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Retos para una definición de "Edificios de consumo energético casi nulo"

Challenges for a definition of Nearly Zero Energy Buildings

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Abstract

The concept of 'nearly zero energy buildings' (nZEB) could represent a more sustainable aspiration within construction policies, although it has been a little analyzed approach in the Latin-American context. Currently there are different approaches in the world to determine the appropriate requirements and methodologies to define buildings as nZEB. The present work is based on an analysis of the main common variables defined in the international literature to establish this classification such as the buildings passive design, the energy balance methodology and the indicators of renewable energy. It is defined and it is discussed the five main challenges for Cuba, analyzed country as a study case, if a similar energy efficiency directive is implemented in buildings, based on a comparison between the European experience in energy efficiency and the national situation. The presented discussion about the challenge of establishing a suitable national directive according the regional features is useful for analyzing the Latin-American region.

Keywords: *Nearly-zero energy buildings, energy efficiency, renewable energy sources, environmental performance of buildings, sustainable architecture*

Resumen

La concepción de 'edificios de consumo de energía casi nulo' (nZEB) podría representar una aspiración más sostenible dentro de las políticas de construcción, aunque ha sido un enfoque poco analizado en el contexto Latinoamericano. Actualmente existen distintos enfoques en el mundo para determinar cuáles son los requerimientos y metodologías apropiados para definir a las edificaciones como nZEB. El presente trabajo parte del análisis de las principales variables comunes definidas en la literatura internacional para establecer esta clasificación, tal como el diseño pasivo de las edificaciones, las metodologías de balance energético y los indicadores de energía renovable. Se definen y discuten los cinco retos principales para poder establecer en el ámbito nacional, una directiva de eficiencia en edificaciones, similar a la del contexto europeo, a partir de una comparación entre la experiencia ya existente en este campo y el contexto actual de Cuba, país que se asume como caso de estudio. La discusión que se presenta ante tal desafío, resultaría válida para analizar el contexto latinoamericano actual.

Palabras clave: Edificios de consumo de energía casi nulo, eficiencia energética, fuentes renovables de energía, comportamiento ambiental de las edificaciones, arquitectura sostenible

1. Introduction

Constructions have been considered responsible for a significant part of global greenhouse gas emissions. This is why the European Union (EU) has set as a goal for 2020 that all new buildings will have to be "nearly zero energy buildings" (nZEB). This means that they must be buildings with high energy efficiency and they must largely meet their low demand for energy from renewable sources at or near the site (Unión Europea, 2010). This position has changed the way of solving energy problems in constructions, due to the fact that it has integrated with the same object of analysis, consumption and generation valuations, as well as the energy impact of design and construction. This new model of architecture is widely accepted outside the European regional bloc in contexts as dissimilar as the United States, India and China.

With the implementation of the European regional directive, there were intense discussions about the definition of nZEB due to its generic nature (Garde et al., 2014). It was questioned, among other things, the terms that were left to the individual interpretation, such as the meaning of "very high level of energy efficiency"; the amount of a "broad measure of renewable energy sources" or the limits of the "site and environment" to establish that the object analyzed is within or near it. According to (Sartori et al., 2012), ambiguity is necessary for each State or region to define this conception based on their specific weather conditions, infrastructure and traditions, among other aspects. This process has effectively been carried out, and 60% of EU Member States now have a legal document that establishes what they consider and expect to be an nZEB building based on requirements that are not uniform. (Unión Europea, 2016).

This issue has been little discussed in the Latin American context, despite the fact that the endogenous assimilation of this new global paradigm in the field of buildings would contribute to increasing resilience to climate change. The present work is the result of a broader investigation, which initially had to confront these definitions in order to establish a current and contextualized theoretical framework. The main challenges involved in drawing up a similar directive are discussed, based on the key elements that previous research has determined in order to identify

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buildings as "nearly zero energy consumers". Cuba is taken as a study case since, despite the actions aimed at mitigating global warming and guaranteeing energy security, more comprehensive projections and approaches are still required in the construction sector in order to respond to new environmental challenges.

2. Materials and methods

At present, there are different approaches that determine the requirements and methodologies appropriate to nZEB buildings. Despite the fact that each country has its own indicators and parameters, a number of research projects have been based on a common framework in order to group different trends together (Unión Europea, 2016); (Sartori et al., 2012); (Marszal et al., 2011); (Hermelink et al., 2013).

In order to establish the challenges presented in the work, a state of the art approach to buildings with nearly no consumption is used, based on referenced publications, as well as reports on the implementation of national and regional energy directives. The basic principles under research include the passive design of buildings, the energy efficiency of equipment, human comfort, energy sectors considered, the physical limit of the object of study, standardization of indicators and climate data, renewable energy options and indicators, the relationship with the electrical infrastructure, energy storage and the balance methodology. This first stage is based on theoretical research based on the bibliographic review of standards and regulatory documents on the subject in different countries and regions. In addition, interviews were conducted with Belgian experts working in the Department of Architecture & Urban Planning of the School of Engineering & Architecture from the University of Ghent.

In a second stage, the Cuban context characterizes the determining variables for a future national definition of nZEB based on the main published literature on these topics and interviews with experts in the fields of energy, renewable sources, energy efficiency and passive building design.

The confrontation between the international state of the art and the main deficiencies and conflicts to be solved in each of the variables in the country allowed defining which the five main challenges to implement a similar directive in the Cuban context are. The main issues that have more weight for developing countries are discussed, as well as those that determine a different way of analyzing and solving the energy impact of buildings.

The main unquestionable challenge lies in the fact that this topic has not been discussed previously in the country, which would require multidisciplinary research to establish its own parameters and indicators. This analysis is presented as the first approach to this issue from the point of view of the authors.

3. Results and discussion

Challenge 1: The energy impact of buildings has to be limited by regulations.

This is the main objective of establishing a directive for nearly zero consumption buildings, which means reducing it to a range in which the cost-benefit investment is considered adequate. Each nZEB directive in Europe establishes the methodology to estimate the permitted energy balance. In general, all of them calculate the amount of primary energy consumed in a year, from which the amount of generation from renewable energy sources (RES) in the same period is subtracted, and the result must meet the range (kWh/m^2/year) established by each country (D'Agostino, 2015). This value is not the same in all cases, nor are the parameters used to define it. A preliminary comparison between international nZEB and hotels in Havana showed as a result that the indicators in the selected Cuban cases are double or even triple than those of European hotels classified as nZEB and other examples considered as nZEB in hot humid climate (Collado et al., 2018) See (Figure 1). This shows that in Cuba, despite the existence of standards and the fact that measures are taken to avoid high energy consumption[1], there are no buildings with high energy efficiency that can be compared to the standards met abroad.

[1] Energy plans are included within the government measures, which limit monthly consumption. The main control strategy for the private and residential sector is the collection based on differentiated rates.

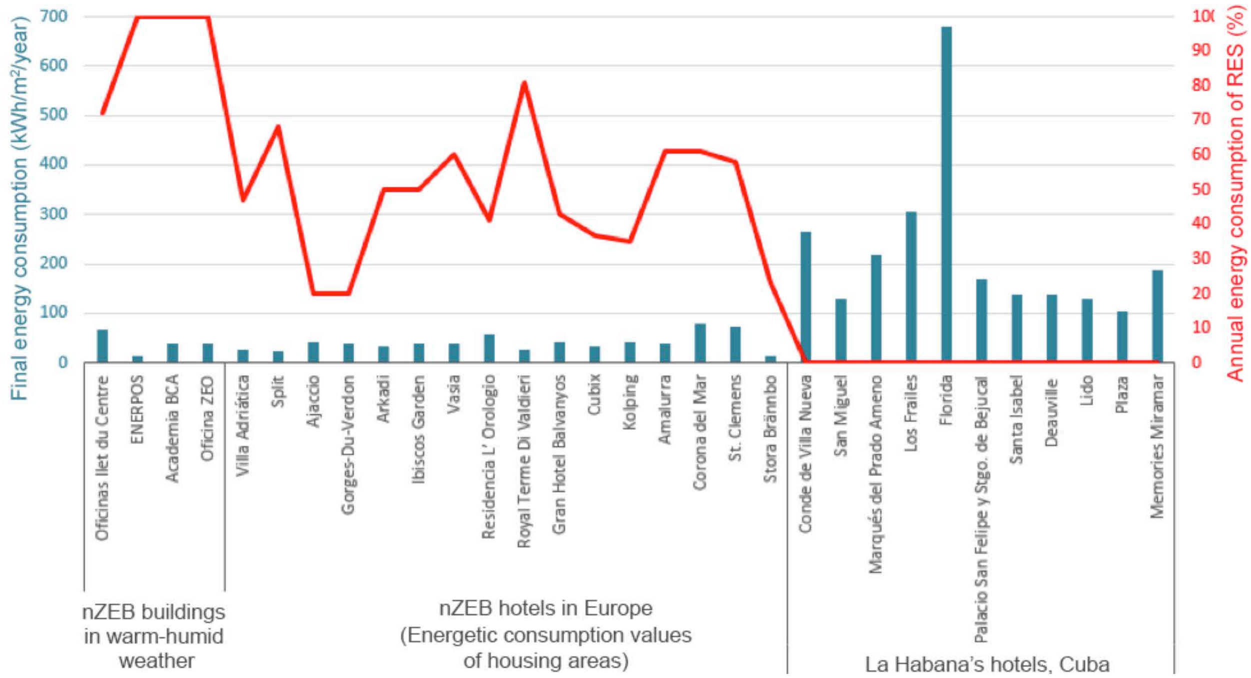

Figure 1. *Indicator of final energy consumption in study cases and generation through RES. Source: (Collado et al., 2018)*

The three types of calculation methods for energy balances, according to ISO 13790, are the "Almost Stable Monthly State Method" (used in Belgium), "Simple Hourly Calculation Method" (used in France and Finland) or "Dynamic Simulation Methods" (Santos et al., 2014). According to (Carlier, 2016), differences in these methods lead to a variation in the results due to the number of assumptions in the values they define the balancing methodology, as well as the elements considered from the volumetric-spatial solution [2] within the calculation of the energy balance. Currently in Cuba, there is no comprehensive calculation methodology that establishes the energy consumption of buildings.

The selection of the elements to consider within the energy balance is another of the requirements that are different from the EU. According to the Buildings Performance Institute Europe, (BPIE, 2015), countries should consider the consumption of heating, air-conditioning, hot water and ventilation for residential buildings, as well as lighting in buildings with other functions such as offices. However, several national definitions also take into account the consumption of ancillary systems, as well as household appliances in countries such as Austria, Estonia, and Finland. Other aspects less considered are electrical mobility and the water treatment system (Sartori et al., 2012). For example, in the Estonian definition of nZEB, a residential building is allowed a maximum of primary energy between 50 and 100 kWh/m^2 (including appliances) while in Romania the admitted range is between 93 and 217 kWh/m^2 (excluding appliances) (BPIE, 2015). This is one of the influential factors in the existence of international approaches that aspire to net zero energy buildings, and to buildings with surplus energy.

Although this admissible range is given in most countries from primary energy as a metric of the balance[3] and CO_2 emissions, the first to consider, in addition to consumption, transmission, conversion and generation losses (Hermelink et al., 2013), and the second case because it gives greater weight in the evaluations to the reduction of greenhouse gas emissions[4]. Other metrics for making existing energy balances are final energy, energy costs and environmental credits. The latter two options, while incentivizing investments in renewable energy sources, do not stimulate major changes in the design of buildings. In Cuba, most energy analyses are carried out on the basis of final consumption and only data on primary energy values are provided at the national level (ONEI, 2008).

In order to be able to use a metric in the balance, it is necessary to have conversion factors of the energy carriers defined at national or even regional level, based on the real

[2] Some European countries include within the calculation of the energy balance parameters of the spatial volumetric solution such as the area of the surface of the architectural envelope, the area that needs heating, the volume of the space and the surface that has access to natural light. (Carlier, 2016).

[3] The metric of the energy balance is considered to be the unit of measurement by which "the nearly zero" consumption is measured.

[4] Only including CO_2 emissions as an indicator could promote the use of nuclear energy (Payne et al., 2010), an alternative highly criticized for the potential risks of accidents and the radioactive waste it generates (McCombie and Jefferson, 2016).

conditions of each context[5]. These factors can also be used to promote or control the use of a given energy source, as in the case of the Swiss regulation that assigns a very high conversion value to biomass in order to avoid widespread use of this resource (Sartori et al., 2012) and prevent negative impacts such as damage to biodiversity, food production, and indiscriminate felling of forests (McCombie and Jefferson, 2016). In Cuba, the established factors convert the consumption of some energy carriers into equivalent tons of oil (ONEI, 2008). These do not consider all energy carriers (such as some RES), but in addition, they are not sufficiently updated or have very little accessibility and diffusion.

The energy range determined by each country is standardized for a given area (kWh/m²/year), however, the type of surface assumed by each methodology also varies. Among the options used are the area of use, the net area and the treated area (with heating or air conditioning). Other methodologies also take buildings and the number of people as a unit of measurement (Hermelink et al., 2013). It is also necessary to standardize the weather conditions considered in the energy assessment of buildings, which consists of defining a typical year for each region/city based on the standard time behavior of several years (Won et al., 2016).

Few architecture programs in Cuba have energy efficiency indicators. The main hotel chains have defined energy consumption indicators for their facilities in accordance with the daily room occupancy rate (kWh/HDO (from the Spanish Habitación Día Ocupadas)). However, this type of indicator has already been criticized, because it does not reflect the influence of the energy consumption of services, does not take into account the variations in volume and area between rooms, and does not consider the influence of outside temperature (Cabrera et al., 2006).

Beyond the fact that most regulations seek to enforce high energy performance from quantitative indicators, various requirements must be met, considering, for example, the different typologies of buildings and architecture programs. It is recommended, even for buildings with different service subsystems such as hotels, to define specific indicators for each one since they allow a more precise evaluation of energy efficiency solutions (Tsoutsos et al., 2013).

It should also be important to consider the impact of the urban context on energy behavior, as it could be a conflict that high RES generation requirements in buildings could lead to the design of regular block scale profiles to avoid the shadow cast from one volume on another (as solar thermal and photovoltaic systems are some of the most used).

While the European goal is to reach 2020 with all its new buildings considered to be nZEB, a lot of research has also been done and measures have been taken to transform existing buildings. This entails detailed analyses, not only on the technically and economically feasible solutions to be implemented but also on the impact of these measures on the values present in the inherited built heritage.

Challenge 2: It will never be enough to generate energy from renewable sources if the design of buildings and equipment is not energy efficient.

The design concept of nZEBs must passively use the energy found in nature (such as when natural lighting and ventilation are guaranteed) and avoid negative consequences, such as heat gain from solar radiation. In addition, these buildings must use energy efficient equipment and technologies to minimize consumption, solutions associated with automation systems and energy control of buildings. It is only when "high energy performance" is achieved (Unión Europea, 2010) that renewable sources of energy should be used, with a view to further reducing the consumption of fossil fuels.

Energy efficiency in the passive design of buildings and equipment is internationally regulated by different standards that define the parameters and minimum requirements that must be met. Most of these regulations have been updated over the last decade to incorporate stricter requirements to achieve the nZEB goal. Several regulations also establish different performance scales based on energy labels (as is common in the classification of household appliances), such as in Norway, Bulgaria, Italy, Lithuania, Spain, and France. This type of energy classification for constructed spaces is considered a best practice, as it encourages meeting very high standards, but at the same time establishes minimum ranges to meet nZEB requirements.

As part of 22 national nZEB definitions, in Europe, indicators of envelope performance are declared EPBD, 2015 (European Commission, 2015). These are generally related to the Global Heat Transfer Coefficient of the walls, fenestrations and covers. Similarly, six of these nZEB definitions establish indicators to assess the performance of building technology systems EPBD, 2015 (European Commission, 2015).

In Cuba, the basic standard that establishes design requirements for energy efficiency is NC: 220 2009 (Oficina Nacional de Normalización, Cuba, 2009), as well as those that guarantee an adequate indoor climate[6]. International standards of the ISO system are currently being evaluated for possible adoption. However, the main problem to be faced is to change the prevailing trend at some decision-making levels, mainly in the housing construction sector, that is to pay much attention to the initial implementation costs and little to energy consumption during the life cycle of buildings (González, 2009). In those constructions, in which the investment processes have a greater budget, the greatest danger is to import foreign projects, as well as the copy of stereotyped designs related to great development, mostly associated with complete glass facades, with almost no solar protection and very little use of natural ventilation see (Figure 2).

[5] For example, in European countries where they have nuclear power plants, the factor for converting electricity consumption to CO_2 emissions is lower than in those that do not have this generation system. In these factors, the technical state of the electrical infrastructure for converting from final to primary energy is also included.

[6] NC: 198 (2004) Buildings. Code of Best Practice for the Design of Visual and Thermal Indoor Climate (from the Spanish Código de buena práctica para el diseño del clima interior térmico y visual); NC: 166 (2002) Buildings. General Principles for the Environmental Design of Interior Spaces of Buildings (from the Spanish Principios generales para el diseño ambiental de los espacios interiores de los edificios); NC: 1005 (2014) Buildings. Requirements for daylighting calculation.

Figure 2. *SW façade of the Panorama Hotel, Miramar (left) and proposed SE façade of a future hotel in the central region of La Rampa (right). Source: (Tripadvisor, 2019).; (Granma, 2018)*

Challenge 3: Power generation must have solutions at the national, regional and local levels.

The initial conception of the nZEBs considered the scale of the energy problem only for buildings, as individual entities within urbanized or rural contexts. At present, research proposes larger built environments such as public spaces, urban blocks, sectors or even communities or cities (Strasser et al., 2017) because of the advantages offered by the system work for the use of the RES, the technological possibilities offered by a larger study area, and the management of the potentials and restrictions of the context with respect to the sun and the wind (Himpe and Janssens, 2014). This is a recommendation that could be complex for any country from the point of view of management and investment, due to the diverse actors that have an influence on larger scales. However, there are now some examples that apply this regional analysis concept such as the coal-neutral BedZed settlement in London (UK); the energy self-sufficient Gussing community (Austria); the carbon-neutral Venning neighbourhood (Belgium) and the energy self-sufficient Samso Island (Denmark).

The nZEB concept requires a precision of the physical space (Unión Europea, 2010) where energy will be generated from renewable sources (Sartori et al., 2012). Previous research has pointed out that RES can be in the construction (as photovoltaic panels on roofs), outside (energy that is managed from wind turbines inserted in the region) or as a combination (as when using biomass boilers located in the building, whose raw material comes from another territory) (Marszal et al., 2011). Each country defines its own indicator and amount of coverage generated by RES in buildings, and how much energy is preferable to provide through the national grid, also from renewable sources that can be operated on a country scale. Currently, there are several parameters that regulate the minimum use and even some countries such as France or the Flemish region of Belgium flexibilize compliance (Groezinger et al., 2014) See (Table 1). In Cuba, the goal is to cover 24% of energy consumption through RES by 2030 from a number of investments and development plans. However, there are still no indicators to define the generation in local and individual energy productions.

Table 1. *Main ways to regulate the use of RES in nZEB definitions in Europe (Groezinger et al., 2014)*

Variables	***Example of Region/Country***	***Example of adopted indicators***
Generation according to building area and RES type	*Flemish Region (Belgium)*	*The quantity varies according to the type of RES. For residential buildings, it must be ≥ 10 kWh/m^2 of useful area/year.*
	Ireland	*10 kWh/m^2/year (hot water and heating) and 4 kWh/m^2/year (electricity)*
Formulas from different scenarios	*Romania*	*In the National Plan, there is a formula and the different parameters to be included such as the shape and height of the buildings.*
	Lithuania	
Coverage percentage	*Bulgaria*	*15%*
	Cyprus	*25% (primary energy)*
	Denmark	*Between 51 and 56% (by 2020)*
	Germany	*It varies depending on the type of RES (between 15% and 50%)*
	Hungary	*25%*
	Italy	*50% (of the use of heating, air-conditioning and hot water)*
	Slovakia	*50%*
	Slovenia	*25% (of the final energy used)*
Permitted low conventional energy consumption	*Brussels-Capital Region (Belgium)*	*The requirement for the use of RES is not included in the nZEB definitions, but its use is implicitly required by admitting very low ranges of conventional energy consumption.*
	Denmark	
	The Netherlands	

The territory adjacent to the buildings should be taken into account, not only as a potential option to use RES, but also to evaluate the consumption that generally occurs in larger contexts such as transportation, road lighting, among other urban equipment and services (Hachem et al., 2012). Although some existing methodologies for classifying nZEBs may be appropriate for a group of buildings (Carlisle et al., 2009), more detailed research specifying the particular requirements for the assumption of "communities or cities with nearly zero energy consumption" should also be needed. A larger scale study would involve a different analysis of the differences between urban and rural contexts, different densities, and also the variety of urban morphologies, in the same way as on an architectural scale, requirements are specified independently, for example, for residential and office buildings.

nZEBs, as a concept, do not involve storing locally the energy that has been criticized for its high costs, environmental impact and the increase in energy embedded in buildings (Torcellini et al., 2006). The energy balance is generally based on the balance between the energy consumption taken from the grid and the amount injected from local generation. Using existing infrastructure also means that the national grid must adapt to the new circumstances as a smart grid as well as having new regulations defining this interaction with different producers and consumers. According to the National Statistics and Information Office of Cuba (from the Spanish Oficina Nacional de Estadísticas e Información de Cuba) (ONEI, 2016), 99.5% of the settlements in the country are connected to the electricity grid, so it is neither necessary nor economically efficient to make self-sufficient buildings. Although at present there are rural communities that are supplied through autonomous systems of small and medium power (Camejo and Ramos, 2011), the use of RES by individual entities and institutions is not a widespread solution. However, the current Law-Decree No. 345 will allow natural and legal persons to install technology for RES generation, which could favor the future development of nZEBs.

The importance of energy storage in the face of disasters was demonstrated in Japan, where an earthquake and tsunami occurred in 2011 (Kosai and Tan, 2017). Therefore, in the case of Cuba, it is also desirable to be able to store energy for reasons of security and stability due to extreme weather events that have seriously affected the national energy grid of the country for even months. Energy storage is also of great importance to reduce the "Electricity Peak Demand"[7] that could be increased with the use of photovoltaic systems between the period of their generation (which occurs during the day) and times with higher consumption, which occur between 5:00 pm and 9:00 pm. Energy storage, if developed on a community scale, could have a lower environmental impact and be more affordable.

Challenge 4: The solutions to improve energy efficiency cannot affect the comfort of spaces.

A key factor in the design of nZEBs is that they must consume much less energy than conventional buildings, ensuring quality and comfort. Indoor spaces must meet the

[7] Period of the day with highest values of electric energy consumption.

requirements for thermal, visual and acoustic comfort, the protection against electromagnetic radiation and air quality (Enescu, 2017).

As a result of the discussion of the nZEB directive in Europe, it has been shown that excessive insulation of the envelope to reduce energy consumption in the winter can lead to buildings that overheat in the summer, and especially in recent years as a result of climate change (McLeod et al., 2013). While this does not represent a major energy impact, it does lead to inadequate comfort standards for people in the summer. Therefore, countries like France, Denmark and two regions of Belgium have incorporated overheating indicators as an nZEB requirement.

Inadequate levels of air quality, due to the airtightness required to be energy efficient, has been widely discussed within the causes of the well-known "sick building syndrome" (Awbi, 2016). Also, incorrect levels of natural lighting in interior spaces due to a noticeable decrease in the windows area was another of the problems detected in the new nZEB designs (Janssens, 2018). The requirements of daylighting and air quality standards in most European countries have had to be updated in line with energy efficiency.

A trend also criticized has been the generation of "active buildings and passive occupants" by promoting complex automation systems to be efficient without the interference or decision making of people (Garde et al., 2014). This limits the "adaptive comfort" achieved by humans in modifying and adapting to the environment by, for example, opening or closing windows, changing clothes, modifying the physical activity or even having a cold or hot drink according to the thermal state they feel (Enescu, 2017). This emphasizes the importance of establishing comprehensive approaches that seek a balance between requirements that may be contradictory to each other.

Making decisions that reduce energy consumption without affecting comfort is a very complex task, starting from the fact that establishing what is considered comfortable depends on environmental parameters (humidity, temperature, light level), physiological characteristics (metabolic rate, age, health) of people, and even the customs of society (dress code, environmental commitment, comfort expectations) (Enescu, 2017); (Yang et al., 2014); (Djamila, 2017). The expectation must be to reduce energy consumption without affecting the user, and that the change in habits regarding the use of energy be the product of higher consciousness and not only the consequence of an imposed need.

Challenge 5: Succeeding in the implementation of an nZEB directive does not only depend on regulations on energy efficiency and renewable energy sources.

The definition of national and regional directives, as well as their implementation in each country of the European bloc, was born from promoting scientific and technological development in the energy branch and the environmental performance of buildings. In the field of nZEBs, the EU has promoted joint studies with universities and specialized centers to determine the feasibility and application of the new regulations, while private companies have increased investments in research in order to be competitive in the face of new requirements. The directive of energy efficiency of buildings is still under evaluation to achieve better results by 2030 (Unión Europea, 2016).

Moreover, the nZEB directives have been accompanied by a monitoring and evaluation mechanism to verify compliance with the requirements of the standards, both at the design stage and after construction. This has been made possible by having research centers, universities and specialized laboratories to perform simulations and measurements to verify compliance with energy efficiency solutions. This is obviously accompanied by a legal mechanism to penalize those people or entities that do not comply with the provisions.

The aspiration to achieve nZEB will change the way we design and build mainly due to the need for greater integration between equipment, the technology of the buildings and the design of their spaces (Attia, 2012); (Tsoutsos et al., 2013). Design methodologies will increasingly be directed towards performance-based design (Soares et al., 2017), in which the use of simulation programs will play a transcendental role in evaluating their impact, and architecture professionals will have to be more prepared in subjects related to engineering, physics, and modeling, in order to achieve appropriate communication in interdisciplinary work.

On the other hand, the aspiration to be more independent and energy efficient must lead to changes in financial mechanisms that allow high initial costs to be assumed by means of subsidies, tax reductions and loans, among other instruments (Aelenei et al., 2015).

4. Conclusions

Starting discussions on national definitions of "nearly zero energy buildings" would allow the integration of the various actions considered to reduce the energy consumption of buildings into a single approach.

The differences between all the factors that determine the energy balances allow reaffirming the diversity of options and peculiarity of each nZEB definition in Europe. This confirms that numerical comparisons between different solutions are not feasible without a deep understanding of the peculiarities of the balance methodology used. The European experiences also allow stating that the definition of the magnitude of nearly zero energy consumption is based on socio-economic assessments at the national level. These have to manage the technical possibilities and environmental conditions of each region or country to set pre-established standards.

The generation of energy through renewable sources will never be sufficient if the design of buildings and the equipment in which they are located are not energy efficient. For this reason, related regulations are needed to establish the minimum requirements of buildings and ensure human comfort.

The regulations to limit the energy consumption of buildings must determine the range of consumption and generation, the calculation method, the elements to consider in the energy balance, the metric of the balance, the conversion factors and the normalization of consumptions. It is not possible to aspire to standardized solutions or to similar *energy behavior, as standards must be flexible to take into account the differences given by the variety of architectural typologies and programs, the diversity of urban contexts, as well as the inherent restrictions involved in modifying existing buildings.*

Energy generation must have solutions at the national, regional and local levels in order to have diversified RES options, must make use of a national infrastructure better prepared for this consumption-generation interaction and must be able to carry out comprehensive analyses at different scales.

Succeeding in the aspiration of nZEB does not only depend on design standards for energy efficiency and renewable energy sources. It is also necessary to have investments in research, control mechanisms and evaluation of solutions; with financing possibilities for energy efficiency investments, as well as changing the methods and the way of teaching and designing buildings.

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