

Nearly Zero Energy Buildings (nZEB) in the CEN draft standard



JOHANN ZIRNGIBL
CSTB, France
johann.zirngibl@cstb.fr

About the author:

Johann ZIRNGIBL is Head of Division in the French state owned technical and scientific building research center (CSTB). He is managing research project related to the energy performance of buildings on European and International level and is involved in setting up national energy assessment methods.

The author is Convenor of several European standardization groups (e.g. CEN TC 371/WG1, CEN TC 228/WG4) working on the CEN standards linked to the EPBD and International standardization groups (e.g. ISO TC205/WG9).

A binding roadmap and a definition of nearly zero energy buildings (nZEB) is given in the Energy Performance of Buildings Directive (EPBD). Member States are asked to report detailed application in practice of the definition and provide a roadmap towards nZEB.

Keywords: nearly zero energy building, nZEB, standard, CEN, primary energy factor, PEF, renewable energy ratio, RER.

The analysis of the applications in the Member States shows that the definitions of nZEB are varying a lot. Therefore a coherent and common definition of nZEB is needed:

- to be able to understand the content of the numerical indicator and the related requirement in the different Member States;
- to guide the industrials in the development of solutions and to give them the possibility showing the impact of the developed solution in a transparent manner at European level.

The European Commission asked CEN (mandate M480) to develop standards supporting the application of recast EPBD in the Member States. This article shows and explains the first ideas of the CEN development for a common definition of nZEB in prEN 15603.

Mandate from the European Commission for standardisation

To support the Member States in the transposition of the Directive into national application, the Commission gave mandate to CEN to work out a set of standards. CEN completed the Directive with more detailed

definitions and worked out transparent and unambiguous calculation procedures. The target was to set up a common and flexible methodology allowing the Member States to take into account national, regional or local characteristics within this common methodology.

Within this common structure the Member States can set up their level of requirements according to their priorities (e.g. more focusing on the building envelope; more focusing on the total primary energy, etc.).

CEN definitions for “renewable sources”, “on-site” and “nearby”

The Directive indicates that the localization of the energy sources or energy conversion to be taken into account should be ‘on-site’ or ‘nearby’ but does not define both perimeters.

The definition of on-site and nearby has an important influence on the assessment of an nZEB. As all new and refurbished building shall be nZEB’s, and as some Member States intent to make the renewable energy ratio (RER) mandatory, the definition impact also the development of technologies and the choice of investments made by building owners.

In order to increase the energy performance of his building, a building owner could decide to invest not only in the building itself, but also in the 'nearby' energy source (e.g. in a biomass boiler of a district heating plant where his building is connected to). In this case, enlarging the assessment perimeter will contribute to increase the use of energy from renewable sources, make the investments more cost efficient and open new possibilities for increasing energy performance.

"On-site"

CEN defines 'on-site' as the building and the parcel of land on which the building is located. In case of building sites with multiple buildings, it is the parcel of land allocated to the assessed building. It has to be clearly stated which part of the parcel of land is allocated to which building in order to avoid double counting of energy sources (e.g. to count electricity production from PV cells on a garage several times).

The rationale for the definition of "on-site" is the unique and strong link with building.

"Nearby"

CEN defines 'nearby' as energy source which can be used only at local or district level. This definition was estimated as weak and therefore completed by having a dedicated connection, requiring specific equipment for the assessed building to be connected. The rationale for the definition of 'nearby' was the possibility to calculate a specific primary energy factor and to have still a specific link between the building and the energy source.

Renewable energy ratio (RER)

The Directive indicates that the very low amount of energy required has to be covered to a very significant extent by energy from renewable sources.

In prEN 15603 [1] CEN define the renewable energy ratio RER as the ratio of the renewable primary energy, (calculated with renewable primary conversion factors), on the total primary energy (calculated with total primary conversion factors). The renewable energy ratio *RER* can be differentiated according to the different perimeters (e.g. on-site, nearby) and the related delivered energies or energy productions.

General principles for a coherent assessment of nZEB – the CEN hurdle race

EPBD sets already two requirements to define nZEB. The use of only one requirement, e.g. the numeric indicator of primary energy use, is misleading. In prEN 15603 different requirements are combined to a coherent assessment of nearly Zero Energy Building (nZEB).

Interpreting the different requirements in EPBD, a nZEB should be a building that has a very low amount of energy required associated with a typical use of the building including energy used for heating, cooling, ventilation, hot water and lighting), taking into account:

- indoor climatic conditions;
- thermal characteristics of the building, building elements having a significant impact on the energy performance of the building envelope;
- HVAC installation, hot water supply, built-in lighting installation, optimising the energy use of technical building systems;
- active solar systems and other systems based on energy from renewable sources;
- district or block heating and cooling systems.

The very low amount of energy required by a nearly zero-energy building should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.

A nearly zero-energy building is characterized by a numerical indicator of primary energy use expressed in kWh/m² per year.

CEN propose to combine the different requirements in a coherent assessment of nZEB. The proposed assessment methodology goes step by step 'from the needs to the overall energy performance expressed in primary energy use'. Only if the requirement of each step is reached, then the building can be qualified at the end as 'nZEB'. This approach is comparable to a hurdle race (**Figure 1**).

First requirement: the building fabric (Energy needs)

The first requirement is reflecting the performance of the building fabric characterised by the energy needs. The energy needs are based on local conditions and the designated function of the building.

They take into account:

- the quality of the building envelope (e.g. insulation, windows);
- the bioclimatic design (e.g. solar gains, natural lighting),
- the inertia, the partitioning; and the need to guarantee adequate indoor climatic conditions in order to avoid possible negative effects such as poor Indoor Air Quality (due to lack of ventilation).

The energy needs are calculated with EN ISO 13790 [2].

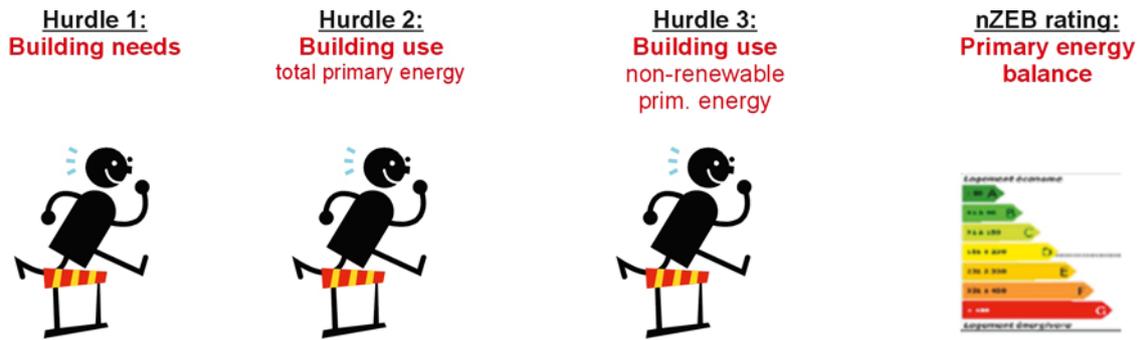


Figure 1. The CEN hurdle race towards nZEB rating.

Second requirement: The total primary energy use

The second requirement is reflecting the performance of the technical building systems (HVAC installation, domestic hot water supply, built-in lighting installation) characterized by the energy use.

Technical building systems are linked to an energy carrier (e.g. gas boiler; auxiliary consumption). To sum up the different energy carriers in a coherent way the second requirement is expressed in total primary energy.

Default values for primary energy factors are given in prEN 15603.

NOTE: Primary energy is defined as energy from renewable and non-renewable sources. The related primary energy factors (PEF) are defined as:

- non-renewable primary energy factor taking into account only non-renewable energy overheads of delivery to the point of use, excluding renewable energy overheads and primary energy components;
- renewable primary energy factor taking into account only renewable energy overheads of delivery to the point of use, excluding non-renewable energy overheads and primary energy components;
- total primary energy factor. The total PEF is the sum of the non-renewable primary energy factor and the renewable primary energy factor.

The total primary energy use is a coherent way for setting technical building system requirements because some systems (e.g. direct electrical emitters) have parts of their systems losses outside the building assessment boundary (e.g. electricity generation). The total primary energy factor takes into account the losses outside the assessment boundary.

Only energies delivered through the assessment boundary from nearby and/or distant are taken into account to link the total primary energy use with the energy counters.

The total primary energy use is calculated according to prEN 15603.

Third requirement: Non-renewable primary energy use without compensation between energy carriers

The third requirement is reflecting the contribution of energies from renewable sources (e.g. active solar systems), characterized by the non-renewable primary energy consumption.

This third requirement does not take into account:

- compensation between different energy carriers for example between gas and on-site PV production;
- the effect of exported energy.

This requirement takes into account only the energy that is used to provide on-site services (heating, ventilations, etc.)

The non-renewable primary energy use is calculated with prEN 15603.

Final nZEB rating: Numerical indicator of non-renewable primary energy use with compensation

At this stage the compensation between energy carriers and the effect of exported energy is taken into account. The numerical indicator of non-renewable primary energy is calculated with prEN 15603.

Table 1. Example illustrating the CEN proposal in prEN 15603 for nZEB rating with four individual requirements.

			
1 st requirement	2 nd requirement	3 rd requirement	Final nZEB Rating
Build. fabric	Tech. Build. systems + related energy carrier only nearby, distant!!	Renewable source on-site, nearby, distant	Compensation by exporting on-site, nearby, distant
Energy needs ¹⁾	Total primary energy use $f_{P,tot}$ ²⁾	Non-renew. Prim. Energy $f_{P,nren}$ ²⁾	Tot + nren. Prim. energy $f_{P,nren}, k_{exp}$ ³⁾
Heating : 60	Gas * $f_{P,tot}$: 80 * 1,05= 84	Gas* $f_{P,nren}$: 80 * 1,05= 84	Gas* $f_{P,nren}$: 80 * 1,05= 84
Cooling : 20	PV * $f_{P,tot}$: 40 * 1,00= 40	PV * $f_{P,nren}$: 40 * 0,00= 0	PV * $f_{P,nren}$: 40 * 0,00= 0
Lighting: 10	$\Sigma 120$ (needs+losses)		PV _{prod.} 60, $k_{exp}=1$ > exported: 60*1 - 40= 20
For information only: DHW: 20	<u>NOTE</u> : DHW added		PV _{exp} * $f_{P,nren}$: 20 * 2.5=50
Result: 90	Result: 124	Result: 84	nZEB-rating: 34
Requirement:100	Requirement:125	Requirement:80	Requirement: 50
fulfilled	fulfilled	Not fulfilled	No nZEB rating

1) Services linked to building fabric only (e.g. envelope, partition, inertia, etc)

2) Example of primary energy factors $f_{P,tot}$ = total primary energy factor , $f_{P,nren}$ = non renewable primary energy factor

3) Part of exported energy (production related!) between 0–1

Example

Table 1 illustrates the CEN hurdle race by an example. In this example there would be no nZEB rating (even if nZEB rating result is lower than requirement) because the third requirement is not passed.

Resume

The European Commission asked CEN (mandate M480) to develop standards supporting the application of EPBD in the Member States and to complete EPBD definitions where needed.

CEN completed the nZEB definition, worked out a common, clear, unambiguous assessment structure and the related standards to calculate the very low amount of energy required by nZEB. The common structure is flexible in order to take into account national, regional and regional choices.

CEN combined the definition of nZEB's and the different EPBD requirements in one assessment method (hurdle race). By following the hurdle race negative side effects (e.g. uncomfortable buildings) can be avoided.

The Member States can set level of requirements according to their priorities within this common assessment structure.

EPBD nZEB requirement is a significant contribution to EU commitments (e.g. climate change) and a huge challenge for the EU building sector. A common, unambiguous definition of nZEBs and a transparent assessment method is needed to guide and motivate EU professionals in the development of adapted solutions.

European professional needs clear, unambiguous European rules and definitions. ■

Bibliography

[1] prEN 15603:2013 Energy performance of buildings — Overarching standard EPBD.

[2] EN ISO 13790: Energy performance of buildings — Calculation of energy use for space heating and cooling.