

# Technical comments on the zero-emission building definition in EPBD recast proposal



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The definition of the zero-emission building (ZEB) is a major topic in the EPBD recast proposal. It sets requirements and threshold values for primary and renewable energy impacting the installation of technical building systems. ZEB also defines class A of the Energy Performance Certificates (EPC).

In this document the problem with the actual requirements of the EPBD recast proposal of the ZEB definition are explained and illustrated by a calculation example of a residential building in Nordic climate fulfilling the current Estonian NZEB level. Proposals are made to improve the zero-emission definition.

## Actual definition of the zero-emission building

The EPBD recast proposal dated 15.12.2021 defines in **article 2.2**:

“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”

**Article 16** « Energy performance certificates » requires that **class A of an EPC shall correspond to zero-emission buildings**. The definition of the **best energy performance class A shall ensure the convergence** of the **energy performance class** scale towards a common understanding of **zero-emission** buildings.

**Annex III** provides additional details:

- The total annual primary energy use of a new or renovated zero-emission building shall be fully covered, on a net annual basis, by
  - energy from renewable sources generated on-site and fulfilling the criteria of Article 7 of Directive (EU) 2018/2001 [amended RED],
  - **renewable** energy provided from a **renewable energy community** within the meaning of Article 22 of Directive (EU) 2018/2001 [amended RED], or
  - **renewable** energy and waste heat from an **efficient district heating and cooling system** in accordance with Article (24(1) of Directive (EU) .../... [recast EED]
- A zero-emission building shall not cause any on-site carbon emissions from fossil fuels
- Only where, due to the nature of the building or lack of access to renewable energy communities or eligible district heating and cooling systems, it is technically not feasible to fulfil the requirements under the first paragraph, the total annual primary energy use may also be covered by energy from the grid complying with criteria established at national level.

## Understanding and commenting the terms of the actual version

### Total primary energy

There was a discussion among the **total primary energy** used in EPBD. It seems that this is partly caused by some terminology issues. There are differences in energy terminology details in EED (and energy statistics) and EPBD, coming from the scope and purpose of directives.

EPBD use bottom-up definitions for energy calculation in buildings and makes a reference to European standards, especially to the overarching EPB standard EN ISO 52000-1.

EED recast Article 2 ‘primary energy consumption’ definition is different from total primary energy, because EED defines primary energy as the gross available energy from which ambient heat is excluded.

Amended RED defines clearly that solar thermal, solar photovoltaic, geothermal energy and ambient energy are renewable energy and therefore are to be accounted in the total primary energy in the context of EPBD.

Historically this might have been the reason that EPBD used just ‘primary energy’ which was specified in the cost optimality regulation and EN standards to be **non-renewable primary energy**. Because EED recast Article 2 definition 44 ‘efficient individual heating and cooling’ uses **non-renewable primary energy**, this should be used consistently throughout EPBD to enable meaningful energy calculation.

### “net” annual basis

“net” is not defined in the EPBD recast proposal.

It is understood that “net” emphasizes the energy exchange between the building (e.g. exported on-site PV) and the energy infrastructure (e.g. electricity grid).

It is proposed to add a definition of “net” (see proposal in “summary”)

### fully “covered”

it is understood that the **low amount of energy** still required can be **supplied by other energy carrier than the renewables defined in annex III**, e.g. by the electrical grid, but that the total primary energy use amount shall be **compensated** (equal or lower) by

the amount of renewable energy from on-site, energy communities or district heating

It should be made clear that **other energy carriers than those mentioned to “cover” the energy still required can be used. This formulation excludes the renewable part of electricity from grid.**

**It is proposed to change “covered” by “compensate” and to include renewable energy from the energy infrastructure in the compensation.**

**It is not specified how the compensation has to be done, for example only by self-use, or also by exported energies.** As some countries allow exporting energy others not, this **decision can be taken at national basis.**

**If exported energy is not taken into account, the self-use of PV will be accounted on a net annual basis.**

### No on-site carbon emission

The EPBD recast proposal states that a zero-emission building **shall not cause any on-site carbon emissions** from fossil fuels. Therefore, the possible **delivered energy carriers of ZEB** will only be:

- district heating and cooling;
- biomass;
- grid electricity and on-site and nearby PV electricity.

This formulation is not **technology neutral** because **gas boilers and cogeneration are phased out on-site** while they are **admitted at district heating level until 2050 according to EED recast.**

A **technology neutral option** would be to require that emissions from fossil fuels shall be compensated by renewable energy generation.

### Technically not feasible

If “due to the *nature of the building ...it is technically not feasible* to fulfil the requirements ...the *total annual primary energy use* may also be *covered by energy from the grid* complying with criteria established *at national level*”.

This clause makes it possible to side pass the requirements.

**It is proposed to delete this clause.** If it is technically not feasible to fulfil the requirements, then the building will simply not be able to reach the zero-emission level.

**Attention:**

*Class A of an EPC shall correspond to zero-emission buildings (article 16).*

*There are several requirements (e.g. threshold, coverage) to be fulfilled to be classified as zero emission building.*

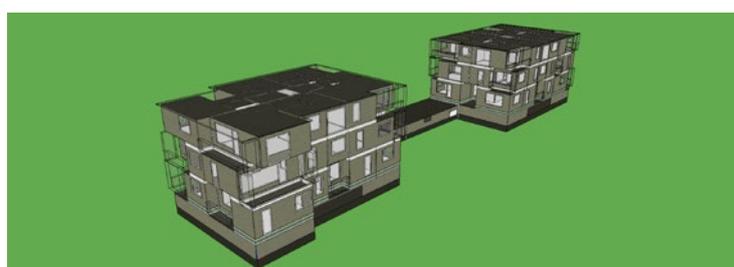
*It is not defined what happens if one of these definitions is not fulfilled. Which class the building*

*will be if not all requirements are reached? It is needed to define a class A for the EPC.*

### Example case: Comparison of a Nearly Zero Energy apartment Building (NZEB) in Nordic climate with the zero emission requirements

In the example hereafter (**Figure 1**) ZEB requirements in the EPBD recast proposal are applied to a NZEB apartment building in Nordic climate to check if and under which conditions these requirements could be fulfilled.

Apartment building calculation example (Nordic climate)					input data
Primary energy factors & CO <sub>2</sub> emission coefficients					
	non-ren.	renewable	total	kgCO <sub>2</sub> /kWh	€/kWh
Grid electricity & PV export	2.3	0.2	2.5	0.42	0.2
Natural gas	1.1	0	1.1	0.22	0.1
DH (district heat)	0.6	0.6	1.2	0.12	0.08
RE (solar, geo, ambient)	0	1	1	0	0



U<sub>wall</sub>=0.14; U<sub>roof</sub>=0.12; U<sub>floor</sub>=0.14; U<sub>window</sub>=0.9; q<sub>50</sub>=1.5 m<sup>3</sup>/hm<sup>2</sup>. Heat recovery ventilation, 80% temp.ratio, electric reheating coil. No cooling (passive measures to control summer thermal comfort). Heat source options: DH (district heating), Gas (gas boiler), GSHP (ground source heat pump) and AWHP (air to water heat pump).

System efficiencies, -	
Boiler efficiency, DH	0.90
Boiler efficiency, gas	0.95
Em&distr. efficiency	0.97

Heat pump, -		GSHP	AWHP
Energy ratio		0.78	0.81
SPF space heating		4.2	2.8
SPF DHW		2.6	2.0

Energy calculation	Energy need kWh/m <sup>2</sup> a	Energy use kWh/m <sup>2</sup> a			
		DH	Gas	GSHP	AWHP
Space heating	25.9	29.7	28.1	10.8	12.8
DHW	30	33.3	31.6	11.5	15.0
Supply air heating	4.4	4.4	4.4	4.4	4.4
Fans and pumps	5.5	6	6	5.5	5.5
Fixed lighting	1.4	1.4	1.4	1.4	1.4
PV generation	16				
PV self use, -		0.55	0.55	0.7	0.7
PV self use, kWh/m <sup>2</sup> a		8.8	8.8	11.2	11.2
PV export <sup>1)</sup> , 0/1	1	7.2	7.2	4.8	4.8
Non-ren. primary energy, kWh/m <sup>2</sup> a		28	56.0	40.6	53.1
<b>Total primary energy<sup>2)</sup>, kWh/m<sup>2</sup> a</b>		<b>81.1</b>	<b>71.2</b>	<b>93.7</b>	<b>101.8</b>
<b>Renewable energy<sup>3)</sup>, kWh/m<sup>2</sup> a</b>		<b>53.8</b>	<b>16.0</b>	<b>49.5</b>	<b>44.1</b>
CO <sub>2</sub> emissions, kgCO <sub>2</sub> /m <sup>2</sup> a		5.8	11.4	7.4	9.7
add. PV to compensate total primary energy		10.9	22.1	17.7	23.1
add. PV to compensate CO <sub>2</sub> emission		13.8	27.1	17.7	23.1
Energy cost <sup>4)</sup> , €/m <sup>2</sup> a		5.2	6.1	4.2	5.3

1) PV export not taken into account =0, is taken into account = 1

2) If PV export=0, only self used PV is accounted in the total primary energy

3) Renewable energy does not include renewable energy from grid electricity as specified in EPBD draft

4) Exported electricity compensation is assumed to be 1/3 of the electricity price

**Figure 1.** Example case: Comparison of NZEB building in Nordic climate and the zero-emission level.

EPBD No 1  
EPBD No 2

This building configuration meets current Estonian NZEB requirements with District heating (DH) and Ground Source Heat Pump (GSHP) if PV generation is 16 kWh/(m<sup>2</sup>.y). Air to Water Heat Pump (AWHP) would need some improvement and gas would need major changes.

**EPBD recast proposal** sets, as first requirement, the total primary energy for residential ZEB in Nordic climate to 75 kWh/(m<sup>2</sup>.y).

**Figure 1** indicates the primary energy factors and CO<sub>2</sub> emission coefficients of the different energy carriers (including renewables as thermal energy extracted by the heat pumps).

**Figure 1** line “EPBD No 1” shows that only **the gas boiler will reach** this first requirement of the zero-emission definition when calculated with PV export. Especially heat pump systems will have difficulties because the total primary energy (see **Figure 1**) includes the renewable part taken from the environment.

The **second** requirement in the ZEB definition ask to **fully cover**, on a net annual basis, the total primary energy use by renewables (without renewables from the energy infrastructure). **Figure 1** line “add. PV to cover “tot. prim. energy” shows that to fulfil this requirement a high amount of **additional on-site PV generation** would be needed. This would be practically impossible in the example because the roof allows only to install 24 kWh/(m<sup>2</sup>.y) PV generation.

**These results show that the total primary energy-based requirements are not sound.**

## Proposals to revise the ZEB definition

### First requirement (threshold on primary energy use):

It is proposed to revise the first requirement by changing from “total primary energy use” to “non-renewable primary energy use”.

#### Rational:

If “total primary energy” is calculated according to existing, physical correct definitions (including the ambient heat recovered by the heat pump, heat pumps will have very high total primary energy use because of extracting energy from ambient. The valorisation of on-site renewables will be less.

**Figure 1** shows that the non-renewable primary energy-based requirements can be reached. It is in line with the NZEB definition. **The non-renewable primary energy use will allow to limit the non-renewable primary consumption and valorise the renewables.**

It is understood that the reason to use the **total primary energy** was chosen to **keep a good quality of the building envelope** and high system efficiencies which should not be possible to compensate with extensive amounts of renewable energy generation. Therefore, by changing from “total” to “non-renewable” primary energy **this limitation must be re-established.**

These limitations could be related to the building needs (e.g. for NZEB building), to the efficiency of the technical building systems, etc. They should be defined in the chapter related to NZEB buildings.

**It is proposed that Annex III refer to it.**

### Second requirement (zero emission level):

The **first requirement is close to the definition of a nearly zero (non-renewable) primary energy building** (low amount of energy). The **second requirement** of the EPBD recast proposal add as **zero-emission level** by the coverage (compensation) of the total primary energy use by **renewables**.

**It is proposed to replace** the coverage of the **total primary energy use** by the coverage of the **CO<sub>2</sub> emissions**. This makes this requirement straightforward, clearly focussing on the target of zero-emission.

To illustrate how to reach to zero-emission level **Figure 1** line “add. PV to compensate CO<sub>2</sub> emission” shows the amount of how much additional **PV should be installed** to cover the emissions. It is likely that zero-emission is not reachable in Nordic climate, because of the higher heat losses and lower solar radiation than in southern countries. Future cost optimality calculations, including better insulation, DHW heat recovery, higher system efficiency or a higher amount of delivered renewables, would help to clarify the situation.

Zero Energy Buildings



## Summary

If including onsite renewables in the total primary energies, the **total** primary energy does not allow meaningful energy calculation because not distinguishing renewable not causing CO<sub>2</sub> emissions from non-renewable energy causing CO<sub>2</sub> emissions. Also, the sustainability of renewables is neglected.

Attention is also drawn to the target of ZEB definition to be zero-emission. Not primary energy but CO<sub>2</sub> emissions should be fully covered/compensated by renewable energy to be zero-emission.

Therefore, and to clarify several terms, the following improvements could be proposed:

### Article 2 Definitions

“Net energy” means the balance of energy exchange between the building (e.g. exported on-site PV) and the energy infrastructure (e.g. public grid).

### Article 2.2. 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 **CO<sub>2</sub> emissions due to energy still required use** is fully covered **compensated** 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 **or from energy infrastructure**, in accordance with the requirements set out in Annex III.

### ANNEX III

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

An additional requirement shall be added to avoid that the energy use (building quality) is too much compensated by renewable energy.

Replace “**total**” by “**non-renewable**” in the Figure and note.

- The ~~total annual primary energy use~~ CO<sub>2</sub> emission of a new or renovated zero-emission building shall be fully ~~covered~~ compensated, on a net annual basis, by energy from renewable sources generated on-site, energy infrastructure and fulfilling ...
- With proposed changes the following requirement becomes redundant and can be deleted. ~~A zero-emission building shall not cause any on-site carbon emissions from fossil fuels.~~
- To avoid negative side-effect of exceptions, delete the following: ~~Only where, due to the nature of the building ... from the grid complying with criteria established at national level.~~

The proposed updates of the ZEB definition summarise the EU’s main objectives (Energy efficiency, use of renewables, CO<sub>2</sub> neutrality) with a couple of common indicators. This set of indicators is based on the NZEB definition, underlining the convergence of the energy performance class scale towards zero-emission buildings by limiting negative effects of a single indicator. ■

