EXECUTIVE SUMMARY:

COMMON CRITERIA AND PRINCIPLES FOR PUBLIC BUILDING nZEB DEFINITION IN SOUTH AND EAST EUROPEAN COUNTRIES

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Executive summary: Common principles for nZEB definition

RePublic_ZEB Project

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Project consortium

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Project overview

The RePublic_ZEB project is focused on the energy and CO₂ emissions associated with existing public buildings and their refurbishment towards nZEB.

The core objective of the project is to:
  • Define costs-benefit optimized “packages of measures” based on efficient and quality-guaranteed technologies for the refurbishment of the public building stock towards nZEB that are standardized and adopted by builders and building owners.

From this stems three basic objectives:
  (i) State-of-the-art assessment of the public building stock through a country-specific evaluation of the energy consumption and CO₂ emissions;
  (ii) Define reference buildings; and;
  (iii) Develop a common framework and a harmonized methodology for the definition of a nZEB concept for public buildings.

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Executive Summary

This document is one of a series of executive summary of the core deliverables of the RePublic_ZEB project. This is a summary of the second deliverable in Work Package (WP) 3. The flow chart below shows its context in the overall project.

1. Objective

The objective of this report is to review the main definitions of nearly zero energy buildings (nZEBs), and to propose a harmonized methodology for the definition of nZEB including the principles, the energy flow and the system boundary for nZEB public buildings.

2. Introduction

The general definition of nZEB was introduced in Directive 2010/31/EU (EPBD recast). According to Article 2 of the EPBD recast, an nZEB means a building that has a very high energy performance (EP), and the very low (nearly zero) amount of energy required should be largely met from renewable sources, which can be located on-site or nearby.

The calculated or measured amount of energy has to meet the demand associated with typical use of the building, which includes energy needed for heating, cooling, ventilation, hot water and lighting. Article 9 (3a) of the EPBD recast requires Member States to describe the detailed application of the definition of nearly zero energy buildings in practice, including a numerical indicator of primary
energy use expressed in kWh/m² per year. All of the target countries of RePublic_ZEB, except Macedonia, have transposed the general definition of nZEB into national legislation, however many of them have yet to elaborate on the application of the definition or propose a numerical requirement in terms of annual primary energy use. Figure 1 shows nZEB requirements for offices in some of the target countries.

This report reviews the relevant standards and research and considers the legislative status and requirements of the target countries, and presents a common framework and a harmonized methodology for the definition of nZEB public buildings.

3. Energy flow and system boundary

The energy flow and system boundary of nZEB public buildings is shown in Figure 2. The corresponding unit of balance is non-renewable primary energy, and the national primary energy factors are considered in the building energy calculations. All components of the building energy requirement – such as heating, cooling, ventilation, DHW and lighting – are included in the energy performance, except the energy used for appliances. Furthermore, lighting is not included in the energy performance of residential buildings.

The building energy use is the energy used by the building technical systems, which includes all the conversion and system losses. The renewable energy produced on site is deducted from the amount
of energy delivered to the building site, and is taken into account in the calculation of the delivered and exported energy balance at the site. The proposed calculation methodology, the consideration of non-renewable net primary energy is consistent with the guideline accompanying Commission Delegated Regulation (EU) No 244/2012 that has to be followed by each Member State in setting cost optimal requirements. This nZEB concept should be introduced in national legislation for the building EP calculation.

**Figure 2. System boundary for delivered and exported energy on site**

*(Original source: Rehva Report No. 4. REHVA nZEB technical definition and system boundaries for nearly zero energy buildings)*

### 4. Requirements for nZEB

#### 4.1 Overall requirement

The solutions to be considered for nZEB, should meet the following general criteria:

- the EP is lower than the cost-optimal levels (nZEB is more energy efficient than a cost-optimal building);
- the differential Global Cost (\(\Delta GC\)) is negative (i.e. nZEB is cost-effective)\(^1\);
- the national minimum energy performance requirements for nZEBs are fulfilled.

Thus, three indicators have been proposed to be used for the specification of nZEB public buildings:

1. Non-renewable primary energy

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\(^1\) It could be argued that a solution with very high energy efficiency but which is not cost-effective is acceptable.
2. Renewable Energy Ratio
3. CO₂ emission

4.2 Non-renewable primary energy

Considering non-renewable primary energy with the deduction of the exported energy for nZEB public buildings is in line with the guideline accompanying Commission Delegated Regulation (EU) No 244/2012. It is also consistent with the proposal of the standard prEN15603:2015 (Final nZEB rating: Numerical indicator of non-renewable primary energy use with compensation, Annex H.5 in the standard).

The upper limit of the primary energy requirement set according to the principle of cost optimality, is the least ambitious, whilst the lower limit can be set considering the best available technology, which may not be cost optimal currently.

The available (i.e. existing in the target countries’ legislation) cost optimal primary energy consumption of the main public building categories is presented for those countries that have undertaken the cost optimal calculations according to the EPBD recast. (Some target countries are still to fulfil the requirement to define cost optimality.) As an example, Figure 3 shows cost optimal primary energy consumption for educational buildings.

Figure 3. Cost optimal primary energy consumption in educational buildings

These values were taken into account as an upper limit to the primary energy of nZEB.
The lower limit of the primary energy consumption can be set by considering the best available technology as mentioned above. To calculate this level of primary energy takes into account the proposed packages of measures to refurbish public buildings, including energy efficiency measures for the building envelope (insulation of external walls, roof, window replacements, solar shading, etc.), high efficiency HVAC systems and solutions (low temperature heating, high efficiency heat recovery system, etc.) and energy generation systems that use renewable energy sources (thermal solar collector, PV, geothermal heat pump, etc.).

These packages of measures are developed in the next project report and dynamic building energy simulations are undertaken in WP4 of the RePublic_ZEB project. Therefore, at this point, the lower limit of the primary energy can only be estimated from:

1. nZEB requirements in South and East Europe
2. Simulation results of other nZEB related projects
3. Data from nZEB best practice buildings.

4.2.1 nZEB requirements in South and East Europe

Some of the target countries have introduced nZEB primary energy requirements. The primary energy consumption includes energy services, such as heating and cooling, ventilation and lighting, as well as the energy consumption to produce DHW, which makes comparison of the available primary energy values difficult. From the overall primary energy need, the heating energy is roughly proportional to the heating degree day (HDD); however the other parts of the primary energy consumption are influenced by many parameters (e.g. internal heat loads, fresh air need, national standards for DHW and lighting, etc.). Therefore only the heating energy content of the primary energy consumption could be assessed.

The comparison of the existing nZEB primary energy values of heating was achieved by introducing the primary energy ratio (PDD), which is the ratio of the primary energy of heating to the HDD of the climatic zone. Based on this analysis the most ambitious and achievable PDDs were selected as reference values to set the primary energy requirement for space heating and ventilation for those target countries which have not formulated the nZEB primary energy requirement, and to propose stricter requirements for those countries where the requirement does not seem to be sufficiently ambitious.

As a result of the analysis, the primary energy of heating in nZEB public buildings in South and East European countries are estimated depending on the geographical location and the climatic condition:

- nZEB office building: 7-44 kWh/m²a
- nZEB residential building: 6-42 kWh/m²a
- nZEB educational building: 6-38 kWh/m²a
- nZEB health care building: 11-71 kWh/m²a

4.2.2 Simulation results of other nZEB related projects

The corresponding results of the building energy simulations performed in the report Towards nearly zero energy buildings are available for some South and East European cities:

- Zone 1 Catania (Athens, Palermo, etc.): new nZEB office building’s non-renewable primary energy use: 17-30 kWh/m²a
- Zone 3 Budapest (Ljubljana, Milano, etc.): new nZEB office building’s non-renewable primary energy use: 38-55 kWh/m²a

It should be noted that these non-renewable primary energy figures refer to new office buildings, whereas the refurbishment of existing public buildings may have some technical constraints, so the values for refurbishment of public buildings are likely to be less demanding.
4.2.3 Data from nZEB best practice buildings

An nZEB office building located in Helsinki was analysed as best practice. The weather conditions and the primary energy factors of Helsinki differ from the target countries, therefore the net energy demand and the primary energy factors were adjusted in order to ensure the adaptability of these values to the target countries.

As a result of the analysis the non-renewable primary energy of nZEB office buildings within the target countries of the RePublic_ZEB project is estimated between 42-83 kWh/m²a, depending on the climatic conditions.

4.3 Renewable Energy Ratio

The first WP3 report showed that there is a significant variation in the mandatory share of renewable energy. It should be noted that the proposal for the RER requirement for refurbishment of public buildings in the target countries has to be flexible. It needs to take into consideration the GDP, the average global horizontal radiation, and the summer and winter climatic conditions. Taking these into account, Figure 4 shows proposed RER requirements for the refurbishment of public buildings towards nZEB level in each target country.

![Figure 4. Proposed RER for nZEB refurbishment](image)

4.4 CO₂ emission

Introducing an indicator on the CO₂ emission of buildings is a good way to ensure coherence and consistency between the long-term energy and environmental goals of the EU. Therefore both the primary energy and the CO₂ emission should be considered as indicators for nZEB.
The CO₂ emission depends on the CO₂ content of the energy that is used in the building. The CO₂ emission can be calculated using the national CO₂ conversion factors [gCO₂/kWh]. The conversion factor for electricity depends on the fuel-mix and the efficiency of the power plant. As a consequence the requirement for CO₂ emission will not be the same in each target country.

Some example figures are given in this report but the energy simulation in WP4 addressees CO₂ emissions from nZEB refurbishment in greater detail.