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Overview and future challenges of nearly zero energy buildings (nZEB) design in Southern Europe

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ABSTRACT

In times of great transition of the European construction sector to energy efficient and nearly zero energy buildings (nZEB), a market observation containing qualitative and quantitative indications should help to fill out some of the current gaps concerning the EU 2020 carbon targets. Next to the economic challenges, there are equally important factors that hinder renovating the existing residential building stock and adding newly constructed high performance buildings. Under these circumstances this paper summarises the findings of a cross-comparative study of the societal and technical barriers of nZEB implementation in 7 Southern European countries. The study analyses the present situation and provides an overview on future prospects for nZEB in Southern Europe. The result presents an overview of challenges and provides recommendations based on available empirical evidence to further lower those barriers in the European construction sector. The paper finds that the most Southern European countries are poorly prepared for nZEB implementation and especially to the challenge/opportunity of retrofitting existing buildings. Creating a common approach to further develop nZEB targets, concepts and definitions in synergy with the climatic, societal and technical state of progress in Southern Europe is essential. The paper provides recommendations for actions to shift the identified gaps into opportunities for future development of climate adaptive high performance buildings.

1. Introduction

The Climate-Energy Framework 2020 sets three key targets to cut 20% in green gas emissions (compared to 1990 levels), increase the EU renewables share by 20% and improve energy efficiency by 20% [1]. The main instrument to achieve those targets in the building sector is the Energy Performance of Building Directive (EPBD) recast that sets the standards for new and renovated buildings across Europe. The Directive 2010/31/EU (EPBD) at Art. 9 indicates that EU Member States (MS) must ensure that by 2021 all new buildings, and already by 2019 all new public buildings, are nearly Zero Energy Buildings (nZEB) and MS should draft plans and "...encourage best practices as regards the cost-effective transformation of existing buildings into nearly zero-energy buildings"

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Nomenclature

AEC	Architectural, engineering and construction
AC	Air conditioning
ACH	Air change per hour
BEPOS	Bâtiment à énergie positive
BPS	Building performance simulation;
CEN	European committee for standardization
DBT	Dry bulb temperature
DHW	Domestic hot water
EE	Energy efficiency
EPBD	Energy performance building directive
EPC	Energy performance certificate
EUI	Energy use intensity
EU	European Union
FIT	Feed-in tariff
HRV	Heat recovery ventilation
HVAC	Heating, ventilation and air conditioning
IEA	International Energy Agency
IEE	Intelligent Energy Europe
LCA	Life cycle assessment
MS	Member states
MVHR	Mechanical ventilation with heat recovery
nZEB	Nearly zero energy buildings
NZEB	Net zero energy buildings
OT	Operative temperature
PE	Primary energy
PEF	Primary energy factor
pH	Passive house
PMV	Predicted mean vote
PPD	Predicted percentage dissatisfied
PV	Photovoltaic
RES	Renewable energy systems
SCOP	Seasonal coefficient of performance
SEER	Seasonal energy efficiency ratio
SFP	Specific fan power
SHW	Solar hot water
SME	Small and middle enterprise
VRF	Variable refrigerant flow
WWR	Window to wall ratio

[2]. Accordingly, most MS revised recently the existing rules, regulations and guidelines as well started to set up the means for increasing the penetration of those high performance buildings by setting up the nZEB definitions on the national level. However, there are significant differences in the progress and implementation of nZEB across the 28 MS. From one side, Northern MS managed to develop or adapt concepts, definitions and construction technologies of nZEB that are effective and correspond to their heating dominated climates. The PassiveHouse (pH) standard is an example for that. On the other side, Southern MB are still trying to find the most adequate solutions taking into account the local climate and local cultural, social, technical and economic context.

Therefore, the objective of this paper is to provide an overview on the technical and societal challenges of applying nZEB in Southern Europe. The overall aim is to provide a better understanding of nZEB and their market uptake barriers. The cost challenge is excluded from this study because it is discussed in other studies [3]. The study focus is mainly on countries falling between latitude 35°N and 45°N and includes a literature review of more than 95 publications on nZEB implementation in Southern Europe. For this study, we have selected 7 countries, namely Cyprus, France, Greece, Italy, Portugal, Romania and Spain, for which we could have access to representative information and insights. We find the selected countries as significant regarding their population size and buildings stock proportions that represent more than 33% of the European residential buildings stock (see Fig. 1). The originality of the paper is twofold. The paper provides a broad overview on the challenges of nZEB bringing insights from 7 Southern member states, which was not done before. Also, the paper identifies possible synergies between similar climate regions, which can bring a consensus for best practices in Southern European countries regarding deep renovation, to bridge the energy gap and increase the nZEB uptake.

The methodology used consists of reviewing the state of the art in the 7 member states. The first part of the methodology is based on a literature and case studies review. The second part is based on a questionnaire. By proposing five key questions to 14 national experts from Cyprus, France, Greece, Italy, Portugal, Romania and Spain we developed the paper content with a focus on new and existing residential buildings. The five questions are listed below:

1. What is the minimum energy efficiency threshold for nZEB in your country?
2. What is the heating/cooling energy needs balance for nZEB in your country?
3. What is the thermal comfort limit for nZEB in your country?
4. What is the minimum renewables threshold for nZEB in your country? What are the recommendations for minimum EE and RET in your country? (EE energy efficiency, RET Renewable Energy Threshold onsite).
5. What is the construction quality for nZEB in your country?

A post processing phase followed the questionnaire results analysis. The analysis is based on facts tracing to allow the assessment of the existing possibilities and the status of the nZEB legislation and policies as they were applied in these countries in last few years. By this analysis we do not pretend to predict the future, but we can identify the features of the current nZEB situation and assess its development trends. Therefore, we have adopted the method of analysis looking at the social/political and technical backgrounds behind nZEB in Southern Europe. Finally, the analysis provides guidance on the challenges and constraints in each MS and provides an overall list of recommendations and conclusion for nZEB in Southern Europe. This paper is organized into four sections. The first section introduces the research and identifies the research problem, objective and significance. The second section provides an overview of the main challenges of nZEBs in Southern Europe from a technical and societal point of view. The third section summaries different approaches and barriers to implement nZEB in Southern Europe. The final section discusses and concludes the study outcomes, implications and limitation while providing useful recommendations.

2. Nearly zero energy buildings in Southern Europe

The zero energy buildings and zero carbon buildings goals seeking maximum efficiency derive from the notion of neutralizing the resource consumption and define this as zero energy consumption. The design process involves an integrative approach looking to:

1. reduce energy needs for heating and cooling by optimising the envelope and integrating passive heating and cooling techniques;
2. improve energy efficiency of active systems
3. and incorporate renewable energy.

Various potential definitions of Net Zero Energy Buildings (NZEB) were first discussed and proposed on an international level in 2008 [4]. Many of those definitions require a zero energy bal-