter is furthermore equipped with a ventilation system.

Table 156: Exemplary single-family house (SFH) – definition of variants

		"Combination1"			"Combination2"			"Electricity"		
Variant N°		001	002	003	011	012	013	021	022	023
Energy Performance Level		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
U-values										
Roof	W/(m²K)	0.20	0.17	0.10	0.20	0.17	0.10	0.20	0.17	0.10
Wall	W/(m²K)	0.27	0.20	0.10	0.27	0.20	0.10	0.27	0.20	0.10
Window	W/(m²K)	1.10	0.75	0.75	1.10	0.75	0.75	1.10	0.75	0.75
door	W/(m²K)	1.10	0.84	0.84	1.10	0.84	0.84	1.10	0.84	0.84
Floor	W/(m²K)	0.28	0.17	0.17	0.28	0.17	0.17	0.28	0.17	0.17
Thermal bridging supplement (whole envelope)	W/(m²K)	0.10	0.05	0.02	0.10	0.05	0.02	0.10	0.05	0.02
Heat Supply System										
Heat generator		condensing boiler	LT boiler	condensing boiler	electrical heat pump	condensing boiler	condensing boiler	electrical heat pump		
Specification / Supplemental system					external air			external air	soil	soil
Ventilation system		exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery	exhaust air	exhaust air	heat recovery
Thermal solar system		-	-	DHW	-	DWH	DHW	-	-	DHW



Enodružinska hiša	obdobje izgradnje od 2003 do 2008	SFH
arhitekturna zasnova	**tabula šifra**	SI.N.SFH.06.Gen.ReEx.001
	država	Slovenija
	opis stavbe	variacija
	klimatski podatki (tp)	Ljubljana (3300 Kdan)
	zasnova	Preprosta kompaktna oblika
realen primer	**ogrevana površina**	286,81 m²
	streha	126,36 m²
	stena	368,71 m²
	tla	129,59 m²
	okna	64,65 m²
	H_t'	0,185 W/ m²K

toplotni ovoj stavbe – osnovno stanje

sklop	**streha**	**stena**	**tla**	**okna**
U faktor	0,2 W/m²K	0,27 W/m²K	0,3 W/m²K	1,1 W/m²K

komponenta ukrepa	sistem za ogrevanje					
	standard 2010	izkoristek	standard 2015	izkoristek	nZEB	izkoristek
shema in karakteristika		2,8		1,28		1,28
opis	Zračna toplotna črpalka, hranilnik in razvodni sistem je v ogrevanem prostoru, obtočna črpalka.		Nov kondenzacijski plinski kotel v ogrevani kotlovnici, razvod znotraj ogrevanega prostora. Sončni sprejemniki za ogrevanje in pripravo tople vode.		Nov kondenzacijski plinski kotel v ogrevani kotlovnici, razvod znotraj ogrevanega prostora. Sončni sprejemniki za ogrevanje in pripravo tople vode.	

komponenta ukrepa	sistem za pripravo STV					
	standard 2010	izkoristek	standard 2015	izkoristek	nZEB	izkoristek
shema in karakteristika		2,8		5,1		5,1
opis	Centralna priprava tople vode kombinirana z ogrevalnim sistemom (zračna toplotna črpalka). S cirkulacijo.		Centralna priprava tople vode kombinirana z ogrevalnim sistemom (nov kondenzacijski kotel + sprejemniki sončne energije). S cirkulacijo.		Centralna priprava tople vode kombinirana z ogrevalnim sistemom (nov kondenzacijski kotel + sprejemniki sončne energije). S cirkulacijo.	

komponenta ukrepa	sistem prezračevanja					
	standard 2010	izkoristek	standard 2015	izkoristek	nZEB	izkoristek
shema in karakteristika		0		0		0,8
opis	Brez sistema za mehansko prezračevanje.		Brez sistema za mehansko prezračevanje.		Sistem za mehansko prezračevanje z vračanjem odpadne toplote.	

toplotne in ventilacijske izgube [W/K]

	S1	S2	S3
Streha	10	8	8
Stena	39	39	31
Okna	71	71	71
Tla	7	7	7
Vent.	38	33	30

energijske karakteristike stavbe

	S1	S2	S3
Q_{nh}	83	60	43
Q_f	48	64	39
Q_p	78	65	42
CO_2	19	16	10

mejne vrednosti učinkovite rabe energije

	PURES 2010	PURES 2015
$H'_{T,max}$ [W/K]	0,477	0,477
$Q_{nh,max}$ [W/m²K]	30,505	20,605
$Q_{p,max}$ [W/m²K]	248,166	173,166

Figure 66: "Building Display Sheet" of the exemplary SFH <SI> [ZRMK 2014]

Table 157: Exemplary SFH – Results of the energy balance calculation; Procedure: PURES 2010 + TSG-1-004:2010

Variant N°		**001**	**002**	**003**	**011**	**012**	**013**	**021**	**022**	**023**
Label of the variant triplet		“Combination1”			“Combination2”			“Electricity”		
Variation level		Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB	Minimum Require-ment	Improved Standard	Ambitious Standard / NZEB
Energy standard		PURES 2010	PURES 2015	NP NZEB	PURES 2010	PURES 2015	NP NZEB	PURES 2010	PURES 2015	NP NZEB
Calculation method		PURES 2010 + TSG-1-004:2010								
National reference area*	m²	287.0	287.0	287.0	287.0	287.0	287.0	287.0	287.0	287.0
Thermal transfer coefficient by transmission. related to envelope area	W/(m²K)	0.409	0.274	0.178	0.409	0.274	0.178	0.409	0.274	0.178
Relation to requirement		91%	61%	40%	91%	61%	40%	91%	61%	40%
Energy need for heating	kWh/(m²a)	83.21	60.93	43.29	83.21	60.93	43.29	83.21	60.93	43.29
Delivered energy										
Fossil fuels	kWh/(m²a)	114.0	104.3	0.0	0.0	55.0	47.0	0.0	0.0	0.0
Electricity	kWh/(m²a)	4.0	0.0	45.4	37.6	4.5	6.6	31.2	26.1	16.9
Auxiliary energy	kWh/(m²a)	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Primary energy demand	kWh/(m²a)	129.8	133.4	113.6	94.0	69.1	77.5	78.1	65.3	42.3
CO2 emissions	kg/(m²a)	34.1	42.5	28.0	23.2	18.0	23.8	19.3	16.1	10.4

*) "Conditioned floor area" is the floor area of the spaces with controlled conditions excluding non-habitable basement or other non-residential spaces, includes a floor area of all floors, if there is more than one [TSG-1-004:2010]

TABULA calculation results for all exemplary buildings

Table 158 shows the results of the TABULA calculation procedure (standard calculation, not adapted) for all three exemplary buildings.

Table 158: Exemplary new buildings – Results of the TABULA calculation procedure (standard boundary conditions)

Building	Var. N°	Performance Level	h_Transmission W/(m^{2}K)	q_h_nd kWh/(m^{2}a)	q_ve_rec_h_usable kWh/(m^{2}a)	q_h_nd_net kWh/(m^{2}a)	q_g_h_out kWh/(m^{2}a)	q_w_nd kWh/(m^{2}a)	q_g_w_out kWh/(m^{2}a)	q_del_sum_gas kWh/(m^{2}a)	q_del_sum_oil kWh/(m^{2}a)	q_del_sum_coal kWh/(m^{2}a)	q_del_sum_bio kWh/(m^{2}a)	q_del_sum_el kWh/(m^{2}a)	q_del_sum_dh kWh/(m^{2}a)	q_del_sum_other kWh/(m^{2}a)	q_exp_sum_el kWh/(m^{2}a)
SFH  SI.N.SFH.06.Gen ReEx.001	01	Minimum Requirement	0.983	83.2	0.0	83.2	94.9	10	11.5	114.1	0	0	0	4	0	0	0
	02	Improved Standard	0.658	60.9	0.0	83.2	101.3	10	11.1	10.3	0	0	0	0	94	0	0
	03	Ambitious Standard / NZEB	0.428	43.3	0.0	83.2	98.4	10	11.5	0.0	0	0	0	45	0	0	0
	11	Minimum Requirement	0.983	83.2	0.0	60.9	76.1	10	11.5	0.0	0	0	0	38	0	0	0
	12	Improved Standard	0.658	60.9	0.0	60.9	66.1	10	11.5	55.1	0	0	0	4	0	0	0
	13	Ambitious Standard / NZEB	0.428	43.3	23.1	37.9	43.1	10	11.5	0.0	0	0	0	7	47	0	0
	21	Minimum Requirement	0.983	83.2	0.0	43.3	58.5	10	11.5	0.0	0	0	0	31	0	0	0
	22	Improved Standard	0.658	60.9	0.0	43.3	58.5	10	11.5	0.0	0	0	0	26	0	0	0
	23	Ambitious Standard / NZEB	0.428	43.3	21.4	21.9	37.2	10	11.5	0.0	0	0	0	17	0	0	0
TH  SI.N.TH.06.Gen ReEx.001	01	Minimum Requirement	0.879	78.0	0.0	78.0	89.7	10	11.5	109.6	0	0	0	4	0	0	0
	02	Improved Standard	0.586	56.6	0.0	78.0	96.0	10	11.1	10.4	0	0	0	0	90	0	0
	03	Ambitious Standard / NZEB	0.385	40.3	0.0	78.0	93.2	10	11.5	0.0	0	0	0	44	0	0	0
	11	Minimum Requirement	0.879	78.0	0.0	56.6	71.8	10	11.5	0.0	0	0	0	36	0	0	0
	12	Improved Standard	0.586	56.6	0.0	56.6	61.8	10	11.5	51.9	0	0	0	5	0	0	0
	13	Ambitious Standard / NZEB	0.385	40.3	23.2	33.3	38.6	10	11.5	0.0	0	0	0	7	42	0	0
	21	Minimum Requirement	0.879	78.0	0.0	40.3	55.5	10	11.5	0.0	0	0	0	30	0	0	0
	22	Improved Standard	0.586	56.6	0.0	40.3	55.5	10	11.5	0.0	0	0	0	25	0	0	0
	23	Ambitious Standard / NZEB	0.385	40.3	21.3	19.0	34.3	10	11.5	0.0	0	0	0	16	0	0	0
MFH  SI.N.MFH.06.Gen ReEx.001	01	Minimum Requirement	0.430	53.3	0.0	53.3	71.4	15	16.1	15.6	0	0	0	0	69	0	0
	02	Improved Standard	0.286	37.1	0.0	53.3	68.5	15	16.5	0.0	0	0	0	37	0	0	0
	03	Ambitious Standard / NZEB	0.213	28.3	27.2	26.2	31.5	15	16.5	0.0	0	0	0	7	36	0	0
	11	Minimum Requirement	0.430	53.3	0.0	37.1	59.1	15	15.6	67.8	0	0	0	15	0	0	0
	12	Improved Standard	0.286	37.1	0.0	37.1	42.3	15	16.5	38.1	0	0	0	5	0	0	0
	13	Ambitious Standard / NZEB	0.213	28.3	22.7	14.4	29.8	15	16.5	0.0	0	0	0	15	0	0	0

Building	Var. N°	Performance Level	h_Transmission W/(m²K)	q_h_nd kWh/(m²a)	q_ve_rec_h_usable kWh/(m²a)	q_h_nd_net kWh/(m²a)	q_g_h_out kWh/(m²a)	q_w_nd kWh/(m²a)	q_g_w_out kWh/(m²a)	q_del_sum_gas kWh/(m²a)	q_del_sum_oil kWh/(m²a)	q_del_sum_coal kWh/(m²a)	q_del_sum_bio kWh/(m²a)	q_del_sum_el kWh/(m²a)	q_del_sum_dh kWh/(m²a)	q_del_sum_other kWh/(m²a)	q_exp_sum_el kWh/(m²a)
	21	Minimum Requirement	0.430	53.3	0.0	28.3	33.5	15	16.5	0.0	0	0	0	5	51	0	0
	22	Improved Standard	0.286	37.1	0.0	28.3	43.5	15	16.5	0.0	0	0	0	23	0	0	0
	23	Ambitious Standard / NZEB	0.213	28.3	0.0	28.3	50.4	15	16.1	74.6	0	0	0	0	0	0	0
AB  SI.N.AB.06.Gen ReEx.001	01	Minimum Requirement	0.591	58.7	0.0	58.7	76.8	15	16.1	15.5	0	0	0	0	74	0	0
	02	Improved Standard	0.394	40.1	0.0	58.7	73.9	15	16.5	0.0	0	0	0	39	0	0	0
	03	Ambitious Standard / NZEB	0.306	30.4	26.8	31.9	37.2	15	16.5	0.0	0	0	0	7	42	0	0
	11	Minimum Requirement	0.591	58.7	0.0	40.1	62.2	15	15.6	70.9	0	0	0	15	0	0	0
	12	Improved Standard	0.394	40.1	0.0	40.1	45.3	15	16.5	40.4	0	0	0	5	0	0	0
	13	Ambitious Standard / NZEB	0.306	30.4	22.5	17.6	32.9	15	16.5	0.0	0	0	0	16	0	0	0
	21	Minimum Requirement	0.591	58.7	0.0	30.4	35.6	15	16.5	0.0	0	0	0	4	53	0	0
	22	Improved Standard	0.394	40.1	0.0	30.4	45.6	15	16.5	0.0	0	0	0	24	0	0	0
	23	Ambitious Standard / NZEB	0.306	30.4	0.0	30.4	52.4	15	16.1	76.7	0	0	0	0	0	0	0

Explanation of Quantities (TABULA Datafields)

h_Transmission	W/(m²K)	floor area related heat transfer coefficient by transmission / indicator for energy quality of building envelope (compactness + insulation)
q_h_nd	kWh/(m²a)	energy need for heating
q_ve_rec_h_usable	kWh/(m²a)	usable contribution of ventilation heat recovery
q_h_nd_net	kWh/(m²a)	net energy need for heating (q_h_nd - q_ve_rec_h_usable)
q_g_h_out	kWh/(m²a)	generated heat heating system (net energy need + storage losses + distribution losses)
q_w_nd	kWh/(m²a)	net energy need domestic hot water
q_g_w_out	kWh/(m²a)	generated heat dhw (net energy need + storage losses + distribution losses)
q_del_sum_gas, …_oil, …_coal, … _bio, …, _el, … _dh, … _other, …_el	kWh/(m²a)	sum delivered energy, energy carrier gas, oil, coal, biomass, electricity, district heating, other energy carriers
q_exp_sum_el	kWh/(m²a)	sum produced electricity (negative value)

3.17.3 Sources / References Slovenia

Table 159: Sources / References Slovenia

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[Javna agencija RS za energijo 2012]	Javna agencija RS za energijo: Poročilo o stanju na področju energetike v Sloveniji v letu 2011, Maribor, 2012 http://www.agen-rs.si/documents/10926/38704/Poro%C4%8Dilo%20o%20stanju%20na%20podro%C4%8Dju%20energetike%20v%20Sloveniji%20v%20letu%202011	Report on the Energy Sector in Slovenia in 2011
[NP NZEB 2014]	Ministrstvo za infrastrukturo in proctor, Gradbeni inštitut ZRMK: Nacionalni načrt za povečanje števila skoraj ničenergijskih stavb. Ljubljana, 2014. http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm	National plan for nearly-zero energy buildings
[NR COL 2014]	Ministrstvo za infrastrukturo in proctor, Gradbeni inštitut ZRMK: Strokovne podlage za določitev stroškovno optimalnih ravni za minimalne zahteve glede učinkovitosti z uporabo primerjalnega metodološkega okvira. Ljubljana, 2014. http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm	National reports on calculation of cost-optimal levels of minimum energy performance requirements
[PURES 2010]	Pravilnik o učinkoviti rabi energije v stavbah. Ministrstvo za okolje in prostor. Ljubljana, 2010. http://www.uradni-list.si/1/content?id=98727	Regulation on efficient use of energy in buildings
[TSG-01-004:2010]	Tehnična smernica učinkovita raba energije. Ministrstvo za okolje in prostor. Ljubljana, 2010. http://www.arhiv.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/prostor/graditev/TSG-01-004_2010.pdf	Technical guideline on energy efficient use
[ZRMK 2011]	Rakušček, A., Šijanec Zavrl, M., Stegnar, G. Tipologija stavb: energetska učinkovitost stavb in tipične stavbe v Sloveniji. Gradbeni inštitut ZRMK. Ljubljana, Slovenija, 2011. http://www.building-typology.eu/downloads/public/docs/brochure/SI_TABULA_TypologyBrochure_ZRMK.pdf	National typology brochure for the Slovenian residential building stock, developed during the IEE Project TABULA
[ZRMK 2012]	Rakušček, A., Šijanec Zavrl, M., Stegnar, G. National scientific report - Slovenia. IEE TABULA – Typology approach for building stock assessment. Gradbeni inštitut ZRMK. Ljubljana, 2012. http://www.building-typology.eu/downloads/public/docs/scientific/SI_TABULA_ScientificReport_ZRMK.pdf	Description of the revision and further development of the national residential building typology Slovenia
[ZRMK 2014]	Stegnar, G., Rakušček, A., Šijanec Zavrl, M. Tipologija stavb: energetska učinkovitost stavb in tipične stavbe v Sloveniji. Gradbeni inštitut ZRMK; Ljubljana, Slovenija, 2014. http://episcope.eu/fileadmin/tabula/public/docs/brochure/SI_TABULA_TypologyBrochure_ZRMK.pdf	National typology brochure for the Slovenian residential building stock, developed during the IEE Project EPISCOPE

4 Summary and Outlook

During the last decades significant steps have been made towards improving the energy performance of new buildings in Europe. A cornerstone was set in 2002 with the Energy Performance of Buildings Directive (EPBD), which introduced stipulations regarding the application of minimum requirements on new and existing buildings as well as the energy certification of buildings. As a next step, in the recast of the EPBD in 2010 the term 'nearly zero-energy building' (NZEB) was introduced. All EU member states have been asked to set up plans for the introduction of this ambitious standard for buildings newly built after December 2020.

In the last few years it has been discussed how nearly zero-energy buildings can be put into practice and in which way binding requirements can be set up. Despite the tight implementation and reporting schedule determined by the EPBD recast, only few countries defined officially national approaches (e.g. AT, BE, DK); in most of the European member states NZEB definitions are still under debate.

The present report provides deeper insights in the status quo in the respective countries, their methodological approaches, the current minimum requirements and the enacted or assumed future NZEB standards. The substance of the new buildings regulations of a given country and its envisaged changes to include NZEBs has been specified by all EPISCOPE partners by use of a common table template. Methodological varieties are for example:

- the definition of requirements (limits for U-values, for the heat transfer coefficient by transmission, the energy need for heating, the primary energy demand; defined by fixed values, a formula or a set of reference features);
- the calculation periods for energy need for heating (building) and delivered energy (system): yearly/seasonal, monthly, hourly;
- the type and the height of factors for weighting delivered energy (agreed factors, total or non-renewable primary energy factors);
- the type and height of valuating on-site production of electricity (consideration of self-use or complete feed-in).

Depending on the classification scheme of the national building typology, each EPISCOPE partner has chosen two or more exemplary buildings representing the most recent construction year class. For each country variants of the main energy related features have been specified to meet the national minimum requirements for new buildings, an improved standard, and the (decided or assumed) NZEB standard.

The construction elements and their U-values, the type of ventilation and heat supply system and the resulting energy demand of the exemplary buildings is presented in the form of building display sheets and disseminated via typology brochures[29]. The present report is depicting such display sheets from 17 countries, showing which different types and depths of information are possible. The assembly may be useful to stimulate similar brochures in other countries or on different geographical levels but also to further stimulate the development and improvement of the current display sheets.

Beyond these national activities, the EPISCOPE partners have transferred their datasets of exemplary buildings to the common TABULA data structure in order to make the features and energy performance values understandable and comparable between countries. Energy balance calculations have been performed for all of these buildings by use of standard boundary conditions and national climate data. As a result the heat transfer coefficient by transmission, the energy need for heating and the delivered energy by energy carrier (demand and production separately) have been provided for all exemplary buildings at the end

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[29] Downoadable from http://episcope.eu/communication/download/

of each country chapter. According to the TABULA concept the before mentioned quantities are representing the basic level for specifying the energy performance of buildings. Thus, the numbers can directly be compared between the countries. The datasets and calculations will later also be available in a new version of the TABULA WebTool[30] (presumably available in the beginning of 2015).

As regards the energy performance levels of the exemplary buildings a large variation can be stated – even for similar climatic zones: In some countries far reaching minimum requirements close to the best available technology can already be found today. Here only small steps to possible NZEB standards are to be expected. In other countries rather weak requirements for NZEBs are discussed today. As stated in the introduction of this report, part of the European building stock of the year 2050 has not yet been built. Facing the danger of climatic changes, the implementation of very ambitious standards seems to be necessary to meet the required reduction in energy use.

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[30] Online available at: http://episcope.eu/building-typology/webtool/

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