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Legal challenges in the implementation of Nearly Zero Energy Building (nZEB) in SPAIN

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ABSTRACT

Construction activities that include renovation work and energy retrofits add almost twice as much value as the construction of new buildings, and Small and Medium-sized Enterprises (SMEs) contribute more than 70% of the value added in the EU building sector. This article analyses the legislation associated to Nearly Zero Energy Buildings (nZEB) in Spain in order to identify the factors that will leverage their massive implementation. The paper is organized in three main sections: first one, it describes the geographical and social context of nZEB in Spain, then legislative requirements and policies are analysed; and finally, it identifies the training market penetration for nZEB.

KEYWORDS

nZEB, energy efficiency, sustainable building, renewable energy

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1. INTRODUCTION

The construction sector generates about 9% of European Gross Domestic Product (GDP) and accounts for 18 million direct jobs. Construction activities that include renovation work and energy retrofits add almost twice as much value as the construction of new buildings, and SMEs contribute more than 70% of the value added in the EU building sector (JCR,2015). Based on this, on 30 November 2016, the European Commission published the 'Clean Energy for All Europeans' documents (EUR-LEX, 2016), setting targets for (a) energy policy, (b) use of renewable resources (Bonomo et al., 2015), (c) energy efficiency measures and targets, and d) market design initiatives. The released package includes the proposal on the revised Energy Performance Building Directive (EPBD) and relevant articles of the Energy Efficiency Directive (EED) (article 4 is moved to EPBD). EPBD proposal sets renovation targets and minimum performance requirements for existing and new buildings (EUR-LEX, 2010). In this context, it has defined the Nearly Zero Energy Buildings (nZEB) concept, which corresponds to buildings with minimum demand requirements and integration of renewable energies to cover their energy needs (SMD, 2014).

The European Union set in 2009 the 20-20-20 targets regarding the reduction of CO2 emissions, the increase in the use of renewables and the increase in the energy efficiency (De Gregorio, 2016). One of the main implementation strategies in the construction sector refers to the nZEB concept, which is defined as: "nZEB is a building that has very high energy performance, determined in accordance with Annex 1 of the EPBD. The nearly zero or very low energy required should be covered to a very significant extent by energy from renewable sources, produced on site or near-by". The EU Directive establishes the necessity of each Member State to define a plan that includes the definition of nZEB, detailing the national, regional or local conditions and introducing a numerical factor to measure the building use of Energy, in kWh/m^2 per year.

In order to comply with this target, Spain shall adopt an energy efficiency obligation scheme based on a standardized negotiable energy savings certificate approach, which should be flexible and straightforward enough to ensure that there is a high administrative burden for neither the obligated parties nor the regulatory body. This programme is planned in two phases:

- Phase 1: Royal Decree 235/2013 (MP, 2013) approving the basic procedure to certify the energy efficiency of buildings with the incorporation of the basic procedure for certifying the energy efficiency of existing buildings, also taking into consideration the experience of applying this law over the past five years. The Royal Decree sets out the obligation to provide the buyers or users of buildings with an energy efficiency certificate that must include objective information about the energy efficiency of a building and reference values such as minimum energy efficiency requirements or CO2 emission. The Royal Decree sets out the obligation to provide the buyers or users of buildings with an energy efficiency certificate that must include objective information about the energy behaviour of a building and reference values such as minimum energy efficiency requirements, so that the owners or tenants of the building can compare and evaluate its energy efficiency. In addition, the decree includes the obligation for all buildings constructed after the 31st December 2020 to be nZEB, this date is advanced to the year 2018 for the case of public buildings.
- Phase 2: Official definition of nZEB to be approved by 2016-2017 so it could be applied, in a voluntary way, even before the normative is enforced both for public buildings (year 2018) and private ones (year 2020). On February 2016, the Royal Decree 56/2016 (MI, 2016) goes into force transposing EU Directive 2012/27/EU of the European Parliament and Council of 25 of October 2012, on energy efficiency in terms of energy audits, accreditation of service suppliers and energy auditors. This recently approved decree presents the nZEB concept as it is stated in the EU Directive 2010/31/UE, with no further details for its implementation or concrete requirement targets.

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2. GEOGRAPHICAL AND SOCIAL CONTEXT

Spain is located in the Westpart of Europe with a total area of 504.645 km2 with most of it concentrated in the Iberian Peninsula but also including two archipelagos: Balearic Islands, in the Mediterranean Sea, and Canary Island, in the Atlantic Ocean near the West African coast. Total Spanish population reaches 46.439.8664 inhabitants (NIS, 2015).

2.1 CLIMATE

Spain continental area lies between latitudes 36° 00' to 43° 47' N and longitudes 9° 18'W to 3° 19' E and presents 12 different climates zones for energy certification based on limiting energy demand. Winter division is designated by letters (A, B, C, D, E), while summer identification uses numbers (1, 2, 3, 4) (Fig.1). In general terms, the central part of the country has a continental climate, while the coastal areas have a more moderated climate, warmer in the case of Mediterranean coast. Also, extension and rain fall level varies in these areas as it has been analysed in the period from 1997 to 2007 (Tab. 1).
The Atlantic area has mild temperatures: between 12° and 15°C in the winter and 20-25°C in the summer period and the annual rain fall is above 1000 mm. The Mediterranean area has irregular rainfalls, between 400 and 700 mm per year and concentrated in the spring and fall, in the last period with a torrential behaviour. Winters are short and mild, while summers are long and hot. Average annual temperature is in the range 15°-18°C. Finally, the continental area has extreme temperatures: between 25° and -13°C. Winters are long and cold with average minimum temperatures up to -5°C, while in the summer temperatures exceed the 35°C, and even 40°C sometimes. Rainfall in continental zone is low, about 400 mm, in part in the form of storms during July and August (VVAA, 2011).

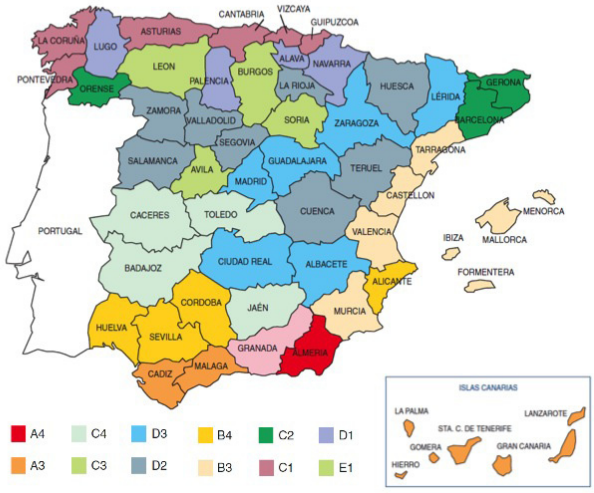

Figure 1.

Climate areas in Spain.

Area	Climate type	Surface fraction	Rain fall
North	Atlantic	10%	High (>1000 mm)
Central	Continental	70%	Low (500 mm)
South and East	Mediterranean	20%	Low but torrential (400 mm)

Table 1.

Historic rainfall level.

2.2 HOUSING STOCK

There are a total of 25.2 million dwellings in Spain, distributed, according to the 2011 census, as follows: 71.5% main dwellings (17,528,518 ones), 14.8% secondary dwellings (3,616,695) and 13.8% as empty and other dwellings (3,374,291) (IDAE, 2011).

In general dwellings are categorized based on usage, with 68.6% of dwellings regarded as multi-family (17,250,759 dwellings) and 31.4% as single-family (7,709,272 dwellings). Moreover, multi-family dwellings have greater weight among main dwellings (71.8% compared to 28.2% of single-family dwellings), while the opposite occurs in the secondary dwelling stock (where single-family dwellings total 46.9% compared to 53.1% of multi-family dwellings). In the case of empty dwellings, the distribution is practically similar to the distribution for the total (68.4% multi-family and 31.6% single-family dwellings).

Out of 18 million Spanish main dwellings, nearly half fall between 61 m2 and 90 m2 in size; 29.6% (5,354,920 dwellings) are between 76 m^2 and 90 m^2 and 18.6% (3,360,925) are between 61 m^2 and 75 m^2 (EIA, 2002).

Registered information of exploited land in 2013 (MD, 2014) makes it possible to differentiate the following dwelling types based on the use of the dwelling: shared (multi-family) in a block or open building, which accounts for 24.1% of the total national dwellings, shared (multi-family) in perimeter blocks, which accounts for 46.3% and, within single-family dwellings, detached and semi-detached homes, accounting for 10% of the total stock. Finally, terraced single-family dwellings or dwellings in a perimeter block (in a traditional urban area or a recent low-density development) reach to 19.6% of the total.

Within a total 25.2 million existing dwellings in Spain, nearly half (47.6%: 11,987,675) are in urban municipalities with over 50.000 inhabitants, with the remaining half distributed as follows: 15.7%

	NO OF PROPERTIES BY USES AND DECADE OF CONSTRUCTION												
	Before 1900	1900–1920	1921–1940	1941–1950	1951–1960	1961–1970	1971–1980	1981–1990	1991–2001	2002–2011	Since 2012 (*)	Other (**)	TOTAL
RESIDENTIAL													***23 142 267***
V - Residential	437 912	1 237 387	944 525	661 857	1 278 305	3 123 052	4 185 544	2 938 095	3 728 153	4 419 507	76 738	111 192	23 142 267
NON-RESIDENTIAL													***11 894 635***
TERTIARY, SERVICES AND PUBLIC FACILITIES													***1 967 237***
O - Offices	1 999	5 898	5 981	5 590	10 328	36 178	51 190	36 706	56 613	71 932	593	344	283 352
C - Commercial	13 401	36 134	35 686	25 735	59 062	211 028	280 036	213 446	235 776	181 623	2 356	1 076	1 295 359
K - Sports	177	704	597	823	1 779	5 872	12 874	13 846	11 620	8 777	240	617	57 926
T - Entertainment	147	433	380	303	425	666	904	765	707	380	10	183	5 303
G - Leisure and Hospitality	1 598	4 340	3 019	2 076	4 418	17 556	45 028	64 020	28 005	24 475	172	2 161	196 868
Y - Health and Charitable	424	1 147	1 137	958	1 506	3 993	8 346	7 886	6 483	5 133	117	252	37 382
E - Cultural	1 151	2 853	3 131	2 820	4 965	8 269	9 315	5 843	4 305	4 139	96	695	47 582
R - Religious	11 605	14 788	2 958	2 025	1 848	2 392	2 561	1 464	1 166	974	86	1 598	43 465
INDUSTRIAL													***1 703 522***
I - Industrial	106 613	272 072	120 087	80 468	90 744	152 938	231 222	202 719	207 094	155 928	2 149	81 488	1 703 522
WAREHOUSE - PARKING													***7 984 295***
A - Warehouse - Parking	24 156	74 466	46 550	33 266	61 810	263 439	1 005 188	1 166 184	2 159 091	3 092 778	49 344	8 023	7 984 295
OTHER													***239 581***
M - Urban design and gardening	3 205	9 213	3 349	2 037	2 004	3 878	35 541	6 130	10 975	30 064	922	39 771	147 089
P - Singular building	1 216	2 535	1 642	1 313	1 430	1 775	3 319	2 443	6 978	2 086	46	483	25 266
B - Agricultural warehouse	281	863	593	458	735	949	1 884	1 176	717	969	5	170	8 800
J - Agricultural Industrial	2 273	7 840	4 906	3 939	4 101	5 731	12 753	8 043	5 031	2 316	12	1 481	58 426
Z - Agricultural													

Table 2.

Categorization of buildings uses and construction decade.
Source: MD, 2014

in municipalities with 20.001–50.000 inhabitants (3,969,298 dwellings), 20% in municipalities with between 5.001–20.000 inhabitants (5,029,342 dwellings) and another 16.7% in municipalities with fewer than 5.000 inhabitants (4,222,297 dwellings).
According to the data from the 2011 census (NIS, 2014), among main dwellings, over three-quarters (78.9%) are owned, while just 13.5% (2,438,575) are rented and 7.6% are made available free of charge.
Addressing the characterization of the non-residential sector of the building stock, it is considered one last differentiation as key vis-à-vis the dwelling stock: energy use largely depends on the activities accommodated by these buildings, and since the types of activities are so variable, it is impossible to assume that there is a common benchmark pattern as there may be in residential buildings – in spite of the undeniable variety that exists among dwellings. Therefore it is considered decisive to form the segmentation of the non-residential buildings based on a differentiation by types of use.
Non-residential buildings can be also considered to check the relative importance of each group on the search for nearly zero energy buildings. The number of properties by uses and construction decade according to the land categories are shown at the following table. It may be deduced that more than 66% of buildings are residential (Tab.2).
Final energy consumption in Spain for residential and non-residential buildings in year 2011 shows the penetration of renewable sources in this sector, together with the gas (Tab.3).
Residential homes are responsible for almost 18% of the total final energy consumption. Using IEA data (IEA, 2017) it is possible to follow up the evolution of the energy consumption of the residential sector. It

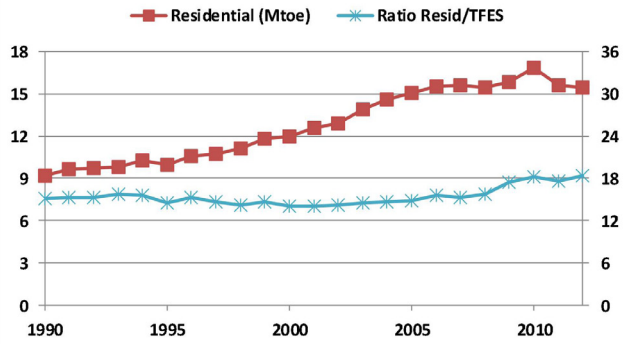

Figure 2.

Energy consumption in residential sector.

FINAL ENERGY CONSUMPTION (ktoe)	COAL	PETROLEUM	GAS	RENEWABLE ENERGY SOURCES	ELECTRIC POWER	TOTAL
INDUSTRY	1717	4356	7697	1256	6317	21344
TRANSPORT	0	33696	83	1721	388	35889
MIXED USE	198	5779	6220	2838	14237	29272
Agricolture	0	1518	466	70	359	2404
Fishing activities		0	0	0	0	0
Business, services and Pubblic	0	1355	1755	104	6992	10206
Residencial	122	2906	3411	2647	6545	15631
Other unspecified	76	0	587	17	351	1031
FINAL ENERGY CONSUPTION	1915	48832	14001	5815	20942	86505

Table 3.

Final energy consumption in Spain according to sectors (2011). Source: IDAE, 2011

Table 4.

Final energy consumption in the residential sector in Spain according to types of use (2011). Source: IDAE, 2011

Type of use	Coal	Petroleum Products			GAS	Renovables				Electric Power	TOTAL
		LPG	Liquid Fuels	TOTAL		Biomass	Solar	Geothermal	TOTAL		
	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe
Heating	12	388	2 033	2 421	1 695	2 368	10	6	2 384	380	6 892
DWH	1	459	183	642	1 566	50	129	3	182	385	2 776
Cooking	2	185	-	185	399	26	-	-	26	479	1091
Lighting	-	-	-	-	-	-	-	-	-	606	606
Air conditioning	-	-	-	-	-	-	-	3	3	120	123
Electrical household	-	-	-	-	-	-	-	-	-	3 188	3 188
Total	15	1 032	2 216	3 248	3 660	2 444	139	12	2 595	5 158	14 676

Distribution according to final energy fuel in heating	Dwelling type	
	Single family	Multi family
North Atlantic zone	MWh	MWh
Total petroleum product heating	2 145 662	862 921
Total gas heating	291 781	1 595 117
Total renowables heating	2 526 742	2 835
Total electricity heating	137 152	539 250
Total	5 101 336	3 000 123
Continental zone	MWh	MWh
Total petroleum product heating	8 145 127	8 950 298
Total gas heating	2 601 256	7 221 319
Total ronowables heating	10 806 596	4 427
Total electricity heating	480 435	1 181 465
Total	22 033 413	17 357 508
Mediterranean zone	MWh	MWh
Total petroleum product heating	5 977 658	1 480 953
Total gas geating	2 099 425	5 491 210
Total renowables heating	13 627 833	1 847
Total electricity heating	594 419	1 392 030
Total	22 299 335	8 366 040
Total	49 434 085	28 723 671

Table 5.

Distribution of consumption according to final energy fuels in heating by SEC-SPAHOUSEC climatic zones and dwelling type (single family/multi-family). Source: IDAE, 2011.

has not decreased during the last years of economic crisis (Fig.2).
In the case of residential homes, the types of use for the same year 2011 enables to consider energy consumption for heating as the key for establishing energy consumption in climate control, since energy consumption for cooling is marginal (accounts for less than 2% of energy consumption for climate control) (Tab.4).
The distribution of consumption according to final energy fuel in heating for the different climatic zones and dwelling type (single family/multi-family) is described in the table 5.
Energy use corresponding to residential sector in Spain accounted for 15.5 Mtoe in 2012 (IEA, 2017) .
This represents 18% of the total final energy use of the country. Taking into account the number of households, the average annual energy use for each household is approximately 10,604 kWh, and assuming that average Spain household size is 90 m^2, the numerical indicator for the typical energy use of the average Spanish household is 117,8 kWh/ m^2 per year.

3. LEGISLATIVE FRAMEWORK

This section will described current policies related to nZEB as well as building standards defined for energy efficiency.

3.1 CURRENT POLICIES

In order to comply with the target in Article 7 of Directive 27/2012/EU and in accordance with the provisions of paragraph 1 of this Article, Spain is adopting the Energy Saving and Efficiency Action Plan 2011-2020 (IEA, 2017) based on the standardised energy certification system.
Regarding to renewable projects, it has defined a special regime (i) Royal Decree 661/2007, regulating electrical energy production under the special regime, (ii) Royal Decree 1578/2008, on the compensation of electrical energy production using photovoltaic solar technology, and (iii) Article 4 and Section 2 of the Fifth Transitory Disposition of Royal Decree Law 6/2009, for the adoption of certain measures in the energy sector and the approval of the social bond ("RDL 6/2009"). Nevertheless, due to the crisis, some provisions have repealed, especially the pre-assignment mechanism. This mechanism was currently in suspension pursuant to provisions of Article 1.b) of Royal Decree Law 1/2012, which had suspended the compensation pre-assignment procedures and suppressed the economic incentives for new renewable, cogeneration, and waste-to-energy plants.
This unfavourable economic framework lead to other design approaches in nZEB (Forlani, 2015; Giordano, 2016).
Actual policies on nZEB are basically based on the abovementioned Royal Decree 235/2013 and the Royal Decree 238/2013, both published the same day, amending certain articles and technical instructions in the Regulations on Building Heating Installations (RITE) of 20 July 2007 to set out stricter requirements concerning the energy performance of heating and cooling equipment, as well as equipment used to move and transport fluids. This amendment arises from the need to transpose Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings into the Spanish legal system and the requirement set out in the Second Final Provision of the abovementioned Royal Decree 1027/2007 to carry out a periodic review at intervals not exceeding five years to keep it in line with the progress of technology and Community legislation.
The second decree regulates the energy efficiency and safety requirements that must be met by heating installations in buildings in order to address the requirements of personal well-being and hygiene. This law sets out requirements related to general energy efficiency, correct installation and sizing, appropriate control and adjustment of the installations that are present in existing buildings. Moreover, it establishes the inspections that must be carried out periodically on the accessible parts of climate control installations throughout their useful lives, in order to verify compliance with the energy efficiency requirement.

3.2 ENERGY EFFICIENCY BUILDING STANDARDS

The Spanish report on Energy Efficiency and Savings Policy Measures (ESE, 2013) breaks down final energy consumption in three sectors (industry, transport and residential, services and other). It uses ktoe units to measure and compare energy savings in 2010, 2011 and 2012, and contrasting their average with the savings targets set on final energy. Total savings target for the period 2014–2020 for Spain – excluding the transport sector– reaches the 21.305 ktoe and for the residential, services and other sector is 12.432 ktoe. In accordance with the possibility set out in Article 7(2) and (3) of the Directive, the cumulative savings target is reduced from 21.305 ktoe to 15 979 ktoe for the entire period between 1 January 2014 to 31 December 2020. Three different final energy consumption savings scenarios have been established for residential buildings (MD, 2014):

- a.1) Scenario 1. HIGH RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 32% of the average total final energy consumption for the years 2010–2012.
- a.2) Scenario 2. AVERAGE RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 26% of the average total final energy consumption for the years 2010–2012.
- a.3) Scenario 3. BASIC RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 7% of the average total final energy consumption for the years 2010–2012.

This last scenario for the residential sector would arise from extending, between 2014 and 2020, approximately, the direct subsidies already committed for improving energy efficiency in the building sector in the various plans and programmes already in force. In addition, it considers the application of an estimated percentage of new European funds 2014–2020 for subsidies for energy efficiency in the building sector (Tab.6).
However, in order to work with the reduction targets in the way to nZEB, it is necessary to recognize the functional logic in the factors that determine climate control energy consumption in buildings. The factors that determine climate control consumption in a building are:

- the use and management of the building and of its elements and systems;
- the energy demand, considering the energy losses due to transmission and the energy losses due to ventilation separately, if desired;
- the efficiency of the climate installations that satisfy the comfort demand;
- the source of the energy that is supplied to the building.

Residential building	Final energy consumption (ktoe)				Cumulative Savings 2014-2020	
	2010	2011	2012	Average	ktoe	%
Scenario 1. High Residential	16 924	15 648	15 512	16 028	5 077	32
Scenario 2. Average residential					4 088	26
Scenario 3. Basic Residential					1 044	7

Table 6.

Energy Efficiency Scenarios for Residential Buildings.
Source: SMD, 2014.

The rational order of intervention in case of separate actions over time is precisely the order in which they have been presented in the list. Normalized codes for these applications are not yet approved in Spain.

3.3 ACTUAL INSTRUMENTS TO PROMOTE nZEB

Currently in Spain there are no schemes promoting nZEB. Nevertheless, there are various schemes regarding the retrofit of domestic buildings towards energy efficiency.

- ICO (Official Credit Institute) Line for the 'Renovation of dwellings and buildings' (WEB 1). The line provides funding aimed at the self-employed, businesses and public and private entities, both Spanish and foreign, that make productive investments within Spain. The portion associated with renovation is aimed at addressing the funding requirements of individuals and homeowners associations, in order to undertake renovation or refurbishment projects on their homes and buildings, common elements and homes. The transactions are processed directly through the credit institutions.
- Institute for Energy Diversification and Saving (IDAE) PAREER Programme (WEB 2). The IDAE's PAREER Programme came about in order to encourage the implementation of integral energy efficiency saving and improvement actions, as well as the use of renewable energy sources, such as the renovation of windows, façades, roofs, boilers, air conditioning equipment, the incorporation of equipment to individually measure heating and domestic hot water consumption, replacing conventional energy with biomass or geothermal energy, etc. (WEB 3).

4. TRAINING MARKET

Given there is still no specific legislation in Spain referring to nZEB, no procedure is defined for the definition and accreditation of nZEB experts. However, several indicatives are in progress at the European level: MEnS (WEB 4) and PROF/TRACT EU (WEB 5) projects, which are developing Open Training Platforms and Qualification framework for professionals dealing with nearly zero energy buildings.
In addition, national strategies have been defined offering particular opportunities for growth and generation of employment in the construction sector. These strategies include a series of measures that need to be undertaken in the short term aimed to:

- Raise awareness and create a pro-renovation culture to create a positive impression of the energy renovation of the building stock. Any basic scenario could noticeably improve if the public were aware of renovation's potential in the improvement of their homes and dwellings, their quality of life, the energy bills they pay and in the revaluation of properties for their owners. At present, the current lines of public aid are not providing the right response, largely due to this lack of awareness and culture, which does already exist in other European countries.
- Develop business strategies with particular focus on the needs of homeowners associations. This would mean facilitating the restructuring of development/construction companies with a view to a new role as integral managers of renovation processes and changing the model of energy suppliers by influencing new emerging values.
- Define administrative measures logically associated with improving coordination between the three levels of public administration: State, regional and municipal. They are all involved in these policies and in the processes to implement the same, in different ways, but the objectives are shared. The coordination must prevent, as far as possible, any duplications or contradictions that could arise.

5. CONCLUSIONS

Spanish housing stock represents an opportunity to increase energy savings and equivalent CO2 emissions in the residential sector based on their large savings potential. Despite the fact that national legislation has included directives regarding minimum energy demand and integration of renewable energy sources in buildings, it is necessary to go a step further. Nearly Zero Energy Buildings (nZEB) concept should be implemented in new public building by 2018, while in the rest of building constructions will be mandatory by 2020. Nevertheless, specific targets and requirements for nZEB are still to be concreted. It is necessary to define a national nZEB roadmap to identify the final goal and intermediate steps in order to achieve a massive implementation of nZEB in Spain.

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