**Technical comments on NZEB and ZEB definition in EPBD recast**

**Johann Zirngibl, Jana Bendzalova**

*The EPBD recast proposal dated 15.12.2021 defines new indicators, as the zero-emission building (ZEB) and set quantified maximum thresholds (Annex III). Quantified thresholds provide more transparency to the ambition level in the EU Member States and contributes to a more coordinated and harmonised approach to reach the EU targets.*

*This document proposes absolute values for the maximum thresholds for NZEB buildings expressed in non-renewable primary energy use and additional minimum requirements for energy to safeguard a good level of the building envelope quality.*

**1. Actual definition and requirement in the EPBD recast proposal**

The EPBD recast proposal, dated 15.12.2021, states:

 **Article 2 Definitions**

* ‘**zero-emission building’** *means a building with a very* ***high energy performance****, as determined in accordance with Annex I,* *where the* ***very low amount of energy still required*** is fully *covered by energy from renewable sources generated on-site,* from a renewable energy community within the meaning of Directive (EU) 2018/2001 [amended RED] or from a district heating and cooling system, in accordance with the requirements set out in **Annex III**;
* ‘**nearly zero-energy building’** *means a building with a very* ***high energy performance****, as determined in accordance with Annex I,* which **cannot be lower than the 2023 cost-optimal level** reported by Member States in accordance with Article 6(2) and *where the nearly zero or* ***very low amount of energy required*** *i*s covered to a **very significant extent** by energy from **renewable sources**, including energy from **renewable sources produced on-site or nearby.**

**Article 5 Setting of minimum energy performance requirements**

* Member States shall take the necessary measures to ensure that minimum energy performance requirements are set for **building elements that form part of the building envelope** and that have a **significant impact on the energy performance of the building envelope** when they are replaced or retrofitted, with a view to achieving at least cost-optimal level.

**Annex III**

REQUIREMENTS FOR NEW AND RENOVATED ZERO-EMISSION BUILDINGS AND CALCULATION OF

LIFE-CYCLE GLOBAL WARMING POTENTIAL (GWP) (referred to in Article 2(2) and Article 7)

**I. Requirements for zero-emission buildings**

The total annual primary energy use of a new zero-emission building shall comply with the

maximum thresholds indicated in the **table 1.**

|  |  |  |  |
| --- | --- | --- | --- |
| **EU climatic zone** | **residential building** | **Office building** | **Other non-residential building\*** |
| Mediterranean | < 60 kWh/(m2.y) | < 70 kWh/(m2.y) | < NZEB total primary energy use defined at national level |
| Oceanic | < 60 kWh/(m2.y) | < 85 kWh/(m2.y) | < NZEB total primary energy use defined at national level |
| Continental | < 65 kWh/(m2.y) | < 85 kWh/(m2.y) | < NZEB total primary energy use defined at national level |
| Nordic | < 75 kWh/(m2.y) | < 90 kWh/(m2.y) | < NZEB total primary energy use defined at national level |

\*Note: the threshold should be smaller than the threshold for total primary energy use established at the Member State level for nearly zero-energy non-residential buildings type other than offices

**Table 1:** **Requirements for zero-emission buildings expressed in total primary energy use**

**2. Understanding and commenting the terms of the actual version**

The new “zero -emission building” (ZEB) definition seems to be based on the “nearly zero-energy building” (NZEB) definition. Until now there was no quantified requirement in the EPBD. Now, **Annex III** set a **maximum thresholds of primary energy use based on the NZEB level definition by Commission Recommendation [1]**.

To **reach the zero-emission level** Annex III requires in addition that the total annual primary energy use of a new or renovated zero-emission building shall be **fully covered**, on a **net annual basis**, by renewables.

**The ZEB definition equals NZEB definition plus 100% renewables.**

The **Commission Recommendation (EU) 2016/1318** on guidelines for the promotion of nearly zero-energy buildings **[1]** provides a recommendation for numerical indicators for the **definition of NZEB** for 4 climates according to the study by Ecofys **[2]:**

* Mediterranean (Zone 1): Catania (others: *Athens,* Larnaca, Luga, Seville, **Palermo**)
* Oceanic (Zone 4): Paris (others: Amsterdam, Berlin, Brussels, Copenhagen, Dublin, London, Macon, Nancy, Prague, Warszawa)
* Continental (Zone 3): Budapest (others: **Bratislava,** Ljubljana, Milan, Vienna)
* Nordic (Zone 5): Stockholm (**Helsinki,** Riga, Gdansk, Tovarene).

The recommended values of NZEB energy performance, projecting the 2020 prices and technologies for the different EU climate zones are reported in **Table 2**. The values are expressed for **useful floor area**.

|  |  |  |
| --- | --- | --- |
|  | **Offices** | **single family house** |
| **EU climatic zone** | « net » primary energykWh/(m2.y) | on-site renewables; kWh/(m2.y) | (Total) primary energy usekWh/(m2.y) | « net » primary energykWh/(m2.y) | on-site renewables; kWh/(m2.y) | (Total) primary energy usekWh/(m2.y) |
| Mediterranean | 20-30 **(25)1)**  | 60 | 80 -90 **(70)2)** | 0-15 | 50 | 50-65 **(60)** |
| Oceanic | 40-55 | 45 | 85-100 **(85)** | 15-30 | 35 | 50-65 **(60)** |
| Continental | 40-55 **(46)** | 45 | 85-100 **(85)** | 20-40 | 30 | 50-70 **(65)** |
| Nordic | 55-70 **(60)** | 30 | 85-100 **(90)** | 40-65 **(53)3)** | 25 | 65-90 **(75)** |

1) Values from ALDREN EPC NZEB level **[3]** (**non-renewable** primary energy) for gross internal floor area (GIA)

2) Values from EPBD recast proposal Annex III (**total** primary energy)

3) Estonian residential NZEB building (**non-renewable** primary energy)

**Table 2**: **Recommended values of NZEB energy performance** **[1]**

**Table 2** shows that the values in EPBD recast proposal Annex III are derived from the NZEB recommendation **[1]**, itself derived from the Ecofys study. It also shows that the “net” primary energy use is inverse proportional to the on-site renewables and that finally the **requirements** related to **the total primary energy use are more or less constant all over Europe for high performing buildings**.

**Our technical comments** made on the **zero-emission building definition in EPBD recast proposal [4]** indicate that the **requirements based on total primary energy use are not meaningful and we propose to replace “total” by “non-renewable” primary energy use.** Total primary energy makes no sense because of heat recovered by heat pumps included in total. If the recovered heat is excluded, then the energy is no longer « total » according to physics and CEN standards.

**Table 2** also shows that the values of the “**net” primary energy use** are in line with the requirements in the **ALDREN Energy Performance Certificate** (EPC) **[3]** for a class A (NZEB) based on **non-renewable** primary energy use and the requirements for Estonian NZEB residential buildings also expressed **non-renewable** primary energy use.

**Therefore, it is proposed** to replace the maximum thresholds in EPBD recast proposal by the following values expressed in **non-renewable** primary energy use. These requirements should be the requirements for a common harmonised NZEB building definition as part of the ZEB building definition (**Table 3**).

|  |  |  |  |
| --- | --- | --- | --- |
| **EU climatic zone** | **Family houses 2)** | **Office building 2)**  | **Other non-residential building\*** |
| Mediterranean | < **15** kWh/(m2.y)(60)1) | < **26** kWh/(m2.y)(70) | < NZEB **non renewable** primary energy use defined at national level |
| Oceanic | <**25** kWh/(m2.y)(60) | < **48** kWh/(m2.y)(85) | < NZEB **non renewable** primary energy use defined at national level |
| Continental | < **30** kWh/(m2.y)(65) | < **48** kWh/(m2.y)(85) | < NZEB **non renewable** primary energy use defined at national level |
| Nordic | < **53** kWh/(m2.y)(75) | < **63** kWh/(m2.y)(90) | < NZEB **non renewable** primary energy use defined at national level |

‘1) Thresholds expressed in **total** primary energy use are in brackets

2) Values are for useful floor area. In case of other type of floor area, the values should be recalculated based on the average national ratio to useful floor area for each building category (e.g. 0.95 was used for ratio from useful to ALDREN gross internal floor area (GIA) for big office buildings)

**Table 3: Requirements for NZEB buildings expressed in non-renewable primary energy use**

It is proposed to change the title of column in **Table 3** from “Residential buildings” to “Family houses”. The same thresholds for all residential buildings would be counterproductive as it will lead to suboptimal targets for big multi-apartment buildings. It should be added that the proposed values in Annex III are for family houses not taking into account lighting.

* **Additional Minimum Energy Performance Requirements on building needs.**

As the **total** primary energy use has been replace by the **non-renewable** primary energy use, **an additional requirement shall be added** to avoid that the energy use (**building quality) is too much compensated by renewable energy** and to **also limit the use of non-renewable energy**.

The calculation of energy performance starts with the calculation of the **energy needs** for heating and cooling and ends with the calculation of the primary energy. The ‘direction’ of the calculation goes from the building's needs to the source (i.e. to the primary energy). First ensuring that the energy needs for heating and cooling are reduced is key.

Setting of minimum energy performance requirements related to the building envelope is also in line with Article 5 of the EPBD recast proposal.

Using 2010 prices and technologies, for every climate and every new building type, the energy needs (being the sum of heating and cooling sensible & latent) for new buildings turned out to be in the following ranges for the different climate zones and for useful floor area (**table 4**).

According to the Ecofys study **[2],** energy needs in non-residential buildings are strongly affected by the availability of daylight at a certain latitude. The Norwegian standard NS 3071:2012 *“Criteria for passive houses and low energy buildings. Non-residential buildings*” sets a maximum value of **12,5 kWh/(m2 .a)** for energy use for **lighting**.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **EU climatic zone** | **Ecofys**Single family houseHeat + cool(kWh/m2a) | **Ecofys**new officeHeat + cool(kWh/m2a) | **ALDREN3)****Office**Heat + cool(kWh/m2a) | **ALDREN3)****Office**Lighting(kWh/m2a) |
| Mediterranean (Zone 1) | 15-30 **(15)2)**  | 15-45 (**40)** | <30 | 8 |
| Oceanic (Zone 4) | <15 **(20)** | 15-30 / 30-45 **(42)** |  |  |
| Continental (Zone 3) | <15 **(20)** | 15-45 **(42)** | <30 | 10 |
| Nordic (Zone 5): | <25 **(30)**1) | 15-30 **(44)** | <30 | 12 |

‘1) Space heating need + supply air in Estonian NZEB building

‘2) Proposal for maximum threshold for energy needs of the building envelope of NZEB building

‘3) Values from ALDRENEPC NZEB level [3] for gross internal floor area (GIA)

**Table 4: Energy needs (heating, cooling, built-in lighting) for different climate zones.**

**Advertisement**

Attention is drawn on the **influence of the shape factor** (ratio of heat exchange area to volume) on the needs especially for small residential houses (shape factor of 1) compared to bigger houses (shape factor of 0,7).

Including **lighting** in the needs, could partly compensate the influence of shape factor. Small building, with a high shape factor, with relatively high heat losses expressed per m2 useful floor area, will have a better daylight use and more solar gains.

The **hypothesis taken for the calculation**, for example the internal and solar gains reducing the energy needs, have also a strong impact on the results.

Another influencing factor is the **floor area.** The threshold must always be linked to a clear definition of the floor area.

Therefore, there could be a **security margin** added to the values proposes with values at EU level. These values could be an **upper limit** at EU level. I**n any case the national values should apply if lower.**

**Table 4** shows that the **values** for **buildings needs of NZEB building** are quite the same for the different EU climatic zones especially for office buildings. The needs are mostly influenced by the product of the U-value and the climate. In colder climate the optimal U values are lower and the climate colder.

**4. Summary**

In the EPBD recast proposal, the ZEB definition is based on the values coming from the Commission recommendation **[1],** plus the 100 % coverage of renewable energy source. But the NZEB definition is expressed in total primary energy use, in contrary to the Commission recommendation **[1]**.

It is proposed to change the requirement from the total to the non-renewable primary energy use. Therefore, **new thresholds expressed in non-renewable primary energy use are proposed** based on the Commission recommendation for NZEB building **[1].**

An additional requirement has to be added to avoid that the energy needs (building quality) is too much compensated by renewable energy and to also limit the use of non-renewable energy.

As **the building needs are the first step in the energy calculation** taking into account also passive solution (geometry, orientation), an **additional threshold related to the building energy need is proposed**.

Finally, the following improvements are proposed.

**Annex III**

I. Requirements for zero-emission buildings

The **non-renewable** annual primary energy use of a new zero-emission building shall comply with the **maximum thresholds indicated in the table** below. If the national cost optimal level has a higher ambition than the national level shall apply.

**Table: Requirements for NZEB buildings expressed in non-renewable primary energy use**

|  |  |  |  |
| --- | --- | --- | --- |
| **EU climatic zone** | **Family houses 1)** | **Office building 1)**  | **Other non-residential building\*** |
| Mediterranean | < **15** kWh/(m2.y) | < **26** kWh/(m2.y) | < NZEB **non renewable** primary energy use defined at national level |
| Oceanic | <**25** kWh/(m2.y) | < **48** kWh/(m2.y) | < NZEB **non renewable** primary energy use defined at national level |
| Continental | < **30** kWh/(m2.y) | < **48** kWh/(m2.y) | < NZEB **non renewable** primary energy use defined at national level |
| Nordic | < **53** kWh/(m2.y) | < **63** kWh/(m2.y) | < NZEB **non renewable** primary energy use defined at national level |

1) Values are for useful floor area. In case of other type of floor area, the values should be recalculated based on the average national ratio to useful floor area for each building category (e.g. 0.95 was used as ratio from useful to gross internal floor area (GIA) for big office buildings)

\*Note: the threshold should be smaller than the threshold for non-renewable primary energy use established at the Member State level for nearly zero-energy non-residential buildings type other than offices.

**To limit the primary energy use**, an additional requirement related to the **building energy needs**, the first step in the calculation of the building energy performance, shall be added. The maximum thresholds are indicated in the table below. If the national cost optimal level has a higher ambition than the national level shall apply.

**Table: Energy needs for different climate zones.**

|  |  |  |  |
| --- | --- | --- | --- |
| **EU climatic zone** | **Family houses1)**Heat + cool | **Office buildings1)**Heat + cool | **Other non-residential building\*** |
| Mediterranean (Zone 1) |  **15** kWh/(m2.y) | **40** kWh/(m2.y) | < NZEB building energy needs defined at national level |
| Oceanic (Zone 4) |  **20** kWh/(m2.y) | **42** kWh/(m2.y) | < NZEB building energy needs defined at national level |
| Continental (Zone 3) | **20** kWh/(m2.y) | **42** kWh/(m2.y) | < NZEB building energy needs defined at national level |
| Nordic (Zone 5): | **30** kWh/(m2.y) | **44** kWh/(m2.y) | < NZEB building energy needs defined at national level |

1) Values are for useful floor area. In case of other type of floor area, the values should be recalculated based on the average national ratio to useful floor area for each building category (e.g. 0.95 was used as ratio from useful to gross internal floor area (GIA) for big office buildings)

**Bibliography**

**[1]** Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices

**[2]** Hermelink, A., et al. - Towards nearly zero-energy buildings. Definition of common principles under the EPBD, Final report–Executive Summary, Ecofys by order of the European Union. March 2013,

**[3]** ALDREN, D2.2 - ALDREN Methodology note on energy rating procedure, <https://aldren.eu/wp-content/uploads/2021/11/D2_2.pdf>

[**4]** Jarek Kurnitski, Johann Zirngibl- Technical comments on the zero-emission building definition in EPBD recast proposal